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York Park Conservation Area

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Executive Summary

SMEC Australia Pty Ltd has prepared this monitoring report on behalf of 22 Barton Pty Ltd to meet the requirement for the year 5 golden sun moth (*Synemon plana,* GSM) flying moth survey, pupae case search and vegetation condition assessment conducted in 2017, in accordance with the *Potential shading impacts on York Park golden sun monitoring plan* (RJPL 2014a).

The key results of the 2017 survey are:

- Flying GSM were recorded in low-moderate numbers during the 2017/18 flying season. GSM abundance was higher than 2013-2016 annual averages at both transects and at each rotational point during 2017.
- Detection rates of GSM pupae cases at York Park remain low. Three pupae cases were found in 2017.
- Vegetation composition and condition at York Park in 2017 was similar to the 2013 – 2016 annual averages; however, a lower diversity of both native and exotic species were recorded in 2017 in comparison with 2016. Weeds remain prevalent throughout the site.
- Data from the loggers deployed at York Park from July 2016 to December 2017 indicate that soil temperatures were more extreme and variable in both summer and winter in zone 1a than in other zones, likely due to substrate differences, and temperatures were slightly cooler during the shaded period in zone 1b than in zones 2a and 2b.

The key results of analysis of the potential impacts of shading are:

- Linear regression analysis did not detect any biologically and statistically significant decline in flying moth numbers at York Park correlated with the onset of shading.
- BACI analysis detected a potential decline in pupae cases at the impact site relative to the control site after shading, which may be indicative of an impact from shading. This effect was not statistically significant, and may be an artefact of the very low numbers of pupae cases recorded and the high level of inter-annual variation in pupae case detection relative to the low numbers detected. No biologically and statistically significant decline in pupae case numbers at York Park correlated with the onset of shading was detected.
- BACI analysis did not identify any biologically and statistically significant decline in vegetation condition at York Park correlated with the onset of shading.
- Graphical review indicates that shading of the impact area from 2015 onwards may have reduced soil temperatures within the impact zone during winter. There is, however, no evidence at this stage that this is adversely impacting GSM populations or NTG.

These analyses address potential impacts over two consecutive post impact seasons. The monitoring plan requires an additional year of monitoring before information required to address impact thresholds, or consideration of whether future monitoring is warranted, is addressed.

The key recommendations are:

- On-going monitoring and control of weeds at York Park, particularly perennial exotic grasses and St John's Wort.
- The continuation of GSM flying moth, pupae case and soil temperature monitoring in 2018 to provide a minimum of three post-construction monitoring events as required in the monitoring plan (RJPL 2014a)
- The Commonwealth reviews the effectiveness and necessity of pupae case monitoring, given the low detection rate and high inter-annual variation.

This report fulfils the reporting requirements for GSM monitoring at York Park for year 5, as specified in the monitoring plan (RJPL 2014a).

1. Introduction

SMEC Australia Pty Ltd prepared this monitoring report, on behalf of Section 22 Barton Pty Ltd, to meet the 2018 annual reporting requirements of the *Potential shading impacts on York Park golden sun monitoring plan* (RJPL 2014a).

The monitoring plan was developed to meet Commonwealth *Environment Protection Biodiversity Conservation 1999 Act* (EPBC Act) approval decision (EPBC 2012/6606) conditions for development of a hotel and carpark at Block 14 Section 22 Barton (14/22 Barton). The monitoring plan contains a detailed description of the site, proposed actions and monitoring procedures (RJPL 2014a).

This report presents the findings of the year 5 monitoring survey undertaken at York Park during the 2017/18 golden sun moth (*Synemon plana*) (GSM) flying season which consisted of GSM traverse and point counts, pupae case surveys and vegetation condition assessment.

Data from the first four years of monitoring are presented in the York Park Golden Sun Moth Monitoring reports as follows and, where relevant, have been referenced for comparison:

- 2013 survey report (RJPL 2014b)
- 2014 survey report (RJPL 2015)
- 2015 survey report (SMEC 2016)
- 2016 survey report (SMEC 2017).

As recommended in the 2013 monitoring plan (RJPL 2014a), a BACI analysis was undertaken following the 2017 survey to compare potential differences in floristic scores and pupae case numbers between the 2013-2014 surveys and the 2016-2017 surveys.

2. Methods

2.1. Regional GSM Observations

ACT researchers and consultants coordinate as an informal monitoring group and annually share information regarding the timing and location of GSM sightings, particularly in relation to the start of the GSM flying season, in the ACT region.

Informal communications were exchanged between group members regarding the start and finish of the flying moth season. General observations on population numbers compared with previous seasons and current weather conditions were also conveyed.

2.2. Flying Moth Surveys

As specified in the monitoring plan (RJPL 2014a), flying GSM surveys were conducted in a manner consistent with the ACT Government (2010a) GSM survey guidelines and with the annual monitoring approach presented in Umwelt (*in prep*, final report not provided), as follows:

- Flying GSMs would be counted along two 100 m transects along the long axis of York Park (Figure 1) and recorded as number of GSM per 100 m transect.
- The transect survey would be undertaken three times approximately half an hour apart during each survey day.
- To compare baseline GSM activity levels with post-shading GSM activity levels, two sets of rotational point counts, involving 10 repeated, 30 second rotational counts, would be conducted at one site in the centre of the York Park GSM site between the transect surveys (Figure 1). All GSM seen in a radius of 25 m are to be recorded. Any individuals that re-crossed the observer's visual path were double counted. Averages were calculated from the ten rotations at each point to provide number of GSM per 30 second rotation. Data recorded using this approach is comparable with data collected during the year 1, year 2, year 3 and year 4 surveys (RJPL 2014b, RJPL 2015, SMEC 2016, SMEC 2017).
- To compare activity levels in the northern and southern ends of the York Park GSM site, two sets of rotational point counts, involving 10 repeated, 30 second rotational counts, would be conducted at two sites approximately one third and two thirds of the way along the centre line of York Park GSM site between the transect surveys (Figure 1), i.e. approximately 25 m from each end. All GSM seen in a radius of 25 m are to be recorded. Any individuals that re-cross the observer's visual path would be double counted. Averages were calculated from the ten rotations at each point to provide a number of GSM per 30 second rotation.

The start of the GSM flying season was confirmed using known reference sites in the ACT, including York Park, and consultation with the ACT GSM monitoring group. In practice, suitable daily weather conditions determine repeat survey timings and shorter survey return times of no less than 3 days may be applied.

- Other on-site weather data was recorded during all flying GSM field surveys to assist with interpreting the GSM survey results annually. The following data was recorded during flying moth surveys:
- wind speed and direction
- air temperature
- cloud cover.

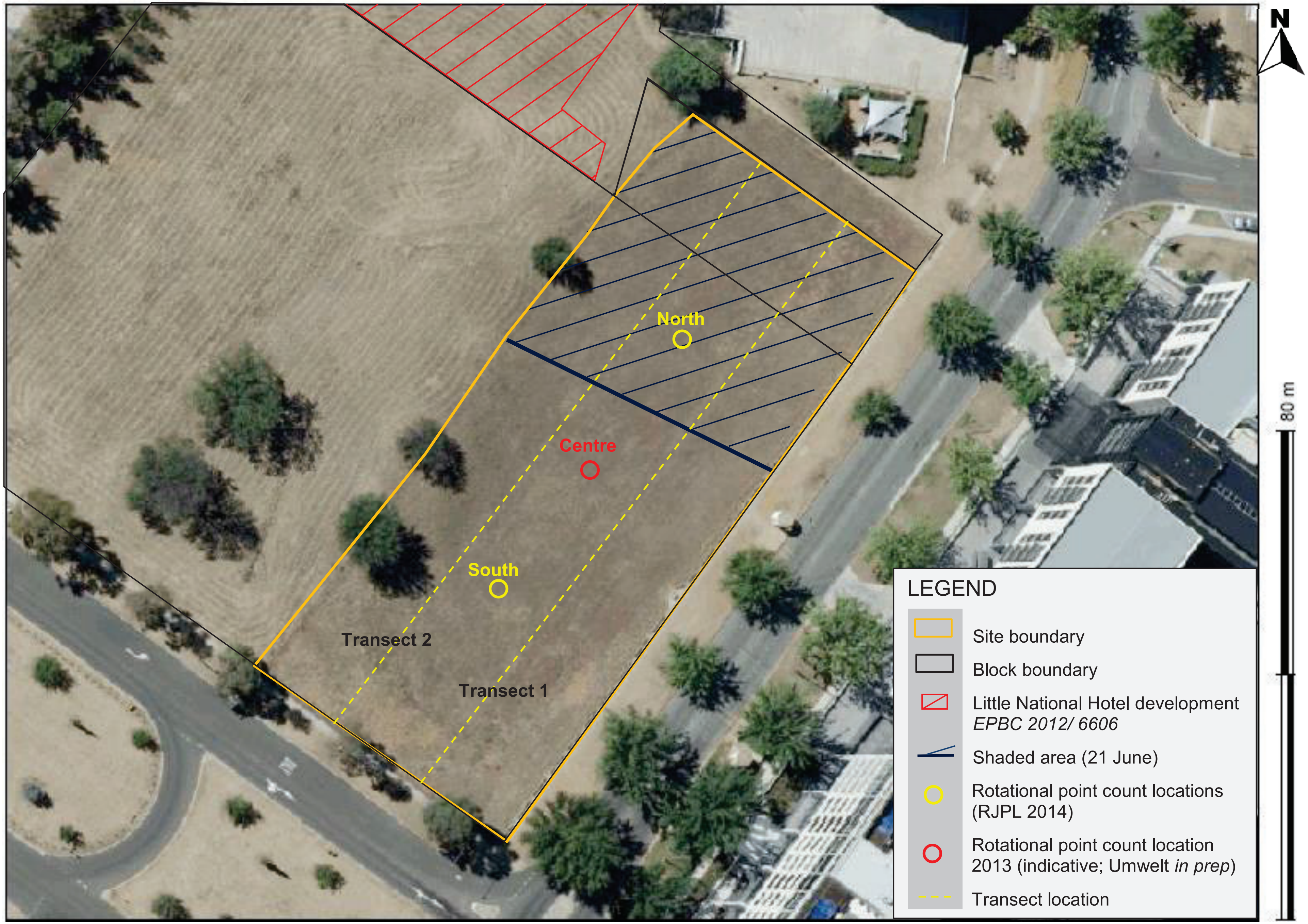


Figure 1. Location of flying GSM surveys at York Park.

2.3. Survey Area and Quadrat Placement

The survey area defined in the monitoring plan (RJPL 2014a) incorporates the York Park GSM site, and excludes the area now developed for road access to 14/22 Barton and areas of exotic perennial grasses and native *Poa* and *Themeda* plantings (Rowell 2012). As specified in the monitoring plan, the site is stratified into the following four zones for the pupae case surveys and vegetation assessments:

- Zone 1a: shaded by the development at 14/22 Barton (impact)
- Zone 1b: shaded by the development at 14/22 Barton and potentially shaded by the proposed development at Part 3/22 Barton (impact)
- Zone 2a: unshaded by the proposed development at 14/22 Barton and unshaded by the proposed development at Part 3/22 Barton (control)
- Zone 2b: unshaded by the proposed development at 14/22 Barton but potentially shaded by the proposed development at Part 3/22 Barton (control).

Twenty-four, 1 m^2 quadrats were established across the site at the beginning of the year 1 baseline survey season (RJPL 2014b). Each of these locations was approximately relocated using GPS locations and the map provided in the monitoring plan (RJPL 2014a). Plots were marked using wire pegs and plastic tags installed flush with the ground to permit relocation of the quadrats for repeat sampling during the season. All plot markers were removed at the end of the season. Figure 2 shows the York Park and GSM transect and plot locations and quadrat placement.

2.4. Pupae Case Monitoring

Pupae case surveys were conducted as specified in the monitoring plan (RJPL 2014a). Pupae cases were counted in each of the 24 quadrats approximately every two weeks over a six-week period (i.e. 3 times) during the GSM flying period from early-to-mid November until late December. All cases detected were removed for identification, also ensuring that individual pupa cases were not double counted.

2.5. Vegetation Monitoring

Data recorded for each quadrat included:

- all species present
- the dominant species (single or multiple)
- cover / abundance (%) using the Braun-Blanquet cover / abundance classes outlined in ACT Government (2010b).

Annual floristic value scores were calculated from abundance data based on Rehwinkel (2007) consistent with ACT Government (2010b). The method to calculate floristic value scores, which underpin the classification of native grassland quality, was revised in 2015 (Rehwinkel 2015); however, to allow comparisons with previous years, the 1 x 1 m quadrats were assessed using the previous floristic value score method of Rehwinkel (2007).

Figure 2. York Park GSM site pupal case and vegetation plot locations.

2.6. Analysis of Monitoring Data

All analyses were conducted in program R 3.4.3 (R Development Core Team 2017), under the assumption of independence and equal variance. Normality was tested using a Shapiro Wilk test and review of Quantile – Quantile Plots. Where normality was rejected, log transformation of data was trialled to determine whether normality was achieved. If normality was rejected for both un-transformed and log-transformed data, analyses proceeded using un-transformed data, and the violation of assumptions was noted.

The difference between the mean number of pupa cases found in the control and the impact areas recorded before and after shading is the BACI contrast.

To determine the effects of shading across the two periods for the number of pupa cases and the average floristic value scores, a two-sample t test was applied. The two-sample t test was applied due to the equal variance in the data and the small sample size. ANOVA was considered, as part of the analysis; however, was not reported due to the small sample size.

GSM population trends, as measured using the central point count and transect surveys from 2013-2017, were examined through regression analysis. We tested whether there was evidence of a difference in the mean response of the average GSM numbers between the before and after period. Data was assessed for normality and tested for autocorrelation.

Data from the 2015 surveys was excluded from the analysis and regression analysis as moths emerging during this period would have been present in the ground as larvae for one year prior to shading and one year subsequent to winter shading due to the Little National Hotel. Data from 2015 is included in graphs for visual comparison of between-year variability in GSM abundance, number of pupae cases and average floristic scores.

For all analyses, statistical significance was determined at the $\alpha = 0.05$ level. The 95% confidence intervals for the model were examined. When 0 was within the confidence intervals, no statistically significant deviation from 0 was recognised, and there was consequently no evidence of a shading effect.

2.7. Soil Temperature Monitoring

On-site soil temperature monitoring in shaded and un-shaded areas commenced using in-ground TidbiT v2 Temperature Loggers on 28 June 2016. Thermocron iButton temperature loggers previously installed had demonstrated a high failure rate and became unusable following a conflict with upgraded Thermocron software, and were subsequently replaced. Temperature logger data was recovered on 9 January 2017 and loggers were then reinstalled.

2.8. Meteorological Data

Meteorological data from Canberra Airport was obtained for the period 2013 to 2017 to assist in the interpretation of potential shading impacts.

3. Results

3.1. Regional GSM Information

The first report of GSM during the 2017/18 season was of 100 males at Jerrabomberra East Grasslands on November 2. By the second week of November (i.e. 6–12) GSM were flying at several sites in the ACT. The start date of the 2017/18 flying season is approximately a fortnight earlier than the 2015/16 and 2016/17 seasons but comparable to the four flying seasons prior to 2015. Due to high rainfall conditions in the last week of November and the first week of December, GSM were not regularly flying in this area. GSM were detected flying in northern ACT until 17 January 2018.

3.2. Flying Moth Surveys

Flying GSM were surveyed according to the method specified in the monitoring plan (RJPL 2014a) on three occasions during the GSM flying period. GSM survey dates and weather conditions are presented in Table 1. All surveys were conducted whilst wind speeds were below 15 km/h and the air temperature was 22-32°C.

Table 1. Site conditions during flying GSM surveys.

Date	Max temperature (ºC)	Last rainfall (mm)	Wind Speed (km/h)	Cloud cover (0-Nil, 8-Full)
10/11/2017	22.0	18.6 (7/11)	<5	1
1/12/2017	26.0	0.2 (29/11)	5-15	7
10/12/2017	31.2	6.2 (8/12)	5-15	0

GSM were recorded in low-moderate numbers on both transects when observed numbers are averaged across the three surveys. GSM abundance was highest during the survey conducted on 10 November during which up to 39 GSM were observed on Transect 2 (*cf*. 15 on 1 December; and seven on 10 December). A summary of the transect survey results and rotational point counts are presented in Table 2 and Table 3. Raw data from the 2017 flying moth surveys are presented in Appendix A.

Table 2. Summary of flying GSM numbers - Transect surveys.

Transect	Transect location	Average number of moths
Transect 1	East	11.9
Transect 2	West	14.7
Combined		13.3

Table 3. Summary of flying GSM numbers - Point count surveys.

Location	Average number of moths	Range
North East Point	2.6	0-12
Centre Point	5.3	0-19
South West Point	3.2	0-9

Flying moth numbers recorded during the 2017 flying season were higher than or equivalent to the 2013-2016 annual average flying moth numbers (SMEC 2016). GSM numbers at transect 2 were much higher in 2017 than during the previous four flying seasons whilst numbers at transect 1 were similar to the past three flying seasons. At each of the three rotational survey points, GSM numbers were higher in 2017 than the 2013-2016 annual average flying moth numbers.

3.3. Pupae Case Surveys

Pupae case surveys were conducted according to the method specified in the monitoring plan (RJPL 2014a) on three occasions. Surveys were undertaken on 24 November, 8 December and 21 December. Three pupae cases were located in 2017 (*cf*. 6 in 2016). The locations of pupae cases detected are shown in Figure 3. A summary of the pupae case survey results for the control and impact zones is presented in Table 4.

Table 4. Summary of the pupae case surveys within control and impact sites.

Zone	Number of pupae cases	Average pupae cases per plot
Zone 1a	1	0.1
Zone 1b	0	0
Zone 1 (impact)	**1**	**0.1**
Zone 2a	1	0.1
Zone 2b	1	0.3
Zone 2 (control)	**1**	**0.2**

3.4. Vegetation Surveys

Dominant species, percentage cover and complete species lists, including Braun-Blanquet abundance scores, were recorded and calculated for each quadrat. Vegetation summary statistics for each of the four zones are presented in Table 5. The floristic score for Zone 1 plots were slightly lower than for plots in Zone 2 despite the higher average number of native species per plot within the former. The number of exotic species per plot was similar in both zones, whilst vegetation cover was slightly higher in Zone 1. A list of species presence / absence during 2017 is presented in Appendix D in relation to the overall York Park flora species list collated by Rowell (2012) and RJPL (2014a). A summary of the floristic values for each plot is presented in Appendix F. Figure 3 shows the locations of quadrats with floristic value scores of greater than 4.

Table 5. Vegetation survey summary for the control and impact sites.

Zone	Floristic score		Native species	Exotic species	Cover (%)
	Average	Maximum	Average number		Average
Zone 1a	2.2	8	4.9	5.4	83
Zone 1b	1.3	2	4.0	5.0	83
Zone 1 (impact)	**2.0**	**8**	**4.7**	**5.3**	**83**
Zone 2a	3.7	11	3.8	5.6	76
Zone 2b	1.7	4	3.7	5.3	63
Zone 2 (control)	**2.3**	**11**	**3.8**	**5.5**	**73**

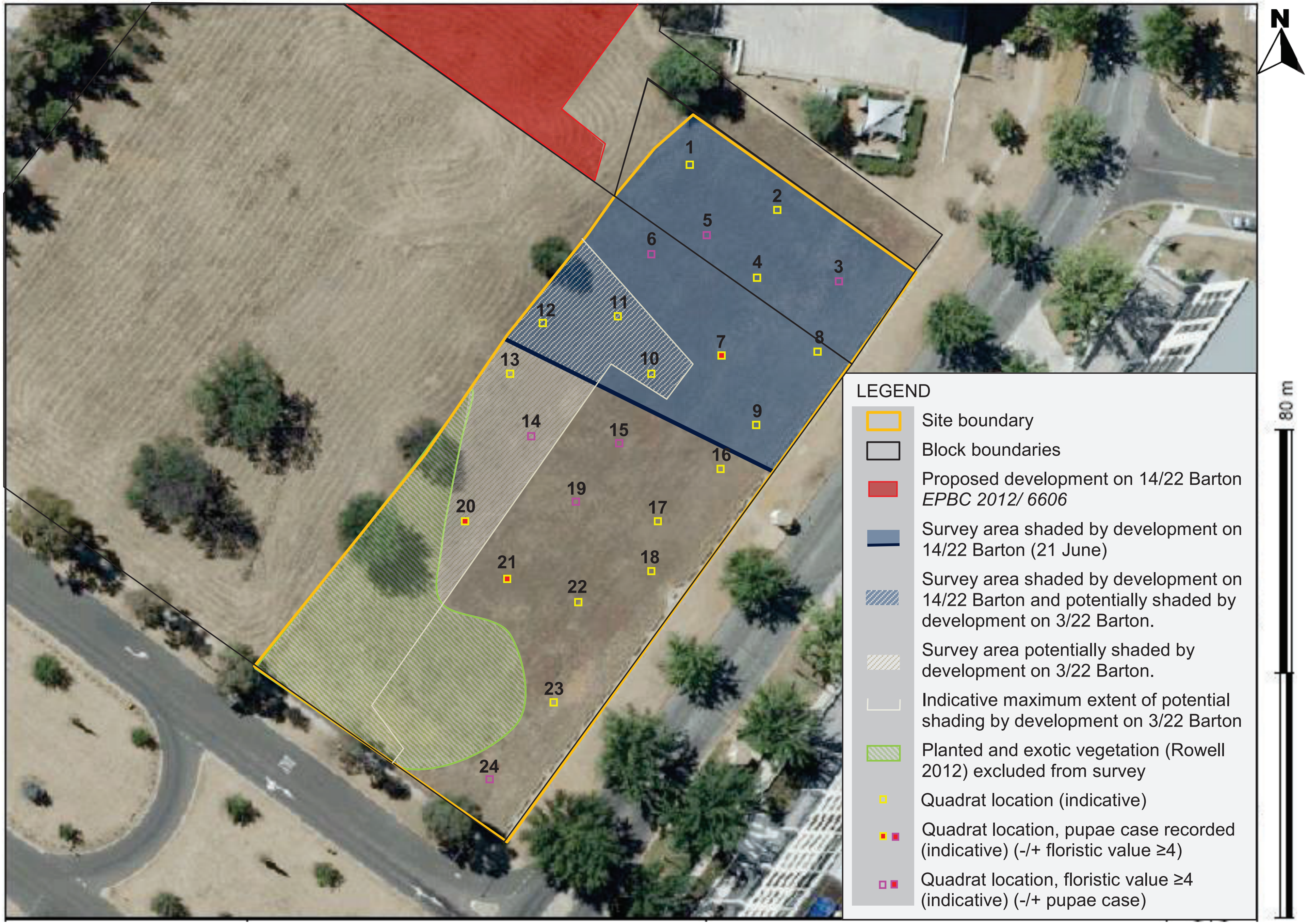


Figure 3. Location of pupae cases and vegetation quadrats with the highest floristic diversity.

3.5. Multiple Year Analyses

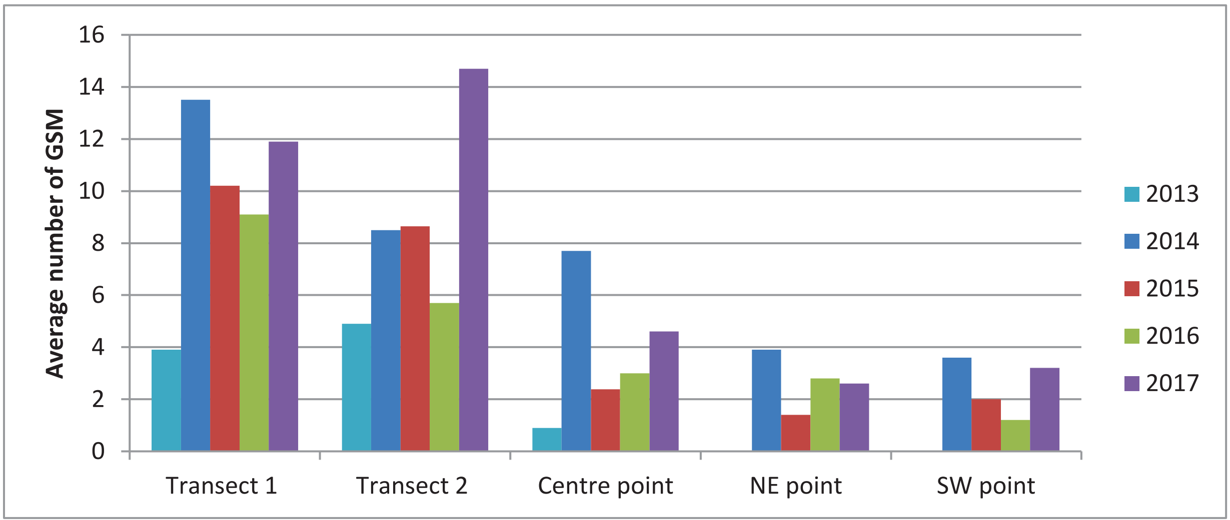
3.5.1. Flying Moths

Table 6 presents the annual average flying moth data for 2013-2017 from the transect and rotational point count surveys. No trends are apparent from graphically displayed data in Figure 4. GSM were particularly abundant during 2014 and 2017, while 2013 was the poorest year for flying moths. Years 2015 and 2016 were otherwise modest in the number of flying moths recorded along the transects or at the rotational point count sites.

Table 6. Average GSM numbers observed on transect and rotational point surveys, 2013 - 2017.

Transect*		2013	2014	2015	2016	2017
Transect 1 (East)		3.9	13.5	10.2	9.1	11.9
Transect 2 (West)		4.9	8.5	8.65	5.7	14.7
Centre point		0.9	7.7	2.38	3	5.3
NE Point			3.9	1.4	2.8	2.6
SW Point			3.6	2	1.2	3.2

** Note NE point and SW point were not surveyed in 2013.*



**Note: NE point and SW point were not surveyed in 2013*

Figure 4. Average GSM numbers observed on transect and rotational point surveys, 2013 - 2017.

Figure 5 and Figure 6 present the average variation in flying moth abundance along transects and at the rotational point count location respectively, for the years before and after the hotel was built. The regression analysis fails to reject the null hypothesis (H_0) which indicates that there is no change in the number of GSM recorded at the monitoring transects ($R^2 = 0.25$, $F(1,2) = 0.1$, $p = 0.92$) or at the central rotational survey point ($R^2 = 0.01$, $F(1,2) = 0.16$, $p = 0.73$) before and after shading at York Park.

Although GSM abundance at York Park has fluctuated since 2013, the overall population appears to be relatively stable. Due to the absence of data for 2013, no trend analysis of GSM abundance at the north-east and south-west rotational survey points was undertaken. A comparison of results from these two survey points by year is discussed in Section 4.1.

The lack of a statistically relationship between the average flying moth abundance for both the monitoring transects and the central rotational survey point according to the regression analysis, does not necessarily confirm that the shading has not, or will have, an effect on flying moth abundance.

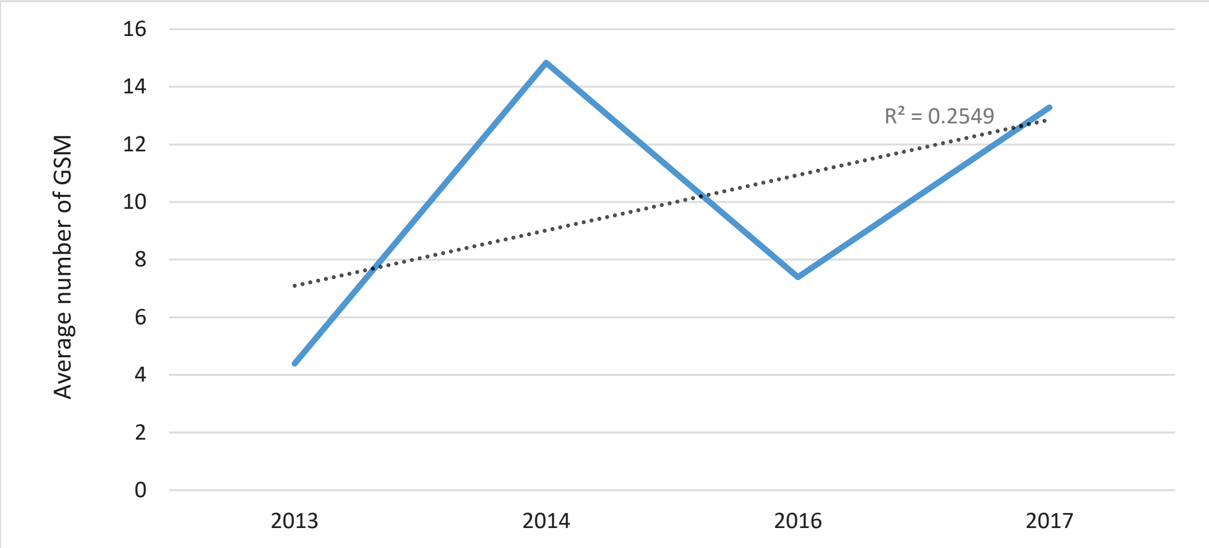


Figure 5. Average number of GSM recorded on transects (2013-2014, 2016-2017).

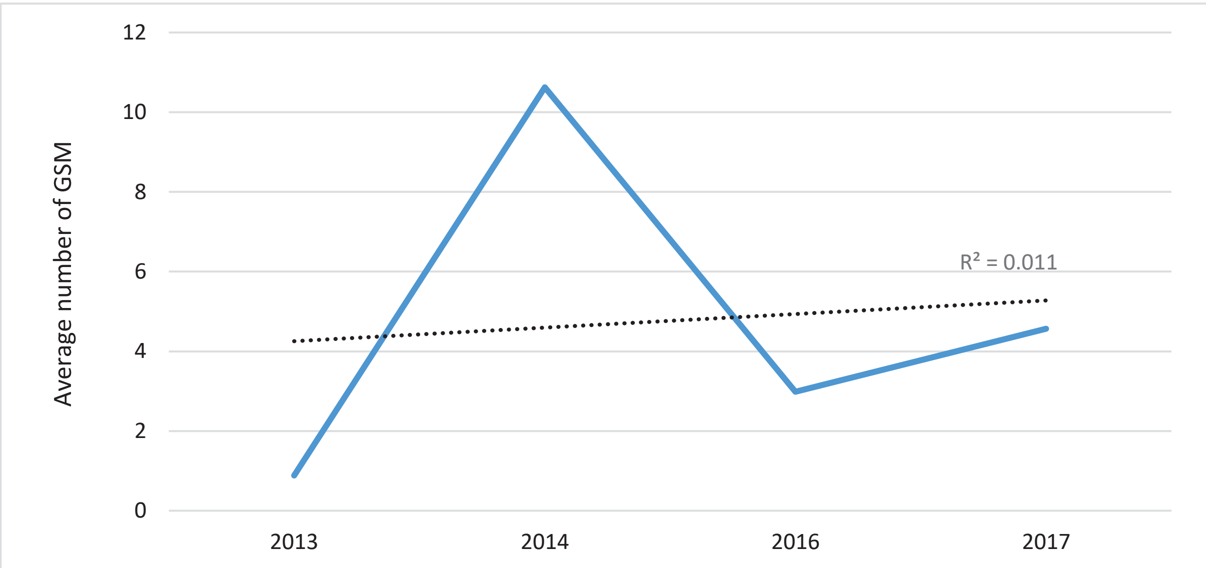


Figure 6. Average GSM numbers recorded at the central rotational survey point (2013-2014, 2016-2017).

3.5.2. Pupae Cases

Three pupae cases were detected during the 2017 search compared with six pupae cases recorded in 2016, six in 2015, three in 2014 and two in 2013 (Table 7, Figure 7). Two pupae cases were located in the control zone in plots 20 and 21 respectively whilst the third pupae case was located in the impact zone in plot 7.

The number of pupae cases recorded in the control and impact zones during the before and after shading periods is presented in Table 7 and Figure 8. An average of 1 pupa case was recorded per year in the impact zone prior to 2015 compared with an average of 1.5 pupa cases per year after shading of this zone. An average of 2 pupa cases were recorded per year in the control zone prior to 2015 compared with an average of 3 pupa cases per year after 2015.

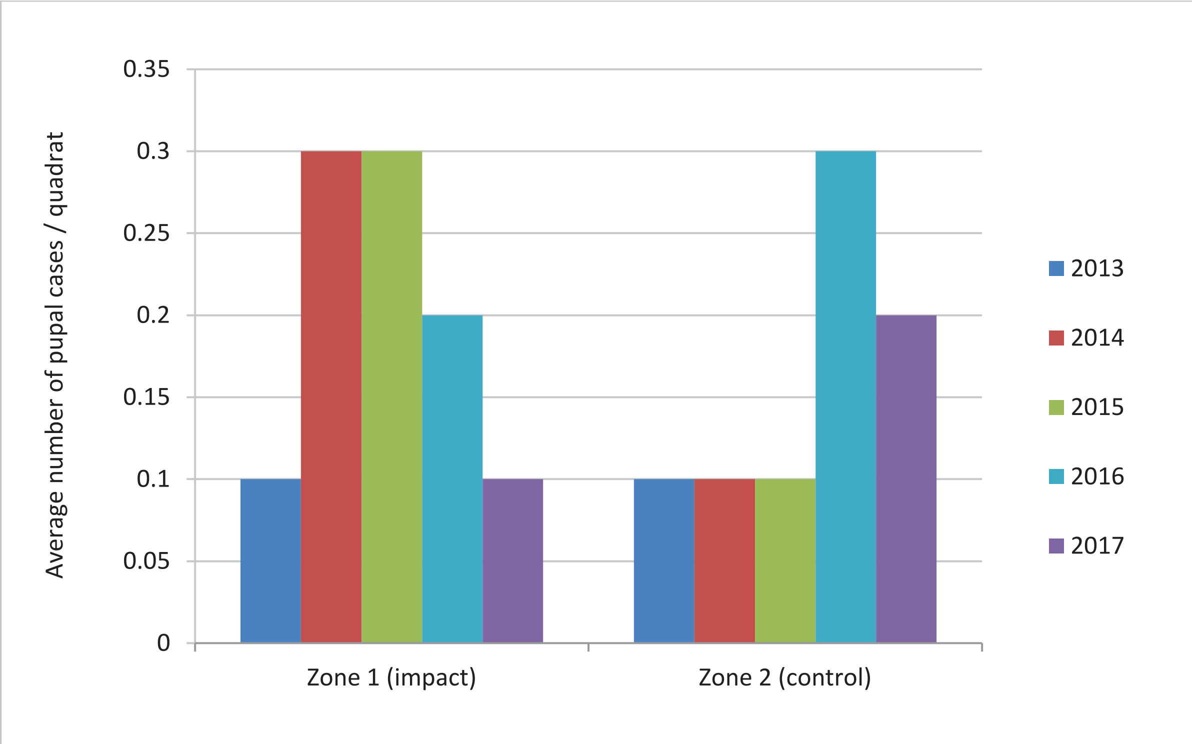


Figure 7. Average number of pupae cases recorded per quadrat in the impact and control zones.

Table 7. Number of pupae cases recorded in the impact and controls zones from 2013 to 2017.

Year	Zone	Total number of pupae cases
2013	Impact	1
2013	Control	1
2014	Impact	3
2014	Control	1
2015	Impact	4
2015	Control	2
2016	Impact	2
2016	Control	4
2017	Impact	1
2017	Control	2

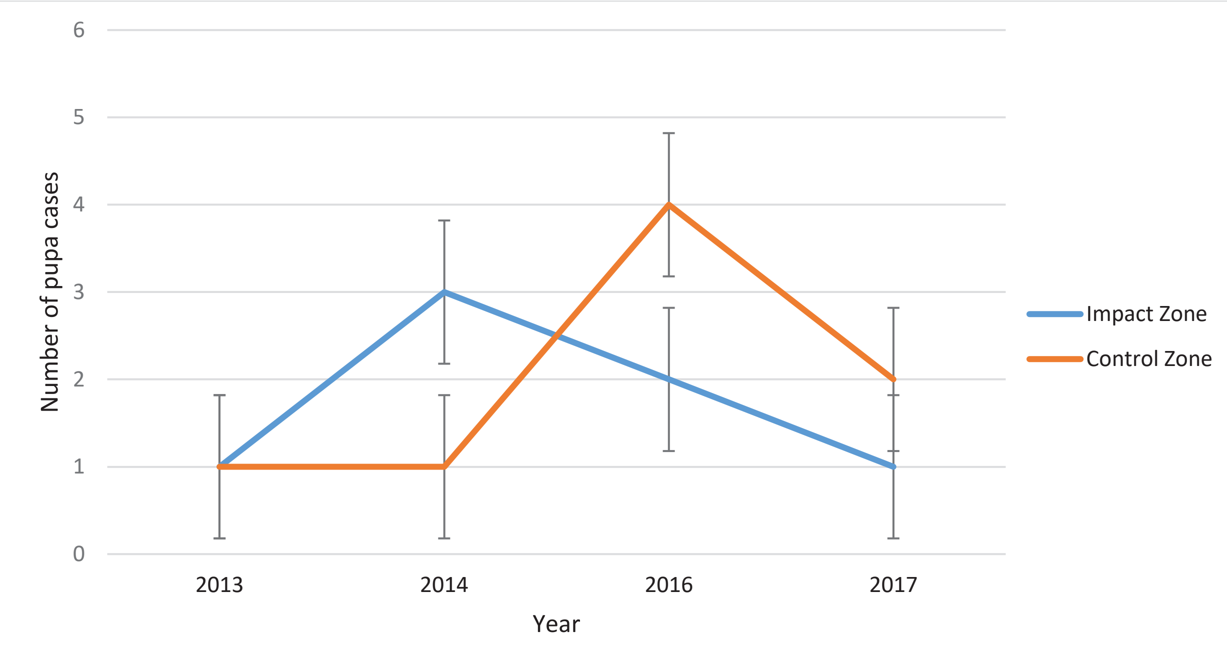


Figure 8. Total number of pupae cases recorded before (2013-2014) and after (2016-2017) potential shading.

The Shapiro Wilks test of normality rejected the null hypothesis of normal distribution (W = 0.80, p=0.03). Square root transformed data was also tested and was also confirmed not to be normally distributed; analyses proceeded despite the breach of this assumption.

The difference of the two changes in mean number of pupae cases at the control and the impact areas that occurs between the before and after periods (Before M^{diff} = 1.0, After M^{diff} = -1.5), indicates a decline in pupae cases detected at the impact site relative to the control site between time periods (BACI Contrast = -2.5, SE = ±0.89). The standard error interval of the BACI contrast does not include 0, indicating that there may be a difference response between the control and the impact areas.

The two-sample t-test of the null hypothesis (H_0) (i.e. that there was not a significant difference between the mean number of pupae cases at the control and the impact areas recorded before and after shading at York Park) failed to be rejected (t = -2.2, p = 0.15, CI^{min} = -7.31, CI^{max} = 2.31), which indicates that shading at York Park is unlikely to have had a significant effect on the number of pupae cases recorded in the impact and control areas between the two periods (i.e. before vs. after). Figure 8 indicates a high level of yearly variation in the total number of pupae cases recorded, making it difficult to detect an effect.

3.5.3. Vegetation

Table 8 and Table 9 present the average and maximum floristic scores and average number of native and exotic species for plots in the impact and control zones respectively. During 2017, the average floristic score in both the impact and control zones was lower than in 2016 but similar to the 2013-2016 annual averages (Figure 9 and Figure 10). Native species diversity in the impact and control zones in 2017 was lower than the past four years. Both native and exotic species diversity was lower in 2017 than in 2016 in the impact and control zones.

The average floristic value score of the impact zone prior to 2015 (i.e. 1.5) was slightly lower than after shading of this zone (i.e. 2.2) (Figure 11). The difference in the average floristic value score of the control zone pre-2015 (i.e. 1.3) and post-2015 (i.e. 2.4) was slightly greater than the observed difference in the impact zone.

Table 8. Summary of vegetation condition indicators in impact zone plots (2013-2017).

Year	Average Floristic Score	Maximum Floristic Score	Average number of Native sp.	Average Number of Exotic sp.
2013	1.6	5	5.7	5.3
2014	2.2	4	6.2	8.2
2015	1.4	4	5.2	5.3
2016	3	7	7.1	6.9
2017	2	8	4.7	5.3

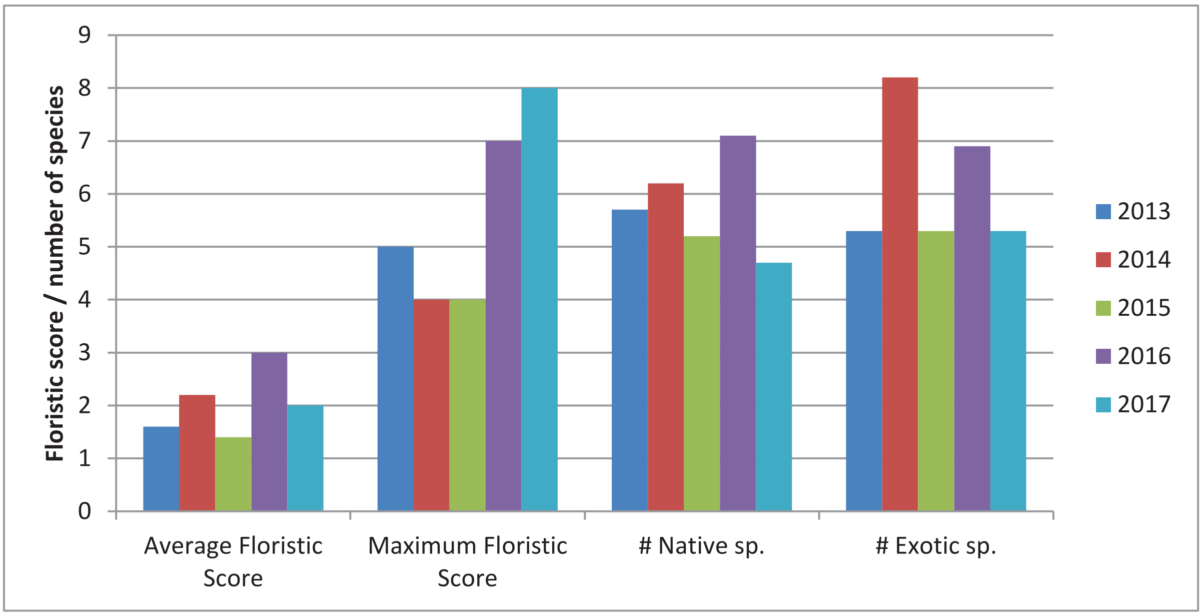


Figure 9. Comparison of impact zone vegetation statistics from 2013 to 2017.

Table 9. Summary of vegetation condition indicators in control zone plots (2013-2017).

Year	Average Floristic Score	Maximum Floristic Score	Average Number of Native sp.	Average Number of Exotic sp.
2013	2.00	11	4.8	4.3
2014	3.90	15	5.2	7.7
2015	0.25	2	3.7	5.7
2016	2.60	11	5.2	7.0
2017	2.30	11	3.8	5.5

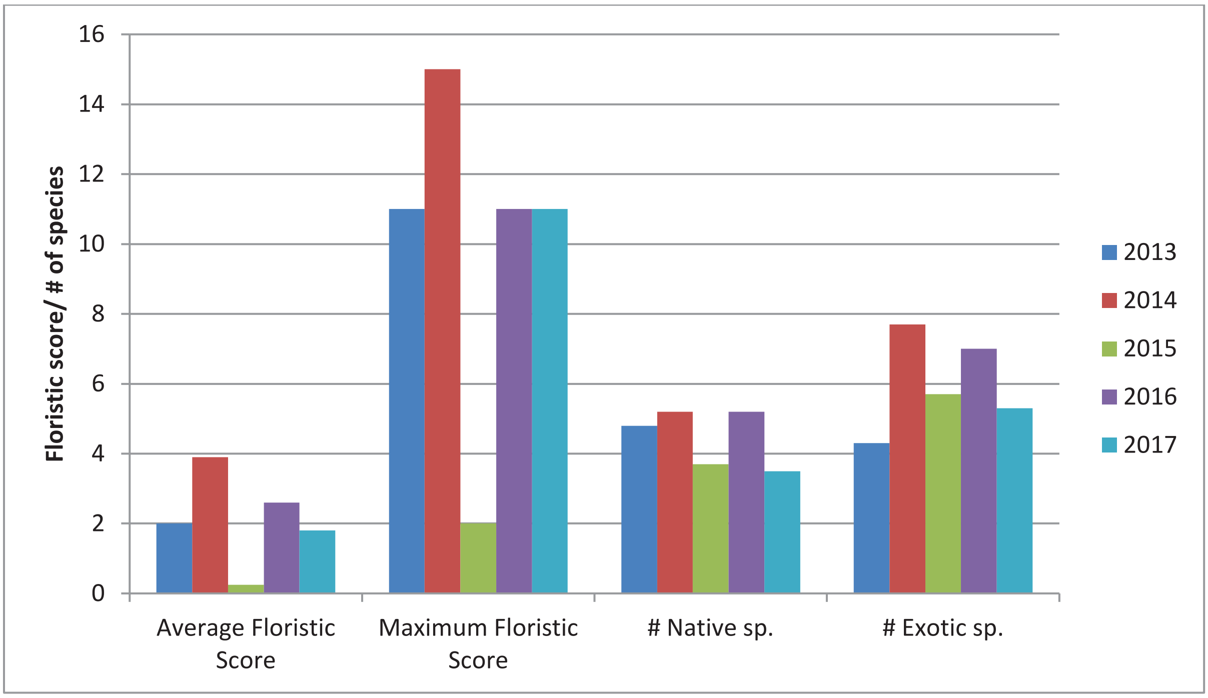


Figure 10. Comparison of control zone vegetation statistics from 2013 to 2017.

The Shapiro Wilks test of normality supports the null hypothesis (H_0) for normal distribution (W = 0.85, p=0.11); however, the review of the Quantile – Quantile Plots suggest non-normality. Log transformed data was also tested and was also confirmed not to be normally distributed; analyses proceeded despite the breach of this assumption.

The difference of the two changes in the mean floristic value scores for the control and the impact areas that occurs between the before and after periods (Before M^{diff} = 0.4, After M^{diff} = -0.2) is a small negative increase (BACI Contrast = -0.58, SE = ±1.24). The BACI contrast standard error interval includes 0, and consequently this value is consequently not considered to represent any trend.

The two-sample t-test of the null hypothesis (H_0) (i.e. that there was not a significant difference between the mean floristic value scores for the control and the impact areas, recorded before and after shading at York Park), failed to be rejected (t = -0.73, p = 0.54, CI^{min} = -4.03, CI^{max} = 2.86) which indicates that shading at York Park has not had a significant effect on the floristic values score between the two periods (i.e. before vs. after) (Figure 11).

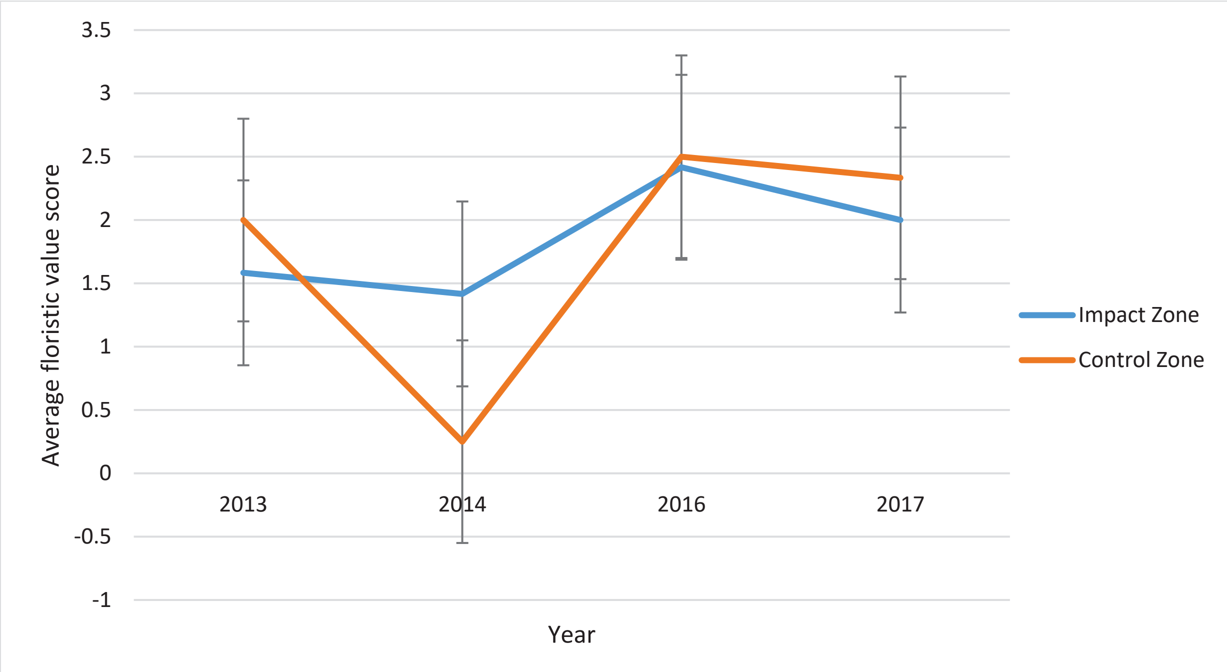


Figure 11. Average floristic scores before (2013-2014) and after (2016-2017) potential shading.

3.6. Soil Temperature Monitoring

The four soil temperature loggers at York Park were retrieved on 9 January 2018 and data from the previous 20 months downloaded. Loggers were then redeployed in the same positions on the same day. The daily maximum (i.e. at 3:00pm) and minimum (i.e. at 6:00am) temperatures recorded by the loggers are presented in Appendix G. Mean daily minimum temperature and mean daily maximum temperature by month are presented in Table 10.

Soil temperature readings from loggers located in zones 1b, 2a and 2b were consistently similar throughout all months from July 2016 to December 2017 (

Table 11). Minimum and maximum temperatures recorded by the logger deployed in Zone 1a were considerably different to the other three sites particularly during the winter and summer months. Minimum temperatures in winter recorded by the logger deployed in Zone 1b were marginally lower relative to unshaded sites (

Table *11*).

The mean minimum temperature recorded by the logger in Zone 1a was lower during winter and higher during summer than in Zones 1b, 2a and 2b (Figure 12). Similarly, the mean maximum temperature recorded by the logger in Zone 1a was also lower during winter and higher during summer than in the other zones (Figure 13). The recorded mean monthly maximum was generally at least 2°C higher in Zone 1a than the remaining sites from November to February.

During the winter months, when the sun angle in Canberra is at its lowest, and shading of the site occurs the mean minimum and maximum temperatures in zone 1a were 5.4°C and 9.3°C respectively. In comparison, mean minimum and maximum temperatures were on average 6.5°C and 10.1°C respectively across in zones 1b, 2a and 2b. During the summer months of 2016/17, daily maximum temperatures were 1.5 - 3.5°C greater in zone 1a than the other three zones. During January and February 2017 for example, the mean maximum temperature recorded in zone 1a was 36.9°C and 34.1°C respectively. The average maximum temperatures in the three other zones was 33.5°C - 34.4 °C in January and 31.3°C - 32.2°C in February.

No data is available for Zone 1a prior to shading, but the higher variability throughout the year, indicates that the substrate insulation characteristics of the logger at Zone 1a are distinct from other sites. This correlates with observations that the logger at Zone 1a is positioned in a loose rocky substrate relative to the other loggers, which are located in a substrate of soil.

Table 10. Average daily minimum and maximum temperatures recorded in zones 1a, 1b, 2a and 2b (July 2016 -December 2018).

Month	Minimum (°C)				Maximum (°C)			
	1a	1b	2a	2b	1a	1b	2a	2b
Jul 2016	6.3	7.2	7.5	7.4	10.0	10.7	10.9	10.7
Aug 2016	7.0	7.7	7.8	7.9	12.3	12.6	12.5	12.4
Sep 2016	10.9	11.0	11.2	11.5	16.6	15.8	15.9	15.9
Oct 2016	13.2	12.8	13.2	13.7	21.0	19.6	19.8	20.1
Nov 2016	18.9	17.8	18.3	18.7	29.3	27.0	27.1	27.3
Dec 2016	22.7	21.6	22.0	22.4	32.1	30.0	29.9	30.2
Jan 2017	25.9	24.6	25.0	25.3	36.9	34.4	33.5	33.8
Feb 2017	24.1	23.1	23.4	23.8	34.2	32.3	31.4	32.0
Mar 2017	20.8	20.5	20.6	20.9	27.5	26.5	26.0	26.7
Apr 2017	14.3	14.4	14.4	14.7	19.3	19.1	19.0	19.5
May 2017	9.0	9.9	10.2	10.4	13.0	13.9	13.6	13.9
Jun 2017	5.4	6.3	7.0	7.1	8.7	9.6	10.0	10.2
Jul 2017	4.1	5.0	5.5	5.7	7.9	8.9	8.8	9.1
Aug 2017	6.6	7.3	7.4	7.6	11.3	11.6	11.1	11.5
Sep 2017	10.1	10.0	10.3	10.7	17.7	16.3	15.3	16.0
Oct 2017	16.1	15.5	16.0	16.4	24.7	22.6	21.8	22.5
Nov 2017	18.2	17.6	18.1	18.4	26.7	24.2	24.0	24.5
Dec 2017	21.8	21.1	21.6	21.9	30.0	27.4	27.0	27.5
Average	**14.2**	**14.1**	**14.4**	**14.7**	**21.1**	**20.1**	**19.9**	**20.2**

Table 11. Average minimum and maximum soil temperature recorded in zones 1a, 1b, 2a and 2b.

	Average minimum (°C)				Average maximum (°C)			
	1a	**1b**	**2a**	**2b**	**1a**	**1b**	**2a**	**2b**
Summer	24.2	23.1	23.5	23.8	34.4	32.2	31.6	32.0
Autumn	14.7	14.9	15.1	15.3	19.9	19.8	19.5	20.0
Winter	5.4	6.2	6.6	6.8	9.3	10.0	10.0	10.3
Spring	14.6	14.1	14.5	14.9	22.7	20.9	20.7	21.1

Due to equipment failure, consistent soil temperature data for previous years is available for the shaded winter months only for zones 1b and 2b (Figure 14 and Figure 15). Data for Zone 1a is missing for winter 2014 and winter 2015, while data for Zone 2a is missing for winter 2015.

In comparison to previous years, there is no clear difference in average maximum temperatures between the control and impact sites during the shaded winter months (Figure 14). Average minimum temperatures at Zone 1b (Impact) appear lower relative to Zone 2b (Control) in 2016 and 2017 post shading compared to before shading, suggesting that the shading may have an impact minimum soil temperatures (Figure 15).

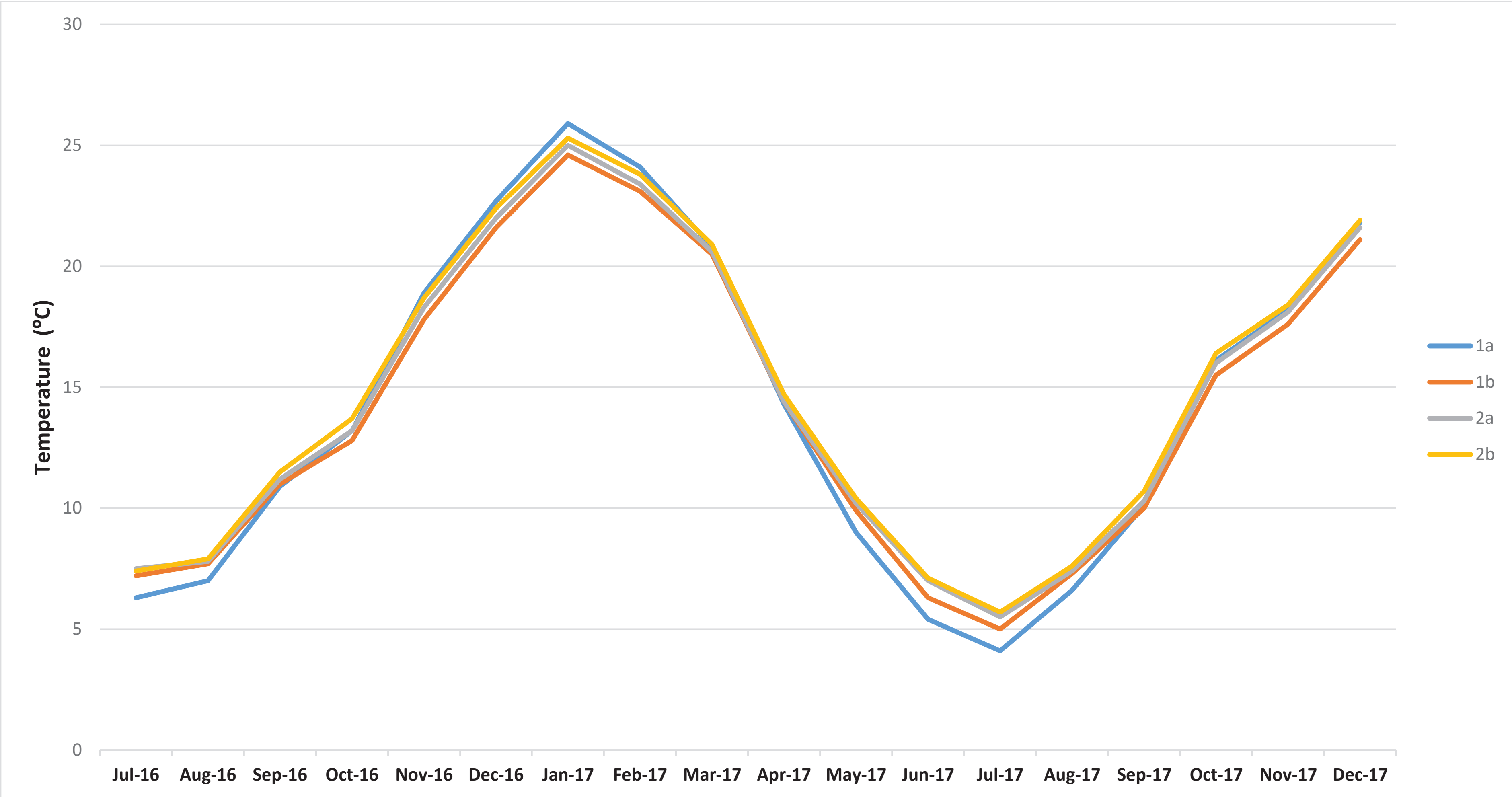


Figure 12. Average minimum soil temperature at 5 cm below ground within Zones 1a, 1b, 2a and 2b at York Park (July 2016-December 2017).

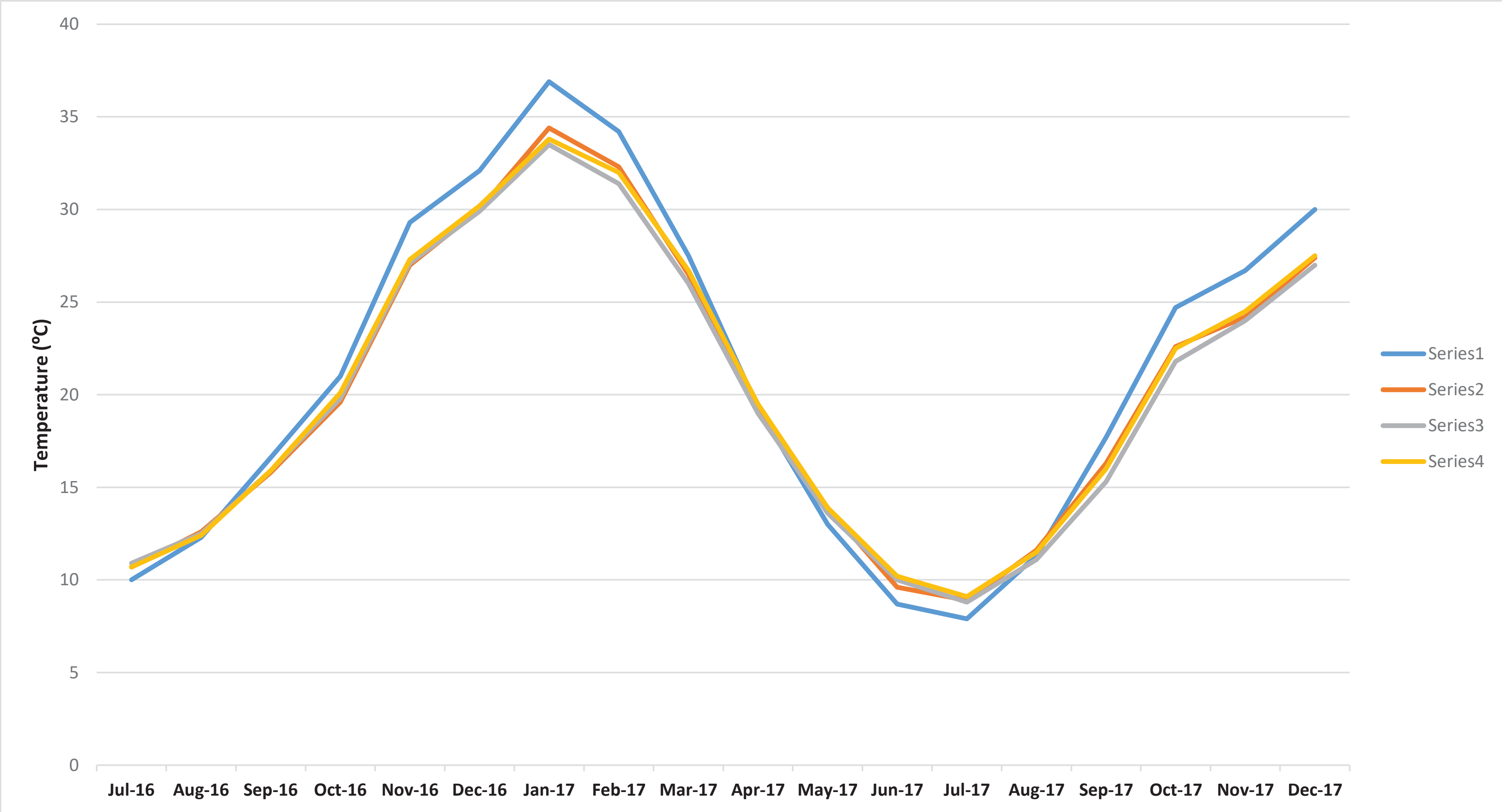


Figure 13. Average maximum soil temperature at 5 cm below ground within zones 1a, 1b, 2a and 2b at York Park (July 2016-December 2017).

Figure 14. Average maximum soil temperature at 5 cm during June to August (2014-2017).

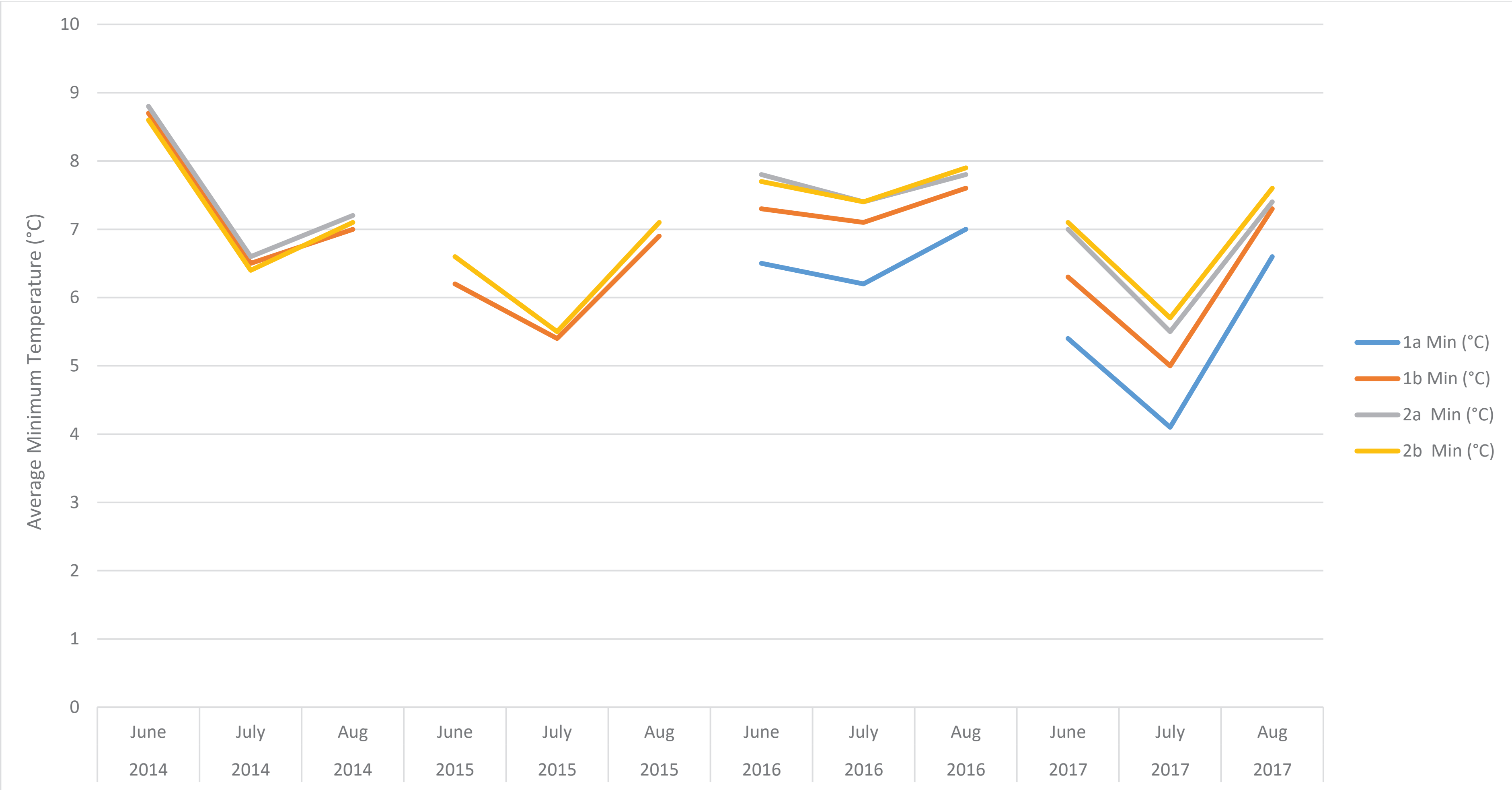


Figure 15. Average minimum soil temperature at 5 cm during June to August (2014-2017).

3.7. Meteorological Data

Monthly rainfall and average daily maximum and minimum air temperatures recorded at Canberra Airport from 2013 to 2017 are presented in Figure 16 and Figure 17 respectively.

Total rainfall during the months leading up to the 2017/18 flying moth season (i.e. June to October: 140.4 mm) was lower than the 10-year average (i.e. 229.6 mm) and far lower than during the same period in 2016 (i.e. 454.2 mm) (Australian Government 2017, 2018). Rainfall during the 2017 flying season (i.e. November / December: 165.5 mm) was slightly higher than the 10-year average (i.e. 149.6 mm) and higher than during the same period in 2016 (i.e. 121.4 mm) (Australian Government 2017, 2018).

Monthly average daily maximum and minimum soil temperatures, recorded at 10 cm depth, from 2013 to 2017 at the Canberra Airport are presented in Figure 18. Daily maximum soil temperature and daily precipitation during the past four GSM flying seasons (i.e. October to December) are presented in Figure 19. The mean maximum temperature in Canberra during 2017 was the third warmest on record. The mean minimum temperature during winter 2017 was the fourth-coolest winter on record however the annual mean minimum temperature was average due to warmer than average minimum temperatures during the autumn and summer months.

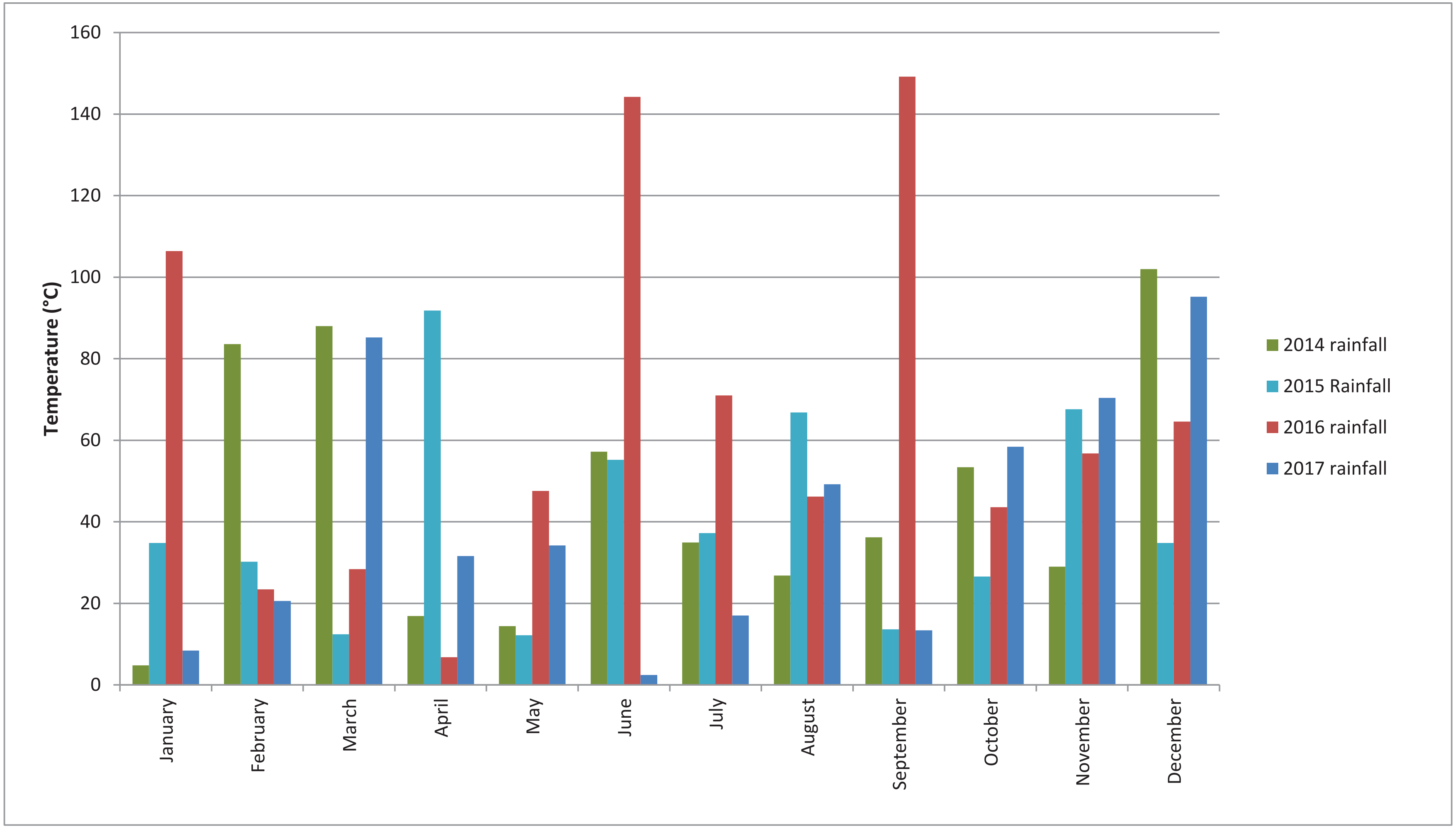


Figure 16. Monthly rainfall at Canberra Airport (2014-2017).

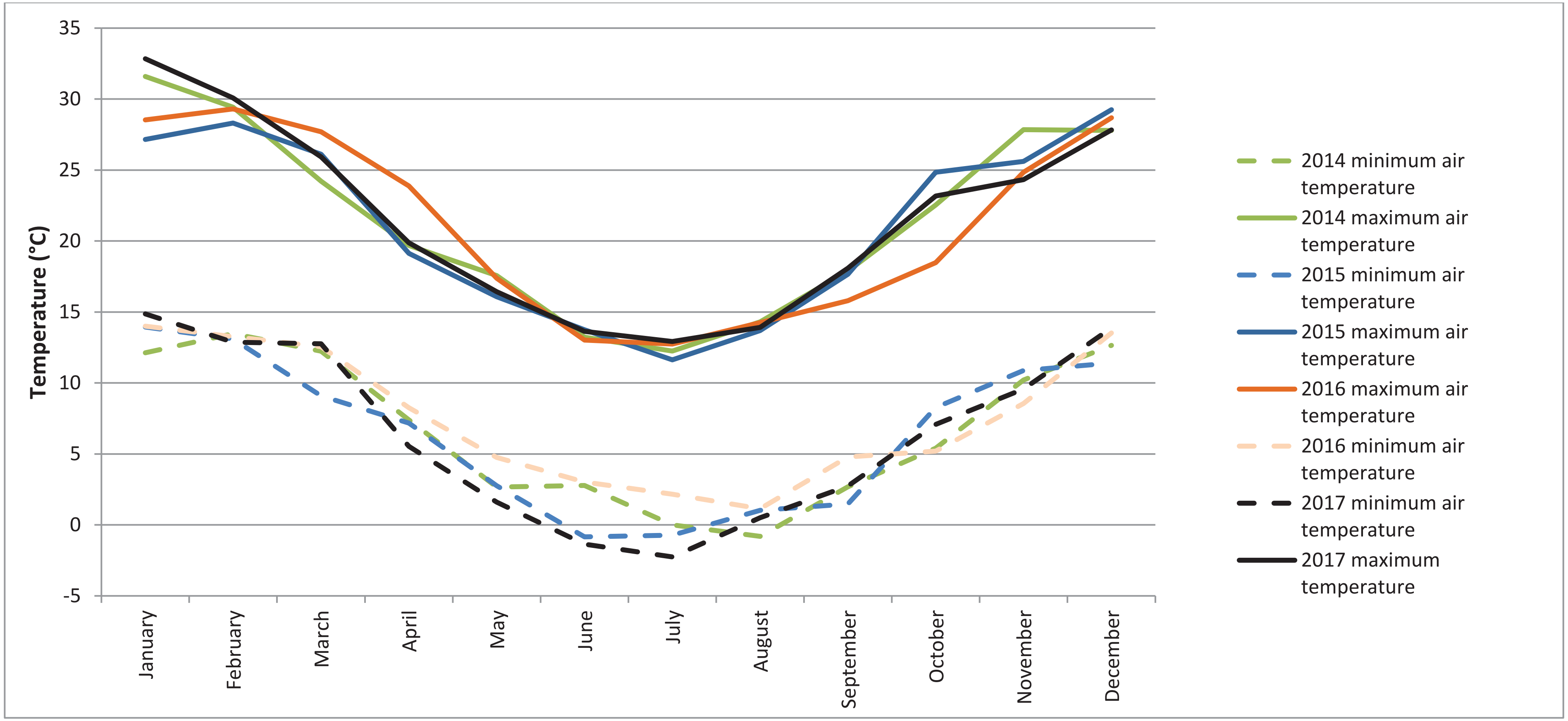


Figure 17. Monthly average maximum and minimum temperate at Canberra Airport (2014-2017).

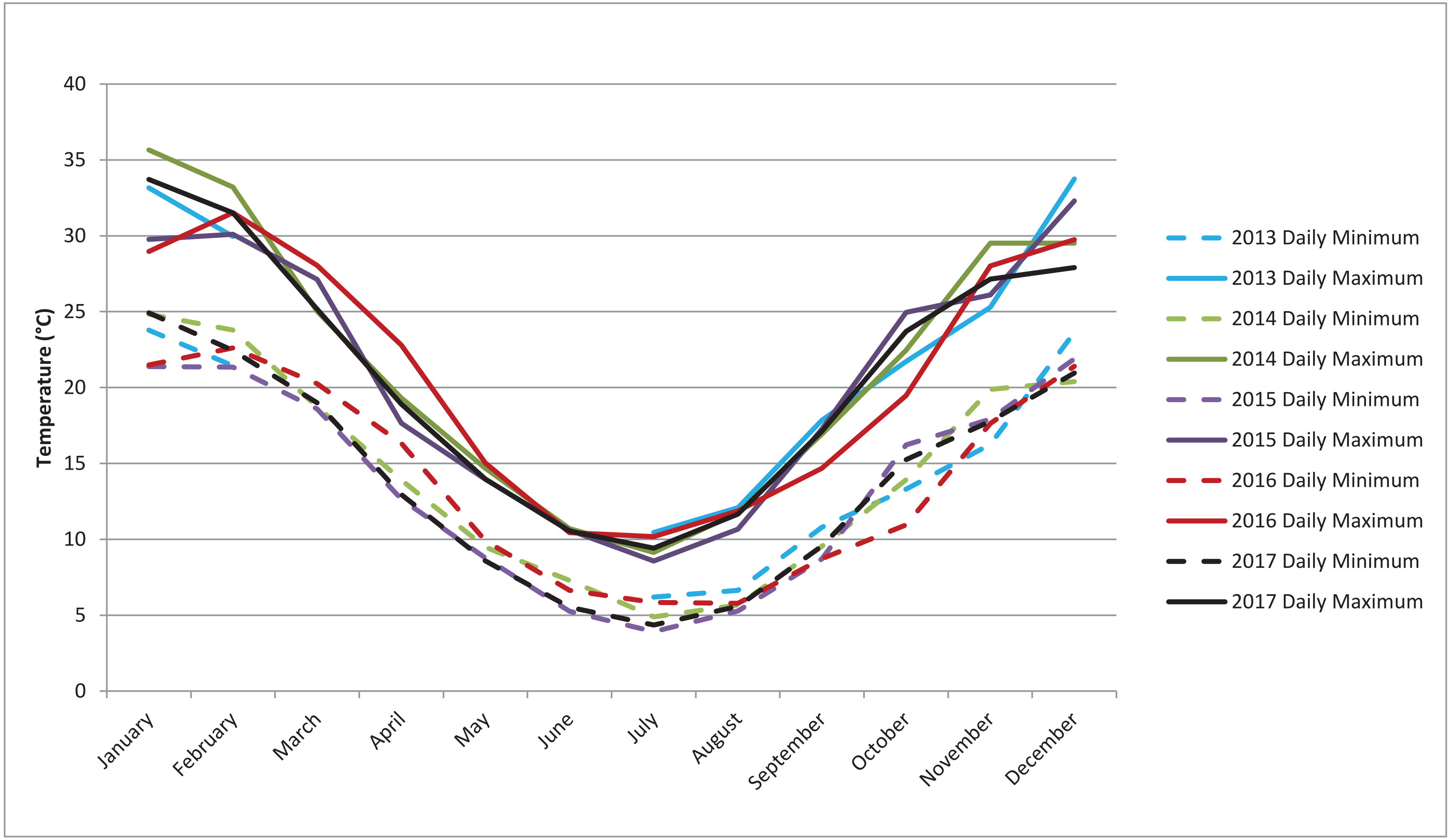


Figure 18. Monthly average daily maximum and minimum soil temperature (at 10 cm depth) at Canberra Airport.

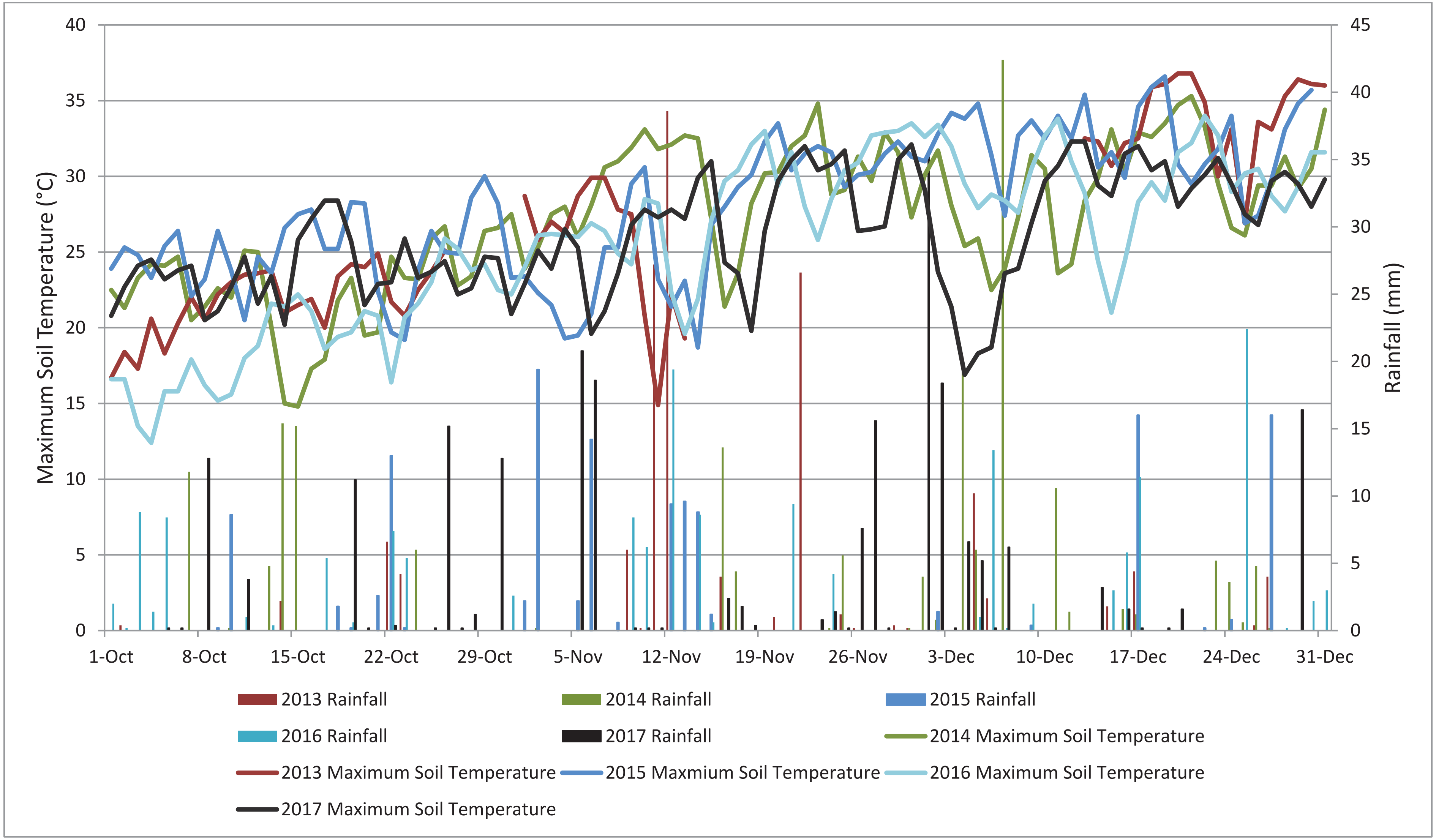


Figure 19. Maximum daily soil temperature and daily rainfall at Canberra Airport during the GSM flying period.

4. Discussion

4.1. Flying Moth Abundance

The GSM abundance observed in the last five years of monitoring has consistently remained in the 'low to moderate' activity range' according to the semi-quantitative assessment of David Hogg Pty Ltd (2010), i.e.:

- Standing rotational counts (based on a 30 second rotation)
  - High 10 or more per rotation
  - Moderate 3 to 5 per rotation
  - Low 1 or less per rotation
- Transects
  - High 40 or more per 100 m of transect
  - Moderate 10 to 20 per 100 m
  - Low 4 or less per 100 m

Previous studies conducted by Rowell (2012) and Richter *et al*. (2013a) at York Park found little variation in GSM densities over time. As all surveys since 2012 were conducted at similar points during the flying season and weather conditions on survey days were generally comparable, it is likely that the observed variation in moth numbers since 2012 is due primarily to the stochastic character of the moths in response to natural variation in climatic and site conditions between years.

The regression analysis indicates that shading at York Park is unlikely to have adversely affected flying moth numbers; however, given the relatively large, annual fluctuations in flying moth abundance and small sample size (i.e. two transects and one rotational point analysed over four years), the outcome remains inconclusive.

Based on the two post-impact surveys conducted, there is no evidence of a biologically and statistically significant decline in flying moth numbers at York Park correlated with the onset of shading. One more year of monitoring is required to provide data for at least three consecutive post impact seasons.

To date, the impact threshold identified in the monitoring plan (RJPL 2014a) for consultation with the Commonwealth and potentially management responses is not triggered on the basis of flying moth numbers.

4.2. Pupae Case Abundance

The low levels of detection at York Park persist despite the relatively high survey effort applied relative to the recommendations of Richter *et al*. (2013b). The very low pupae case numbers are indicative of the GSM low density at York Park and the challenges associated with detecting pupae cases in low density areas. The surveys do show that GSM continue to breed in the shaded area following the onset of shading.

The BACI analysis indicates that that the number of pupae cases recorded in the impact zone has reduced relative to the control zone between the before and after periods (Figure 8); however, this relationship was not statistically significant. The lack of a statistically significant relationship between the number of pupae cases in the control and impact areas, does not confirm that shading either is or isn't, or, will or will not have an adverse effect on pupa case numbers.

Given the very small sample sizes and the high levels of inter-annual variation, this finding is inconclusive as to whether potential shading from the Little National Hotel is adversely affecting the GSM population in adjacent York Park.

Based on the two post-impact surveys conducted, there is no evidence of a biologically and statistically significant decline in pupae case numbers at York Park correlated with the onset of shading. One more year of monitoring is required to provide data for at least three consecutive post impact seasons.

To date, the impact threshold identified in the monitoring plan (RJPL 2014a), for consultation with the Commonwealth and potential management responses, is not triggered because of a decline in pupae cases attributable to shading impacts.

4.3. Vegetation Condition

The lower native and exotic species diversity and floristic scores recorded in 2017 relative to 2016 is likely due to a marked difference in rainfall prior to the vegetation surveys. Total rainfall during the months leading up to the 2017/18 flying moth season (i.e. June to October: 140.4 mm) was lower than the 10-year average (i.e. 229.6 mm) and far lower than during the same period in 2016 (i.e. 454.2 mm) (Australian Government 2017, 2018). Climate variability, particularly rainfall, and seasonal variability, are important factors in grassland composition and cover (Williams *et al*. 2015). This is supported by the high yearly variance in native diversity and floristic scores recorded since monitoring commenced in 2013.

Exotic perennial grass species such as cocksfoot and paspalum, and the exotic forbs catsear and plantain are prevalent to the detriment or potential exclusion of native and other exotic species. While the St John's wort abundance appears to have declined, potentially due to targeted weed control activities, ongoing weed control targeting St John's wort and other exotic species at the appropriate times of year is required to conserve the native grassland character.

The analysis of annual floristic scores indicates that shading of part of York Park has no detectable effect on vegetation condition; however, given the small sample size and highly variable, annual floristic scores, there is a considerable degree of uncertainty with any conclusion. This outcome consequently does not confirm or discount potential shading impacts of the Little National Hotel on the vegetation condition of adjacent York Park.

Based on the two post-impact surveys conducted, there is no evidence of a biologically and statistically significant decline in vegetation condition at York Park correlated with the onset of shading. One more year of monitoring is required to provide data for at least three consecutive post impact seasons.

To date, the impact threshold identified in the monitoring plan (RJPL 2014a), for consultation with the Commonwealth and potentially management responses, is not triggered on the basis of a decline in vegetation condition attributable to shading impacts.

4.4. Soil Temperature

The variation in recorded soil temperatures between 1a and the other three zones is likely due to a combination of factors, specifically:

- Between-site variation in soil / substrate composition under which the loggers were deployed.

  The logger in Zone 1a was deployed in an area with a higher proportion of small rocks within the soil immediately above the logger than the areas where the three remaining loggers were deployed. A logger buried amongst primarily small rocks is likely to be subject to ambient air temperatures to a greater degree than loggers buried under compact soil characterised by fewer and smaller pockets of air. This may explain the higher maximum temperatures recorded during summer in Zone 1a when compared with the three other sites. Similarly, a greater proportion of rocks between the surface and the logger in Zone 1a may have partly contributed to the lower minimum temperatures during the winter months during which frosts are common; however, it is likely that the low winter temperatures recorded in Zone 1a were also influenced to a degree by the influence of shading as discussed below.

- A potential shading effect on soil temperatures during winter.

  The low maximum temperature recordings from Zone 1a from June to July (i.e. when the sun angle is at its lowest in Canberra) is likely influenced by shading from the Little National Hotel. Average temperature readings from 3pm during June (i.e. 8.7°C) and July (i.e. 7.9°C) in Zone 1a were on average 1°C lower than at Zone 2a (i.e. 10.0°C and 8.8°C respectively) and at Zone 2b (i.e. 10.2°C and 9.1°C respectively). The significance of this apparent difference of 1°C in daily maximum temperatures in regard to GSM recruitment requires further consideration.

  Mean monthly minimum temperatures recorded in Zone 1b were consistently lower than in Zones 2a and 2b during every month between July 2016 and December 2017 suggesting a small yet appreciable shading influence. These three loggers were deployed in areas containing almost exclusively soil (i.e. no rocks); however, mean monthly maximum temperatures in Zone 1b were on average slightly higher than at 2a and very similar to 2b even though Zone 1b is a partly shaded site.

The data from Zone 1b compared with the non-shaded sites indicates that average minimum soil temperatures during the winter period may have reduced at the shaded site relative to the impact site following the commencement of shading impacts (Figure 15). While minimum winter temperatures at Zone 1a are substantially lower than all other sites, it is not possible to determine the extent this is attributable to shading, if at all, due to the absence of data prior to shading, and the evidence that this site has a greater temperature range in all seasons relative to other sites.

4.5. Recent Climate

During the GSM flying season, air temperatures were within the average range and rainfall was higher than average. Higher than average rainfall is likely to have reduced GSM activity and prolonged the GSM flying season, and this is supported by the decline in GSM activity detected regionally in late spring and early summer during a period of high rainfall and the detection of GSM flying in ACT until 17 January 2018.

Annual climatic variation can influence the grassland composition and structure at York Park. Drier than average conditions in winter and early spring is considered likely to be responsible for the lower native diversity and the lower than average exotic diversity detected during the 2017 surveys.

5. Compliance with the GSM Monitoring Plan

5.1. Survey Requirements

Transect surveys, pupae case surveys and vegetation surveys were conducted according to the methods specified in the monitoring plan (RJPL 2014a) and data from soil temperature loggers were successfully recovered and assessed. The maximum and minimum temperatures were determined from temperatures recorded at three hour intervals.

5.2. Reporting Requirements

The GSM monitoring plan (RJPL 2014a) requires that annual monitoring reports meet the following specifications:

- Annual monitoring and compliance reports would be prepared in a timely manner each year meeting the EPBC Act approval requirements (Conditions 3, 8) by:
  - providing and assessing the monitoring data for the previous twelve months against the baseline conditions
  - concluding whether or not there has been a decline in the GSM population in the area of York Park shaded as a result of the action, taking into account regional population trends and local ecological conditions
  - reviewing the monitoring plan's applicability in achieving its objectives (Condition 8) to determine whether, under EPBC Act Approval Condition 10, the monitoring plan should be revised in consultation with the Commonwealth.

  When preparing the report, reference would be made to the current NTGMP and any relevant management and monitoring changes relevant to a review of the monitoring plan.

The current report represents the year 5 data monitoring report. The above requirements for analysis against the baseline conditions and assessment of whether there has been a decline in the population of GSM at York Park can only be qualitatively assessed at this stage.

The preparation of this report fulfils the reporting requirements for year 5 surveys as specified in the monitoring plan (RJPL 2014a).

5.3. Impact Thresholds

Detection of either of the following key thresholds of potential concern would trigger consultation with the Commonwealth and potentially a management response:

- 'a biologically and statistically significant decline in pupae case numbers or floristic value attributable to shading impacts over at least three consecutive post impact seasons.'
- 'a biologically and statistically significant decline in flying moth numbers at York Park correlated with the onset of shading over at least three consecutive post impact seasons that cannot be attributable to other factors, such as other developments or seasonal conditions.'

The analyses described in Section 3.5 did not detect

- Any biologically and statistically significant declines in pupae case numbers or floristic value attributable to shading impacts, as assessed by the BACI analysis.
- Any biologically or statistically significant decline in flying moth numbers at York Park correlated to the onset of shading, as assessed by linear regression analysis.

5.4. GSM Monitoring Plan Review

The current monitoring event addresses potential impacts over two consecutive post impact seasons, and consequently an additional year of monitoring is required before information required to address impact thresholds, or consideration of whether future monitoring is warranted, is addressed.

Monitoring of flying moth numbers and vegetation condition is progressing according to the GSM monitoring plan, and the data collected is appropriate for the analyses proposed.

Pupae cases have consistently been detected at very low rates in the quadrats, despite the substantially higher survey effort implemented relative to the recommendations of Richter *et al.* (2013). Given the very low numbers of pupae cases detected and the high levels of inter-annual variance in pupae case numbers, BACI analysis of this data currently has very low statistical power. Considering these results, DoEE should review the effectiveness of ongoing pupae case monitoring.

6. Conclusions and Recommendations

Background

This report provides the results of the 2017 flying GSM survey, pupae case survey and vegetation survey conducted in accordance with the *Potential shading impacts on York Park golden sun monitoring plan* (RJPL 2014a, the monitoring plan).

Results

The key results of analysis of the potential impacts of shading are:

- Linear regression analysis did not detect any biologically and statistically significant decline in flying moth numbers at York Park correlated with the onset of shading.
- BACI analysis detected a potential decline in pupae cases at the impact site relative to the control site after shading which may be indicative of an impact from shading. This effect was not statistically significant, and may be an artefact of the very low numbers of pupae cases recorded and the high level of inter-annual variation in detection relative to the low numbers detected. No biologically and statistically significant decline in pupae case numbers at York Park correlated with the onset of shading was detected.
- BACI analysis did not identify any biologically and statistically significant decline in vegetation condition at York Park correlated with the onset of shading.
- Graphical review indicates that shading of the impact area from 2015 onwards may have reduced soil temperatures within the impact zone during winter. There is, however, no evidence at this stage that this is adversely impacting GSM populations or natural temperate grassland.

These analyses address potential impacts over two consecutive post impact seasons. The monitoring plan requires an additional year of monitoring before information required to address impact thresholds, or consideration of whether future monitoring is warranted, is addressed.

Recommendations

- On-going monitoring and control of weeds at York Park, particularly perennial exotic grasses and St John's Wort.
- The continuation of GSM flying moth, pupae case and soil temperature monitoring in 2018 to provide a minimum of three post-construction monitoring events as required in the monitoring plan (RJPL 2014a)
- The Commonwealth reviews the effectiveness and necessity of pupae case monitoring given the low detection rate and high inter-annual variation.

Summary

This report fulfils the reporting requirements for GSM monitoring at York Park for year 5, as specified in the monitoring plan (RJPL 2014a).

The analyses described in Section 3.5 did not detect

- Any biologically and statistically significant declines in pupae case numbers or floristic value attributable to shading impacts, as assessed by the BACI analysis.
- Any biologically or statistically significant decline in flying moth numbers at York Park correlated to the onset of shading, as assessed by linear regression analysis.

The current monitoring event addresses potential impacts over two consecutive post impact seasons, and consequently an additional year of monitoring is required before information required to address impact thresholds, or consideration of whether future monitoring is warranted, is addressed.

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Appendices

Appendix A Flying GSM Survey 2017 – Transect Data

Date	Transect	Moth numbers / Sample			Moth numbers
		1	2	3	Average (1dp)
10/11/2017	Transect 1	22	27	17	22.0
1/12/2017	Transect 1	1	13	12	8.7
10/12/2017	Transect 1	4	6	5	5
10/11/2017	Transect 2	33	39	17	29.7
1/12/2017	Transect 2	10	6	15	10.3
10/12/2017	Transect 2	3	7	2	4

Appendix B Flying GSM Survey 2017 – Point Observations

Date	Time	Point	Moth numbers	
			Average (1dp)	Range
10/11/2017	12:41	North-east	6.3	3-12
1/12/2017	10:22	North-east	0.3	0-1
10/12/2017	13:16	North-east	1.1	0-5
10/11/2017	12:10	Centre	12.9	5-19
1/12/2017	10:31	Centre	2.0	0-6
10/12/2017	13:25	Centre	1.1	0-3
10/11/2017	12:55	Centre	8.8	5-13
1/12/2017	11:00	Centre	2.3	1-5
10/12/2017	14:05	Centre	0.3	0-1
10/11/2017	12:21	South-west	4.4	2-9
1/12/2017	10:48	South-west	2.0	0-4
10/12/2017	13:54	South-west	3.3	0-7

Appendix C Pupae Case Survey 2017

Date	Survey	Quadrat	Control or Impact site	Zone	Pupae case numbers
24/11/2017	1	1	Impact	1a	0
24/11/2017	1	2	Impact	1a	0
24/11/2017	1	3	Impact	1a	0
24/11/2017	1	4	Impact	1a	0
24/11/2017	1	5	Impact	1a	0
24/11/2017	1	6	Impact	1a	0
24/11/2017	1	7	Impact	1a	1
24/11/2017	1	8	Impact	1a	0
24/11/2017	1	9	Impact	1a	0
24/11/2017	1	10	Impact	1b	0
24/11/2017	1	11	Impact	1b	0
24/11/2017	1	12	Impact	1b	0
24/11/2017	1	13	Control	2b	0
24/11/2017	1	14	Control	2b	0
24/11/2017	1	15	Control	2a	0
24/11/2017	1	16	Control	2a	0
24/11/2017	1	17	Control	2a	0
24/11/2017	1	18	Control	2a	0
24/11/2017	1	19	Control	2a	0
24/11/2017	1	20	Control	2b	0
24/11/2017	1	21	Control	2a	0
24/11/2017	1	22	Control	2a	0
24/11/2017	1	23	Control	2a	0
24/11/2017	1	24	Control	2a	0
09/12/2017	2	1	Impact	1a	0
09/12/2017	2	2	Impact	1a	0
09/12/2017	2	3	Impact	1a	0
09/12/2017	2	4	Impact	1a	0
09/12/2017	2	5	Impact	1a	0
09/12/2017	2	6	Impact	1a	0
09/12/2017	2	7	Impact	1a	0
09/12/2017	2	8	Impact	1a	0
09/12/2017	2	9	Impact	1a	0
09/12/2017	2	10	Impact	1b	0
09/12/2017	2	11	Impact	1b	0
09/12/2017	2	12	Impact	1b	0
09/12/2017	2	13	Control	2b	0
09/12/2017	2	14	Control	2b	0
09/12/2017	2	15	Control	2a	0
09/12/2017	2	16	Control	2a	0
09/12/2017	2	17	Control	2a	0
09/12/2017	2	18	Control	2a	0

Date	Survey	Quadrat	Control or Impact site	Zone	Pupae case numbers
09/12/2017	2	19	Control	2a	0
09/12/2017	2	20	Control	2b	1
09/12/2017	2	21	Control	2a	0
09/12/2017	2	22	Control	2a	0
09/12/2017	2	23	Control	2a	0
09/12/2017	2	24	Control	2a	0
19/12/2017	3	1	Impact	1a	0
19/12/2017	3	2	Impact	1a	0
19/12/2017	3	3	Impact	1a	0
19/12/2017	3	4	Impact	1a	0
19/12/2017	3	5	Impact	1a	0
19/12/2017	3	6	Impact	1a	0
19/12/2017	3	7	Impact	1a	0
19/12/2017	3	8	Impact	1a	0
19/12/2017	3	9	Impact	1a	0
19/12/2017	3	10	Impact	1b	0
19/12/2017	3	11	Impact	1b	0
19/12/2017	3	12	Impact	1b	0
19/12/2017	3	13	Control	2b	0
19/12/2017	3	14	Control	2b	0
19/12/2017	3	15	Control	2a	0
19/12/2017	3	16	Control	2a	0
19/12/2017	3	17	Control	2a	0
19/12/2017	3	18	Control	2a	0
19/12/2017	3	19	Control	2a	0
19/12/2017	3	20	Control	2b	0
19/12/2017	3	21	Control	2a	1
19/12/2017	3	22	Control	2a	0
19/12/2017	3	23	Control	2a	0
19/12/2017	3	24	Control	2a	0

Appendix D Vegetation Survey 2017 – Dominant Species Per Quadrat

Date	Quadrat	Control or Impact site	Zone	Dominant	Co-Dominant	Cover (%)
24/11/2017	1	Impact	1a	*Austrostipa bigeniculata*	*Tricoryne elatior*	80
24/11/2017	2	Impact	1a	*Austrostipa bigeniculata*	*Tricoryne elatior*	80
24/11/2017	3	Impact	1a	*Austrostipa bigeniculata*	*Paspalum dilatatum*	90
24/11/2017	4	Impact	1a	*Austrostipa bigeniculata*	*Bothriochloa macra*	90
24/11/2017	5	Impact	1a	*Austrostipa bigeniculata*	*Bothriochloa macra*	85
24/11/2017	6	Impact	1a	*Austrostipa bigeniculata*	*Hypochaeris radicata*	70
24/11/2017	7	Impact	1a	*Austrostipa bigeniculata*		80
24/11/2017	8	Impact	1a	*Bothriochloa macra*	*Austrostipa bigeniculata*	90
24/11/2017	9	Impact	1a	*Bothriochloa macra*	*Austrodanthonia spp.*	80
24/11/2017	10	Impact	1b	*Austrostipa bigeniculata*	*Bothriochloa macra*	100
24/11/2017	11	Impact	1b	*Austrostipa bigeniculata*		70
24/11/2017	12	Impact	1b	*Austrostipa bigeniculata*	*Bothriochloa macra*	60
24/11/2017	13	Control	2b	*Paspalum dilatatum*	*Austrostipa bigeniculata*	40
24/11/2017	14	Control	2b	*Austrostipa bigeniculata*	*Bothriochloa macra*	70
24/11/2017	15	Control	2a	*Austrostipa bigeniculata*	*Panicum effusum*	95
24/11/2017	16	Control	2a	*Bothriochloa macra*	*Bothriochloa macra*	70
24/11/2017	17	Control	2a	*Bothriochloa macra*	*Bothriochloa macra*	70
24/11/2017	18	Control	2a	*Trifolium arvense*	*Dactylis glomerata*	80
24/11/2017	19	Control	2a	*Bothriochloa macra*	*Austrostipa bigeniculata*	90
24/11/2017	20	Control	2b	*Bothriochloa macra*	*Vulpia* sp.	80
24/11/2017	21	Control	2a	*Dactylis glomerata*	*Trifolium arvense*	70
24/11/2017	22	Control	2a	*Paspalum dilatatum*		80
24/11/2017	23	Control	2a	*Dactylis glomerata*	*Paspalum dilatatum*	90
24/11/2017	24	Control	2a	*Chrysocephalum apiculatum*	*Austrostipa bigeniculata*	55

Appendix E Vegetation Survey 2017 – Plant Species List

Scientific name	Common name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
		Quadrat																							
Native grasses																									
Aristida ramosa	Wiregrass																								
Austrodanthonia auriculata	Lobed Wallaby Grass																								
Austrodanthonia bipartita	A Wallaby Grass																								
Austrodanthonia caespitosa	Ringed Wallaby Grass		1						1	1															
Austrodanthonia carphoides	Short Wallaby Grass						1																		
Austrodanthonia fulva	A Wallaby Grass																								
Austrodanthonia laevis	Smooth Wallaby Grass																								
Austrodanthonia spp.	Wallaby Grasses									3					1		1			2	+				
Austrostipa bigeniculata	Tall Speargrass	4	5	4	3	5	2	5	3		4	3	4	2	4	4	1	2	2	3	2	2	2	1	2
Austrostipa densiflora	A Speargrass																								
Austrostipa scabra	Rough Speargrass																								
Bothriochloa macra	Redleg Grass		1	+	3	3		2	4	5	3		3		2	2	4	5	2	4	2	2			
Chloris truncata	Windmill Grass																								
Elymus scaber	Wheatgrass		r							+															
Eragrostis brownii	A Lovegrass																								
Eragrostis trachycarpa	A Lovegrass																								
Microlaena stipoides	Weeping Grass																								
Panicum effusum	Hairy Panic Grass	2	1		2	1	2	1		1	1	1	1	2	2	3	2	3	1	1					
Poa labillardieri	Tussock Grass																								
Themeda triandra	Kangaroo Grass								2																

Scientific name	Common name	Quadrat																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Native forbs																									
Acaena ovina	Sheeps Burr																								
Asperula conferta	Common Woodruff																								
Bulbine bulbosa	Golden Lily																								
Calocephalus citreus	Lemon Beauty Heads														1										
Carex sp.	Carex		r														r								
Chamaesyce drummondii	Caustic Weed																								
Cheilanthes sp.							+					r													
Cheilanthes sieberi	Rock Fern			r												r									
Cheilanthes tenuifolia																									
Chenopodium pumilio	Small Crumbweed																								
Chrysocephalum apiculatum	Yellow Buttons		1	3		1	2	1			+	1	1		1	3				1					3
Chrysocephalum semipapposum	Clustered Everlasting																								
Convolvulus angustissimus	Australian Bindweed																								
Crassula sieberiana	Australian Stonecrop																								
Cymbonotus lawsonianus	Bear's Ears																								
Drosera peltata	Sundew																								
Eryngium rostratum	Blue Devil																								
Euchiton sp.	A Cudweed																								
Euchiton gymnocephalus	A Cudweed																								
Euchiton sphaericus	A Cudweed																								
Geranium sp.	Cranesbill																								
Glycine tabacina	Vanilla Glycine																								
Gonocarpus tetragynus	Raspwort																								
Goodenia hederacea																+				+	r				

Scientific name	Common name	Quadrat																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Goodenia pinnatifida	Scrambled Eggs			1																					
Hypericum gramineum	Small St John's Wort																								
Juncus sp.	A Rush																								
Lomandra bracteata	A Matrush																								
Lomandra filiformis	A Matrush				+	1														r		r			
Lomandra multiflora	A Matrush					1																			
Lomandra sp.	A Matrush																								
Microtis unifolia	Common Onion Orchid																								
Ophioglossum lusitanicum	Adder's Tongue																								
Oxalis perennans	Soursob	r																							
Pimelea curviflora	Curved Rice-flower															1									
Plantago vari[2]	Variable Plantain																								
Ranunculus sp.	Buttercup																								
Rumex brownii	Swamp Dock																	r							
Schoenus apogon	Bog-rush																								
Sebaea ovata																									
Senecio quadridentatus	Cotton Fireweed																								
Solenogyne dominii	Smooth Solenogyne																								
Stackhousia monogyna	Creamy Candles																								
Tricoryne elatior	Yellow Rush Lily		r	1	1											1				r					
Triptilodiscus pygmaeus	Austral Sunray																								
Vittadinia muelleri	Fuzzweed																								
Wahlenbergia sp.	A Bluebell																								
Wahlenbergia communis	Tufted Bluebell															r									r
Wahlenbergia luteola	A Bluebell																								
Wahlenbergia stricta	Tall Bluebell																								
Wurmbea dioica	Early Nancy																								

Scientific name	Common name	Quadrat																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Xerochrysum viscosum	Sticky Everlasting																								
Exotic grasses																									
Aira sp.	A Hairgrass																			r					
Aira elegantissima	A Hairgrass																								
Avena sp.	Wild Oats	2		1	+	+	r	+		r		r					r			r	1	1	1	2	+
Avena barbata	Bearded Oats																								
Briza maxima	Blowfly Grass	1	1		+	1		1		+	+	1	1	1	1	+	1		1	1	1	1	1		
Briza minor	Shivery Grass																								
Bromus sp.	A Brome Grass																								
Bromus catharticus	A Brome Grass																								
Bromus diandrus	A Brome Grass																								
Bromus hordeaceus	A Brome Grass																				1				
Bromus mollis	Soft Brome																								
Cynodon dactylon	Couch																								
Dactylis glomerata	Cocksfoot		+	+	r	r				+					2		2		3		2	3		3	+
Eleusine tristachya	Goose Grass																								
Eragrostis curvula	African Lovegrass																								
Festuca sp.	A Fine-leaved Fescue																				r				
Festuca arundinacea	Tall Fescue																								
Lolium perenne	Perennial Ryegrass																								
Lolium rigidum	Ryegrass																								
Nassella neesiana	Chilean Needlegrass																					r	r		
Nassella trichotoma	Serrated Tussock																								
Paspalum dilatatum	Paspalum	2												3					1				4	2	2
Phalaris aquatica	Phalaris																								
Poa bulbosa	Bulbous bluegrass																								

Scientific name	Common name	Quadrat																							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Rostraria cristata	Annual Cat's Tail																								
Vulpia sp.	Rat's-tail Fescue		1	r		1	+			+		r	1	1		1	+		1		3		1		
Exotic forbs																									
Acetosella vulgaris	Sorrel																								
Anagallis arvensis	Scarlet Pimpernel																								
Arctotheca calendula	Capeweed						1																		
Bartsia sp.																									
Centaurium erythraea	Pink Stars				r																				
Centaurium tenuiflorum	Branched Centaury							1	+	+							r			r		+			
Cerastium glomeratum	Chickweed																								
Chondrilla juncea	Skeleton Weed																								
Cirsium vulgare	Spear Thistle																								
Conyza bonariensis	Flax-leaf Fleabane																								
Echium plantagineum	Paterson's Curse																								
Erodium cicutarium	Common Crowfoot																								
Galium divaricatum	A Bedstraw																								
Gamochaeta purpurea	A Cudweed																								
Gnaphalium sp.	A Cudweed																								
Hirschfeldia incana	Hoary Mustard																								
Hypericum perforatum	St John's Wort		+	+	r					+		+		r	1				1						
Hypochaeris glabra	Smooth Catsear	+			1	1	1				1	r	+			1									
Hypochaeris radicata	Catsear	2	1		+	+	2	1			+		+			+		+	r	1		2	+	+	+
Lactuca serriola	Prickly Lettuce																								
Lepidium africanum	A Peppercress																								
Parentucellia latifolia	Common Bartsia																								
Petrorhagia nantueilii	Proliferous Pink			2																					
Plantago lanceolata	Ribwort Plantain	1	1					r	2	1	1	2	+	1	1		+		2	+	+	1	+	2	+
Romulea rosea	Onion Grass																								

Scientific name	Common name	Quadrat																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Salvia verbenaca	Wild Sage																								
Silene gallica	French Catchfly																								
Sonchus oleraceus	Common Sow-thistle																								
Tragopogon dubius																									
Tragopogon porrifolius	Salsify																								
Trifolium angustifolium	Narrow leaf Clover																		3						
Trifolium arvense	Haresfoot Clover								+									1							
Trifolium campestre	Hop Clover																								
Trifolium dubium																									
Trifolium glomeratum	Clustered Clover																								
Trifolium striatum																									
Trifolium spp.	Clovers																								

Appendix F Vegetation Survey 2017 – Floristic Value Scores

Indicator	Quadrat number																							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Number of Common Species	3	5	2	3	2	3	4	5	5	3	2	3	2	3	4	4	3	2	4	3	2	1	1	2
Number of indicator level 1 species	0	1	1	1	2	1	0	0	0	1	1	1	0	1	1	0	0	0	2	0	1	0	0	1
Number of indicator level 2 species	0	1	3	0	1	1	0	0	0	0	1	0	0	1	4	0	0	0	2	1	0	0	0	0
Total number of native species	3	7	6	4	5	5	4	5	5	4	4	4	2	5	9	4	3	2	8	4	3	1	1	3
Number of exotic species	6	6	5	7	6	4	5	3	7	4	6	5	5	5	4	6	3	8	6	6	7	7	5	4
Number of significant weed species	0	1	1	1	0	0	0	0	1	0	1	0	1	1	0	0	0	1	0	0	1	1	0	0
Site value score	0	2	8	1	5	4	0	0	0	1	2	1	0	4	11	0	0	0	5	1	0	0	0	7

Appendix G Daily Minimum and Maximum Soil Temperatures for each Zone

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
1/07/2016	5.1	8.5	6.0	9.3	6.3	10.1	6.2	9.9
2/07/2016	3.3	7.6	4.5	8.7	4.9	9.5	4.9	9.2
3/07/2016	2.8	7.0	4.0	8.4	4.5	9.2	4.4	8.9
4/07/2016	3.8	7.3	5.0	8.3	5.7	8.8	5.6	8.5
5/07/2016	4.9	7.2	5.8	7.7	6.4	8.1	6.3	7.9
6/07/2016	6.1	8.7	6.7	9.1	7.1	9.4	7.0	9.2
7/07/2016	7.3	10.7	7.6	10.9	8.0	11.1	7.9	11.0
8/07/2016	6.8	10.2	7.2	10.3	7.6	10.5	7.6	10.3
9/07/2016	7.9	11.2	8.2	11.4	8.4	11.5	8.5	11.4
10/07/2016	7.6	11.8	8.1	11.7	8.5	11.9	8.6	11.7
11/07/2016	8.7	10.7	9.3	11.2	9.7	11.5	9.7	11.4
12/07/2016	7.2	10.2	7.7	10.6	8.3	10.9	8.2	10.7
13/07/2016	5.1	8.2	6.2	9.4	6.9	10.0	6.8	9.6
14/07/2016	3.8	7.8	5.2	9.3	5.6	9.8	5.5	9.4
15/07/2016	3.0	7.8	4.3	9.3	4.8	9.7	4.6	9.3
16/07/2016	3.3	8.6	4.7	10.0	5.0	10.3	4.8	9.9
17/07/2016	5.1	9.8	6.3	11.2	6.7	11.4	6.6	11.1
18/07/2016	4.5	10.6	5.9	11.1	6.1	11.1	6.1	11.0
19/07/2016	9.9	13.6	10.2	13.9	10.4	13.8	10.4	13.7
20/07/2016	10.7	13.0	10.8	13.0	11.0	13.2	11.2	13.1
21/07/2016	10.4	13.3	10.6	13.2	10.8	13.3	11.0	13.2
22/07/2016	10.7	13.7	10.8	13.4	11.0	13.4	11.2	13.4

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
23/07/2016	7.6	10.9	8.5	11.5	9.1	11.8	9.0	11.6
24/07/2016	5.4	8.6	6.7	9.3	6.9	9.5	6.9	9.3
25/07/2016	6.4	10.4	7.2	11.1	7.5	11.1	7.4	10.8
26/07/2016	6.7	9.9	7.4	11.2	7.5	11.1	7.5	10.9
27/07/2016	7.0	10.1	7.7	11.4	8.0	11.5	8.0	11.3
28/07/2016	5.7	10.3	6.9	11.7	7.0	11.5	7.0	11.3
29/07/2016	4.4	9.7	5.7	11.2	5.8	11.0	5.8	10.7
30/07/2016	5.9	9.1	6.9	10.8	7.2	10.8	7.2	10.5
31/07/2016	6.4	12.1	7.6	12.6	7.7	12.4	7.8	12.2
1/08/2016	7.8	11.3	8.5	11.4	8.8	11.4	8.8	11.3
2/08/2016	7.2	10.1	7.8	10.4	8.2	10.6	8.3	10.5
3/08/2016	5.7	10.8	6.6	11.9	6.7	11.6	6.8	11.5
4/08/2016	5.8	11.0	6.9	11.4	6.9	11.3	6.9	11.2
5/08/2016	6.0	11.7	6.8	12.5	7.0	12.3	7.1	12.1
6/08/2016	5.9	10.7	6.9	11.0	7.1	10.9	7.1	10.8
7/08/2016	7.1	10.8	7.7	10.9	7.9	11.0	8.0	10.8
8/08/2016	5.8	11.7	6.6	12.4	6.5	12.1	6.7	12.0
9/08/2016	6.0	11.7	6.9	12.4	6.9	12.2	7.0	12.0
10/08/2016	7.8	13.0	8.5	13.7	8.6	13.4	8.7	13.3
11/08/2016	7.4	12.5	8.3	13.2	8.2	12.8	8.4	12.8
12/08/2016	5.3	11.0	6.3	11.4	6.4	11.4	6.5	11.2
13/08/2016	5.9	11.6	6.8	12.7	7.0	12.3	7.1	12.3
14/08/2016	6.0	12.7	7.0	13.3	6.9	13.1	7.0	12.9
15/08/2016	5.7	12.6	6.7	13.2	6.6	13.0	6.7	12.8
16/08/2016	5.9	12.9	6.8	13.6	6.8	13.2	6.9	13.0

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
17/08/2016	7.1	11.6	7.9	11.9	8.1	11.8	8.1	11.7
18/08/2016	6.3	13.9	6.9	13.9	6.9	13.5	7.1	13.4
19/08/2016	6.9	13.6	7.3	13.6	7.4	13.3	7.6	13.2
20/08/2016	8.2	12.1	8.7	12.4	8.7	12.5	8.9	12.3
21/08/2016	7.3	10.9	8.0	11.4	8.3	11.4	8.4	11.3
22/08/2016	6.9	12.3	7.5	12.4	7.8	12.7	7.9	12.4
23/08/2016	8.6	13.2	9.2	13.0	9.0	13.1	9.2	13.0
24/08/2016	9.2	11.8	9.5	11.7	9.7	12.0	10.0	11.9
25/08/2016	7.6	14.2	8.1	14.1	7.9	13.9	8.1	13.8
26/08/2016	6.8	13.5	7.2	13.5	7.3	13.4	7.5	13.4
27/08/2016	6.1	13.2	6.8	13.3	7.1	13.2	7.3	13.1
28/08/2016	7.1	11.4	7.8	11.5	8.1	11.6	8.2	11.5
29/08/2016	6.5	13.5	7.0	13.0	7.2	13.0	7.4	12.9
30/08/2016	8.5	15.2	8.6	14.9	8.8	14.6	9.0	14.6
31/08/2016	11.1	14.5	11.2	14.3	11.5	14.2	11.7	14.3
1/09/2016	9.3	15.9	9.5	15.3	9.7	15.1	9.9	15.2
2/09/2016	10.7	12.1	10.7	12.1	10.9	12.1	11.1	12.2
3/09/2016	10.4	13.8	10.6	13.3	10.9	13.4	11.0	13.5
4/09/2016	9.2	16.1	9.6	15.3	9.7	15.2	9.8	15.2
5/09/2016	10.1	16.5	10.2	15.8	10.5	15.9	10.6	15.8
6/09/2016	9.2	17.5	9.3	16.5	9.6	16.3	9.7	16.4
7/09/2016	10.1	16.1	10.1	15.4	10.3	15.5	10.4	15.4
8/09/2016	11.8	18.0	11.7	17.1	11.8	16.9	12.0	16.9
9/09/2016	11.5	14.4	11.3	14.0	11.4	14.0	11.7	14.1
10/09/2016	12.3	15.2	12.3	14.7	12.5	14.7	12.7	14.7

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
11/09/2016	10.6	17.4	10.7	16.5	11.0	16.6	11.1	16.4
12/09/2016	10.0	18.4	10.2	17.1	10.2	17.1	10.5	17.1
13/09/2016	11.8	16.1	11.7	15.3	11.8	15.5	12.1	15.3
14/09/2016	12.0	15.7	12.0	15.3	12.1	15.2	12.4	15.2
15/09/2016	10.7	14.8	10.9	14.3	11.1	14.4	11.2	14.1
16/09/2016	10.7	16.1	10.8	15.7	11.0	15.7	11.2	15.8
17/09/2016	9.6	17.4	9.8	16.4	10.2	16.4	10.5	16.3
18/09/2016	11.4	14.1	11.3	13.8	11.5	13.9	11.8	13.9
19/09/2016	11.1	18.7	11.2	17.3	11.4	17.5	11.5	17.3
20/09/2016	10.2	16.7	10.2	15.9	10.5	15.9	10.8	15.7
21/09/2016	11.2	13.4	11.5	13.1	11.7	13.3	11.8	13.4
22/09/2016	11.0	14.8	11.3	14.4	11.4	14.5	11.5	14.5
23/09/2016	10.6	19.1	10.7	18.0	10.9	18.0	11.2	18.2
24/09/2016	11.4	19.6	11.3	18.2	11.5	18.1	11.9	18.1
25/09/2016	13.8	19.5	13.4	18.6	13.5	18.6	13.9	18.8
26/09/2016	11.3	19.8	11.2	18.6	11.6	18.6	12.1	18.8
27/09/2016	12.0	18.3	12.0	17.7	12.3	18.0	12.7	18.2
28/09/2016	10.1	20.2	10.4	18.6	10.8	18.8	11.3	18.9
29/09/2016	11.6	17.0	11.9	15.7	12.4	15.9	12.8	16.1
30/09/2016	10.5	16.7	11.0	15.2	11.4	15.4	11.6	15.5
1/10/2016	11.4	16.9	11.6	16.1	11.9	15.8	12.1	16.0
2/10/2016	11.1	20.8	11.0	19.0	11.3	19.1	11.7	19.5
3/10/2016	13.2	18.9	12.9	17.8	13.6	18.2	14.0	18.7
4/10/2016	11.5	16.8	11.6	16.1	12.2	16.5	12.6	16.8
5/10/2016	9.5	17.3	10.0	16.4	10.4	16.6	10.7	17.1

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
6/10/2016	11.6	20.1	11.6	18.9	12.1	19.2	12.6	19.7
7/10/2016	13.4	18.9	13.2	18.0	13.6	18.1	14.1	18.5
8/10/2016	13.4	20.3	13.0	19.1	13.4	19.4	13.9	19.4
9/10/2016	12.2	17.3	11.9	16.6	12.3	16.5	12.8	16.8
10/10/2016	12.6	16.2	12.5	15.7	12.8	15.9	13.3	16.2
11/10/2016	10.6	19.7	10.7	18.5	11.1	18.8	11.6	19.3
12/10/2016	10.5	17.9	10.5	17.1	11.1	17.4	11.5	17.8
13/10/2016	11.2	21.1	11.3	19.6	11.8	20.0	12.4	20.3
14/10/2016	11.4	22.4	11.2	20.6	11.6	20.8	12.1	21.0
15/10/2016	12.4	23.4	11.8	21.3	12.2	21.5	12.6	21.9
16/10/2016	14.0	23.3	13.4	21.6	13.7	21.5	14.1	22.1
17/10/2016	14.9	21.3	14.6	20.1	15.0	20.5	15.7	21.0
18/10/2016	12.9	20.7	12.6	19.6	13.0	19.8	13.7	20.7
19/10/2016	12.6	22.8	12.3	21.0	12.7	21.2	13.6	21.7
20/10/2016	13.1	22.3	12.5	20.7	12.8	21.1	13.4	21.1
21/10/2016	13.1	22.3	12.4	20.5	12.8	20.7	13.1	20.9
22/10/2016	14.1	19.9	13.6	18.9	13.8	18.6	14.5	19.2
23/10/2016	12.0	18.7	11.6	17.8	11.9	17.8	12.6	18.2
24/10/2016	11.3	22.8	11.0	21.1	11.2	21.3	11.8	21.2
25/10/2016	13.1	23.2	12.5	21.4	12.8	21.6	13.2	21.7
26/10/2016	15.4	25.5	14.7	23.3	14.9	23.6	15.3	23.6
27/10/2016	16.3	27.4	15.4	25.0	15.7	25.3	16.1	25.3
28/10/2016	17.2	21.1	16.2	19.9	16.6	20.1	17.0	20.0
29/10/2016	17.0	23.1	16.3	21.9	16.6	22.0	16.8	21.7
30/10/2016	17.2	22.0	16.5	20.9	16.7	20.8	16.9	21.1

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
31/10/2016	14.4	25.1	14.0	23.0	14.4	23.6	15.0	23.7
1/11/2016	13.3	23.9	12.5	22.0	13.2	22.6	13.5	22.5
2/11/2016	13.5	26.4	12.7	24.1	13.4	24.5	13.8	24.6
3/11/2016	15.1	27.9	14.0	25.6	14.8	25.8	15.1	25.9
4/11/2016	16.2	29.1	15.0	26.6	15.6	27.0	15.9	26.9
5/11/2016	17.7	28.6	16.6	26.2	17.3	26.9	17.6	26.8
6/11/2016	16.8	29.3	15.5	26.6	16.5	26.9	16.8	27.1
7/11/2016	17.7	30.5	16.2	27.9	17.2	27.9	17.5	28.1
8/11/2016	18.8	26.6	17.2	24.8	18.1	24.8	18.4	25.0
9/11/2016	19.5	27.5	18.4	25.7	19.0	25.8	19.3	25.7
10/11/2016	19.1	29.4	18.3	27.1	18.7	27.4	18.9	27.8
11/11/2016	18.9	30.1	18.1	27.7	18.6	28.3	18.9	28.1
12/11/2016	19.7	28.8	19.2	26.5	19.1	26.9	19.7	27.2
13/11/2016	18.5	25.7	17.8	23.7	18.4	24.3	18.9	24.8
14/11/2016	17.6	23.0	16.9	21.8	17.4	22.0	18.0	22.3
15/11/2016	16.1	25.8	15.6	24.1	16.0	24.1	16.6	24.4
16/11/2016	17.1	28.1	16.3	25.9	16.6	26.3	17.2	26.2
17/11/2016	19.7	29.7	19.0	27.3	19.2	27.8	19.7	27.7
18/11/2016	19.7	30.5	18.7	28.4	19.0	28.1	19.3	28.3
19/11/2016	21.2	32.1	20.1	29.8	20.3	29.6	20.7	29.5
20/11/2016	22.3	31.6	21.0	29.3	21.3	29.1	21.6	29.2
21/11/2016	22.4	32.5	21.3	30.0	21.5	29.7	21.9	30.2
22/11/2016	21.9	32.6	20.8	29.9	21.1	30.1	21.6	30.3
23/11/2016	19.3	23.4	18.8	22.3	19.2	22.6	19.7	22.9
24/11/2016	16.2	27.7	15.8	25.7	16.4	25.7	16.8	26.2

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
25/11/2016	17.2	30.2	16.4	27.3	17.0	27.6	17.5	27.7
26/11/2016	19.9	31.5	18.7	28.6	19.2	28.8	19.6	28.8
27/11/2016	20.7	32.8	19.3	30.0	19.7	30.1	20.1	29.7
28/11/2016	23.1	34.6	21.6	31.6	22.0	31.5	22.2	31.6
29/11/2016	21.7	32.6	19.9	30.0	20.6	29.6	20.8	30.1
30/11/2016	22.8	33.8	21.2	31.2	21.7	30.9	22.2	31.2
1/12/2016	23.5	35.8	21.8	32.7	22.3	32.6	22.8	32.9
2/12/2016	22.8	34.8	20.9	32.0	21.6	32.1	22.2	32.2
3/12/2016	24.2	35.9	22.4	33.1	23.1	33.0	23.6	33.0
4/12/2016	24.2	34.5	22.4	32.0	23.0	31.6	23.5	31.8
5/12/2016	25.5	30.4	23.9	28.7	24.3	28.6	24.8	28.7
6/12/2016	22.6	26.4	21.7	25.4	22.0	25.4	22.5	25.7
7/12/2016	19.6	31.7	18.9	29.4	19.4	29.8	19.9	29.8
8/12/2016	20.4	32.1	19.4	29.4	19.9	29.9	20.3	30.2
9/12/2016	20.0	31.7	19.0	28.9	19.6	29.3	20.4	29.8
10/12/2016	20.3	33.4	19.1	30.7	19.7	30.7	20.4	30.8
11/12/2016	22.6	35.1	21.2	32.5	21.5	32.2	22.1	32.0
12/12/2016	24.6	37.0	23.2	34.2	23.4	33.8	23.9	33.9
13/12/2016	24.1	34.2	22.3	31.8	22.8	31.2	23.3	31.8
14/12/2016	24.3	28.2	23.1	26.5	23.4	26.5	24.0	27.1
15/12/2016	20.2	23.3	19.6	22.2	20.0	22.6	20.6	23.2
16/12/2016	19.2	22.2	18.7	21.7	19.1	21.7	19.7	22.0
17/12/2016	20.0	27.9	19.6	26.4	19.9	26.6	20.2	27.3
18/12/2016	19.6	31.1	19.0	28.6	19.7	29.4	20.0	29.1
19/12/2016	20.6	31.6	19.8	29.5	20.4	29.7	20.7	29.7

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
20/12/2016	20.9	30.3	19.7	28.2	20.4	28.0	20.5	28.8
21/12/2016	20.9	34.5	19.6	31.7	20.3	31.3	20.5	31.8
22/12/2016	24.2	35.0	22.7	32.5	23.0	32.1	23.3	32.2
23/12/2016	24.9	37.0	23.5	34.5	23.8	33.6	24.1	33.9
24/12/2016	24.8	36.9	23.5	34.5	23.7	33.5	24.1	33.9
25/12/2016	22.1	33.4	21.0	31.0	21.3	31.1	21.7	31.4
26/12/2016	23.4	33.5	22.4	31.2	22.7	31.3	23.1	31.7
27/12/2016	24.8	30.8	23.7	29.3	24.1	29.1	24.4	29.4
28/12/2016	23.9	30.4	22.9	28.8	23.2	28.4	23.5	29.0
29/12/2016	25.2	29.4	24.1	28.1	24.3	27.8	24.7	28.2
30/12/2016	24.4	31.9	23.6	30.3	23.9	30.1	24.2	30.4
31/12/2016	23.4	35.4	22.6	32.8	23.0	33.0	23.4	33.5
1/01/2017	23.6	28.7	22.4	27.4	22.9	27.3	23.5	27.7
2/01/2017	22.6	33.2	21.7	31.3	22.1	30.6	22.7	31.0
3/01/2017	23.9	35.9	22.8	33.4	23.0	32.5	23.5	33.1
4/01/2017	24.2	31.3	23.0	29.6	23.2	29.5	23.8	29.3
5/01/2017	23.3	36.1	22.3	33.9	22.6	32.6	23.0	33.1
6/01/2017	24.5	37.3	23.2	34.7	23.5	33.4	24.1	34.0
7/01/2017	25.3	38.1	23.9	35.4	24.2	34.0	24.7	34.7
8/01/2017	26.5	35.1	25.0	33.1	25.3	32.0	25.7	32.6
9/01/2017	27.3	35.2	25.9	33.2	26.1	32.3	26.5	32.8
10/01/2017	25.8	35.7	24.6	33.5	25.0	32.5	25.4	33.1
11/01/2017	26.5	39.6	25.2	36.7	25.5	35.6	25.9	36.3
12/01/2017	26.5	40.3	24.9	37.3	25.4	36.1	25.8	36.5
13/01/2017	28.9	36.9	27.4	34.5	27.8	33.8	27.9	34.2

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
14/01/2017	26.5	38.7	25.5	35.8	25.9	34.4	26.4	35.3
15/01/2017	25.0	39.2	23.6	36.0	24.1	34.9	24.5	35.3
16/01/2017	27.5	41.1	26.1	37.9	26.5	36.7	26.7	37.2
17/01/2017	27.2	41.5	25.7	38.3	26.2	37.0	26.4	37.6
18/01/2017	28.6	39.4	26.9	36.6	27.4	35.7	27.7	36.5
19/01/2017	27.7	32.9	26.3	31.0	26.8	31.7	27.1	30.7
20/01/2017	24.4	30.3	23.6	29.0	24.1	29.6	24.5	28.9
21/01/2017	20.6	35.4	20.0	32.4	20.6	32.2	21.2	32.3
22/01/2017	24.1	38.0	23.2	35.2	23.6	34.2	24.0	34.4
23/01/2017	25.6	38.1	24.4	35.3	24.6	34.2	24.9	34.5
24/01/2017	27.5	34.1	26.1	32.5	26.5	31.1	26.9	32.2
25/01/2017	24.8	32.8	23.8	30.8	24.1	30.4	24.7	30.4
26/01/2017	24.3	38.4	23.4	35.7	23.8	34.5	24.2	34.7
27/01/2017	26.3	39.1	25.1	36.4	25.4	35.0	25.6	35.3
28/01/2017	26.9	40.1	25.6	37.2	26.0	35.7	26.0	36.2
29/01/2017	26.6	41.0	25.2	37.8	25.7	36.3	25.8	36.7
30/01/2017	28.0	40.4	26.5	37.3	27.0	36.1	27.0	36.7
31/01/2017	29.4	38.8	27.8	36.2	28.2	35.4	28.3	35.7
1/02/2017	24.7	29.8	23.8	28.4	24.5	28.6	24.8	28.8
2/02/2017	22.5	33.1	21.9	31.1	22.5	30.4	22.9	30.8
3/02/2017	23.7	36.3	23.0	33.9	23.3	32.7	23.8	33.2
4/02/2017	24.5	35.1	23.4	32.9	23.7	31.8	24.1	32.1
5/02/2017	25.3	37.5	24.1	35.0	24.5	33.9	24.7	34.2
6/02/2017	27.3	34.1	26.2	32.3	26.3	31.8	26.6	31.9
7/02/2017	23.6	27.5	23.0	26.5	23.3	26.7	23.9	26.9

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
8/02/2017	22.5	26.8	22.1	26.0	22.3	25.9	23.0	26.1
9/02/2017	23.3	35.2	22.9	33.7	23.1	33.0	23.5	32.9
10/02/2017	26.1	38.6	25.1	36.7	25.2	35.4	25.5	35.8
11/02/2017	28.2	39.4	26.9	37.3	27.1	35.8	27.3	36.6
12/02/2017	24.0	33.1	23.1	32.6	23.3	31.1	24.2	32.3
13/02/2017	21.1	34.6	20.3	32.4	20.6	31.0	21.6	32.3
14/02/2017	24.5	37.0	23.5	34.4	23.5	33.2	24.1	34.1
15/02/2017	25.3	37.0	24.0	34.8	24.1	33.3	24.8	34.3
16/02/2017	25.0	38.1	23.6	35.8	24.0	34.3	24.3	35.2
17/02/2017	25.4	37.5	23.9	35.4	24.3	33.9	24.6	34.9
18/02/2017	22.7	28.3	21.7	27.2	22.2	26.9	22.5	27.5
19/02/2017	19.6	31.6	18.7	30.0	19.2	28.5	19.7	29.7
20/02/2017	20.0	31.8	19.2	30.3	19.4	28.8	20.1	30.1
21/02/2017	19.7	33.4	18.7	31.5	19.1	30.1	19.7	31.1
22/02/2017	22.8	35.8	21.7	33.7	21.9	32.1	22.2	32.9
23/02/2017	24.1	36.8	22.8	34.6	23.1	32.8	23.3	33.8
24/02/2017	25.1	37.3	23.6	34.7	23.9	33.5	24.1	34.3
25/02/2017	25.7	29.6	24.6	28.1	25.0	28.4	25.3	28.4
26/02/2017	23.4	34.8	22.4	32.5	22.8	31.6	23.3	32.4
27/02/2017	23.6	33.4	22.4	31.2	22.8	31.0	23.2	31.1
28/02/2017	23.6	31.7	22.6	29.9	23.0	29.6	23.3	30.0
1/03/2017	22.3	33.3	21.3	31.3	21.7	30.5	22.1	31.0
2/03/2017	24.0	31.0	23.0	29.8	23.4	29.2	23.6	29.5
3/03/2017	23.4	32.0	22.6	30.4	22.9	29.9	23.3	30.4
4/03/2017	22.7	27.5	22.1	26.4	22.6	26.6	22.8	27.0

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
5/03/2017	20.7	29.4	20.3	28.3	20.7	27.9	21.0	29.0
6/03/2017	19.3	29.6	19.1	28.6	19.5	27.6	20.0	29.3
7/03/2017	19.9	30.3	19.6	28.7	20.0	28.0	20.5	29.1
8/03/2017	20.8	27.2	20.3	26.1	20.6	25.9	21.1	26.4
9/03/2017	20.3	30.8	19.9	29.2	20.2	28.3	20.6	29.1
10/03/2017	20.0	31.8	19.2	30.2	19.6	28.6	20.1	29.8
11/03/2017	21.8	30.6	21.0	29.3	21.2	28.1	21.7	28.9
12/03/2017	21.9	32.4	21.1	31.0	21.1	29.2	21.6	30.3
13/03/2017	23.3	28.6	22.5	27.1	22.5	26.7	23.1	27.4
14/03/2017	21.2	25.4	20.6	24.3	20.7	24.3	21.3	24.7
15/03/2017	21.1	25.6	20.7	24.5	20.9	24.7	21.1	25.2
16/03/2017	21.7	26.6	21.4	25.9	21.4	25.8	21.8	26.3
17/03/2017	20.9	27.7	20.5	26.8	20.6	26.6	20.8	27.5
18/03/2017	20.0	25.4	19.7	24.7	20.1	25.1	20.4	25.5
19/03/2017	21.1	25.8	20.8	25.1	21.1	25.4	21.4	25.7
20/03/2017	21.4	29.6	21.1	28.7	21.2	28.3	21.5	29.0
21/03/2017	22.2	24.4	22.1	23.9	22.1	23.9	22.3	24.1
22/03/2017	21.2	25.8	21.0	25.6	20.9	24.6	21.1	25.5
23/03/2017	20.3	22.7	20.3	22.3	20.2	22.3	20.5	22.6
24/03/2017	19.6	23.3	19.6	22.7	19.6	22.8	19.8	23.1
25/03/2017	19.2	21.6	19.1	21.4	19.2	21.5	19.5	21.7
26/03/2017	17.6	25.9	17.7	25.2	17.7	24.5	17.9	25.4
27/03/2017	19.7	27.2	19.4	26.1	19.3	25.4	19.7	26.3
28/03/2017	21.3	27.8	20.8	26.6	20.7	26.1	21.2	26.9
29/03/2017	19.6	26.4	19.2	25.2	19.2	24.7	19.5	25.5

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
30/03/2017	18.5	23.1	18.3	22.5	18.4	22.4	18.7	22.8
31/03/2017	16.1	23.1	16.3	22.3	16.1	21.9	16.5	22.8
1/04/2017	16.3	23.3	16.2	22.2	16.1	22.0	16.5	22.7
2/04/2017	17.7	22.6	17.4	21.8	17.5	21.6	18.0	22.3
3/04/2017	15.6	19.4	15.6	19.1	15.6	19.2	16.0	19.6
4/04/2017	14.7	19.7	14.8	19.4	15.0	19.4	15.3	19.8
5/04/2017	14.6	21.7	14.6	20.8	14.8	21.1	15.1	21.4
6/04/2017	15.3	22.3	15.1	21.4	15.3	21.3	15.7	21.9
7/04/2017	14.8	22.0	14.6	21.1	14.9	21.1	15.2	21.7
8/04/2017	15.2	21.6	14.9	20.9	15.2	20.7	15.5	21.2
9/04/2017	14.5	16.7	14.4	16.3	14.5	16.4	14.7	16.7
10/04/2017	13.7	17.6	13.7	17.3	13.8	17.4	14.0	17.7
11/04/2017	13.2	19.2	13.3	19.0	13.4	18.9	13.6	19.6
12/04/2017	14.0	19.7	14.0	19.3	14.0	19.2	14.4	19.8
13/04/2017	14.6	19.4	14.6	18.9	14.6	18.7	15.0	19.3
14/04/2017	13.5	19.7	13.5	19.4	13.4	19.1	13.8	19.8
15/04/2017	14.1	19.3	14.1	19.2	14.2	19.1	14.5	19.7
16/04/2017	12.9	18.7	13.0	18.2	13.1	18.2	13.4	18.8
17/04/2017	13.9	19.5	13.9	19.5	14.0	19.2	14.2	19.8
18/04/2017	15.3	20.7	15.3	20.5	15.3	20.5	15.6	21.0
19/04/2017	15.5	20.7	15.5	20.5	15.6	20.5	15.9	21.0
20/04/2017	15.0	20.2	15.1	20.3	15.1	20.1	15.3	20.7
21/04/2017	15.1	19.0	15.0	18.8	15.2	18.8	15.4	19.1
22/04/2017	16.2	19.2	16.2	19.5	16.2	19.4	16.5	19.7
23/04/2017	14.4	19.6	14.5	19.8	14.6	19.7	14.8	20.2

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
24/04/2017	15.4	19.8	15.4	19.7	15.6	19.8	15.8	20.1
25/04/2017	15.9	18.0	15.9	17.7	15.8	17.7	16.1	18.0
26/04/2017	13.6	16.4	13.7	16.4	13.8	16.4	14.1	16.7
27/04/2017	11.2	15.5	11.6	16.2	11.4	16.0	11.8	16.7
28/04/2017	10.3	15.1	10.7	15.8	10.7	15.7	11.1	16.2
29/04/2017	10.2	14.8	10.6	15.6	10.8	15.5	11.1	16.0
30/04/2017	10.9	15.8	11.4	16.7	11.6	16.5	11.8	17.0
1/05/2017	10.8	15.6	11.2	16.2	11.4	16.1	11.6	16.4
2/05/2017	11.6	16.3	12.1	14.9	12.2	14.9	12.4	15.2
3/05/2017	9.5	14.6	10.3	15.2	10.6	14.8	10.9	15.2
4/05/2017	9.1	14.6	9.9	15.0	10.2	14.6	10.5	15.0
5/05/2017	10.7	15.7	11.4	16.1	11.8	15.7	12.1	16.0
6/05/2017	10.6	14.1	11.2	14.2	11.8	14.1	11.9	14.3
7/05/2017	9.9	14.0	10.7	14.8	11.1	14.6	11.2	14.9
8/05/2017	7.8	12.4	8.8	13.4	9.3	13.1	9.6	13.5
9/05/2017	8.0	12.9	8.9	14.1	9.3	13.6	9.5	14.1
10/05/2017	7.9	12.8	8.9	14.2	9.3	13.6	9.6	14.0
11/05/2017	7.9	13.2	9.0	13.9	9.4	13.4	9.6	13.8
12/05/2017	8.1	13.6	9.0	13.7	9.6	13.3	9.8	13.6
13/05/2017	9.6	13.9	10.2	14.9	10.6	14.2	10.8	14.6
14/05/2017	11.3	14.0	12.1	14.3	12.3	14.2	12.5	14.3
15/05/2017	10.2	13.8	10.8	14.9	11.0	14.4	11.2	14.9
16/05/2017	8.5	12.9	9.3	14.2	9.6	13.6	9.8	14.0
17/05/2017	7.9	12.5	8.9	13.7	9.3	13.1	9.5	13.5
18/05/2017	9.9	13.9	10.8	15.1	10.8	14.5	11.1	14.8

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
19/05/2017	11.2	13.7	12.0	14.1	12.1	13.9	12.3	14.1
20/05/2017	12.1	15.2	12.6	15.7	12.6	15.3	12.7	15.6
21/05/2017	9.2	13.0	10.1	14.3	10.3	13.7	10.4	14.1
22/05/2017	8.4	12.4	9.6	13.8	9.7	13.3	9.8	13.7
23/05/2017	8.2	12.5	9.4	13.6	9.7	13.3	9.9	13.6
24/05/2017	9.8	12.3	10.9	13.2	11.2	13.1	11.2	13.3
25/05/2017	8.4	11.8	9.4	12.1	9.7	12.0	9.8	12.1
26/05/2017	7.8	11.1	8.8	12.4	9.2	12.3	9.3	12.6
27/05/2017	8.4	12.2	9.4	13.2	9.8	13.1	9.9	13.4
28/05/2017	7.4	11.4	8.5	12.1	9.1	12.1	9.1	12.3
29/05/2017	7.3	9.8	8.4	11.3	8.7	11.4	8.9	11.8
30/05/2017	5.3	9.0	6.7	10.3	7.1	10.3	7.3	10.6
31/05/2017	6.5	9.0	7.8	10.5	8.2	10.7	8.4	11.2
1/06/2017	4.8	8.3	6.1	9.8	6.6	10.0	6.7	10.4
2/06/2017	4.2	8.0	5.7	9.5	6.2	9.7	6.3	10.1
3/06/2017	4.3	8.4	5.7	9.8	6.3	10.1	6.4	10.3
4/06/2017	4.3	8.1	5.6	9.5	6.3	9.8	6.4	10.1
5/06/2017	4.4	7.9	5.7	9.2	6.3	9.5	6.4	9.7
6/06/2017	4.6	8.9	5.8	9.6	6.7	9.7	6.7	9.9
7/06/2017	6.1	8.8	6.9	9.7	7.3	9.9	7.4	10.3
8/06/2017	7.2	10.4	8.0	11.3	8.5	11.6	8.6	11.9
9/06/2017	8.6	11.6	9.4	11.8	10.0	12.0	10.1	12.0
10/06/2017	8.7	11.4	9.2	11.6	9.5	11.6	9.6	11.7
11/06/2017	7.4	10.1	8.0	10.9	8.5	11.4	8.6	11.6
12/06/2017	6.5	9.9	7.3	10.6	8.1	11.0	8.1	11.2

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
13/06/2017	5.2	8.8	6.2	9.9	6.9	10.4	6.9	10.6
14/06/2017	4.9	8.5	5.9	9.5	6.8	10.1	6.9	10.4
15/06/2017	4.9	8.7	6.0	9.2	6.9	9.4	6.9	9.5
16/06/2017	5.1	9.1	5.9	9.3	6.7	9.4	6.8	9.4
17/06/2017	7.6	11.1	8.1	11.0	8.5	11.0	8.6	11.1
18/06/2017	6.5	9.1	7.0	10.0	7.5	10.5	7.6	10.8
19/06/2017	4.6	8.2	5.5	9.1	6.2	9.7	6.3	10.0
20/06/2017	4.8	7.9	5.8	8.9	6.8	9.6	6.8	9.8
21/06/2017	5.0	7.9	6.1	9.0	7.0	9.7	7.1	10.0
22/06/2017	5.4	8.5	6.4	9.5	7.1	10.1	7.1	10.4
23/06/2017	4.7	8.1	5.7	9.0	6.6	9.6	6.7	9.9
24/06/2017	5.5	8.3	6.5	9.4	7.2	10.0	7.3	10.3
25/06/2017	4.1	8.2	5.3	9.2	6.1	9.6	6.2	9.9
26/06/2017	4.2	7.7	5.2	8.7	6.0	9.3	6.2	9.6
27/06/2017	3.8	7.9	4.8	8.4	5.7	8.6	5.8	8.7
28/06/2017	6.0	8.4	6.7	9.1	7.3	9.5	7.4	9.7
29/06/2017	4.2	7.0	5.1	7.9	5.9	8.7	6.0	8.9
30/06/2017	3.1	6.2	4.2	7.6	5.1	8.2	5.3	8.7
1/07/2017	1.9	5.6	3.1	6.9	4.1	7.6	4.2	8.0
2/07/2017	1.5	5.3	2.7	6.7	3.7	7.3	3.8	7.7
3/07/2017	1.6	5.5	2.9	6.2	4.0	6.7	4.1	6.8
4/07/2017	4.8	9.0	5.7	9.5	6.2	9.4	6.4	9.6
5/07/2017	6.4	9.2	7.1	9.7	7.5	9.7	7.6	9.8
6/07/2017	4.6	7.8	5.4	8.9	6.0	9.2	6.1	9.6
7/07/2017	4.4	8.4	5.2	9.1	5.9	9.2	6.1	9.5

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
8/07/2017	3.7	7.3	4.5	7.8	5.2	8.3	5.4	8.4
9/07/2017	4.7	8.2	5.4	8.7	6.3	8.8	6.4	9.0
10/07/2017	3.9	8.0	4.6	8.7	5.2	8.6	5.3	8.9
11/07/2017	2.9	6.8	3.7	8.0	4.4	8.4	4.5	8.6
12/07/2017	3.1	7.8	4.0	8.5	4.6	8.2	4.8	8.6
13/07/2017	2.8	6.9	3.7	8.0	4.2	7.8	4.4	8.2
14/07/2017	3.9	8.2	4.7	8.5	5.3	8.3	5.5	8.5
15/07/2017	4.8	8.3	5.3	8.4	5.7	8.3	5.8	8.5
16/07/2017	3.0	6.8	3.6	7.9	4.2	7.7	4.4	8.2
17/07/2017	3.0	7.2	3.8	8.3	4.5	8.0	4.7	8.4
18/07/2017	4.4	8.8	5.1	9.3	5.5	8.9	5.6	9.2
19/07/2017	5.9	9.1	6.5	10.1	6.7	9.7	6.9	10.2
20/07/2017	4.8	7.7	5.6	9.1	5.9	8.9	6.1	9.3
21/07/2017	3.0	7.3	3.9	8.9	4.5	8.3	4.6	8.9
22/07/2017	2.4	6.6	3.5	8.3	4.1	7.8	4.2	8.2
23/07/2017	3.3	7.6	4.5	9.3	4.8	8.6	4.9	9.1
24/07/2017	4.7	8.6	5.8	10.3	5.9	9.5	6.1	10.0
25/07/2017	4.7	9.4	6.0	10.7	6.1	10.1	6.2	10.3
26/07/2017	6.5	9.4	7.4	10.6	7.5	10.2	7.6	10.5
27/07/2017	4.4	8.1	5.3	9.7	6.0	9.2	6.1	9.6
28/07/2017	5.1	8.9	6.2	10.7	6.7	10.1	6.8	10.7
29/07/2017	3.8	8.6	4.9	10.2	5.6	9.5	5.8	10.0
30/07/2017	5.5	9.9	6.7	10.3	7.0	10.0	7.2	10.2
31/07/2017	7.8	9.0	8.3	9.3	8.4	9.3	8.6	9.5
1/08/2017	6.2	9.9	6.7	10.8	6.9	10.4	7.1	10.8

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
2/08/2017	4.7	9.3	5.6	10.4	5.8	10.0	6.0	10.3
3/08/2017	4.5	8.8	5.5	9.0	5.8	8.9	5.9	9.0
4/08/2017	7.6	10.0	8.0	10.7	8.1	10.5	8.2	10.6
5/08/2017	7.3	10.2	7.9	11.0	7.9	10.7	8.1	11.0
6/08/2017	6.3	10.4	7.2	10.9	7.3	10.5	7.4	10.8
7/08/2017	7.1	10.6	7.6	10.5	7.8	10.4	8.0	10.5
8/08/2017	6.2	10.4	6.8	11.1	6.8	10.4	7.1	10.9
9/08/2017	6.0	11.1	6.8	11.7	6.9	11.1	7.1	11.5
10/08/2017	6.7	11.5	7.5	12.1	7.6	11.4	7.7	11.8
11/08/2017	8.4	11.7	8.9	12.6	9.0	12.0	9.2	12.4
12/08/2017	7.2	11.7	8.1	12.5	8.2	11.8	8.3	12.2
13/08/2017	7.3	12.2	8.1	12.9	8.1	12.1	8.3	12.6
14/08/2017	7.1	12.5	8.0	13.2	8.0	12.3	8.2	12.7
15/08/2017	7.5	11.8	8.3	11.9	8.5	11.5	8.7	11.6
16/08/2017	10.0	12.2	10.4	12.8	10.4	12.6	10.5	12.9
17/08/2017	8.1	12.2	8.8	12.4	9.0	12.1	9.2	12.4
18/08/2017	7.8	10.8	8.6	11.8	8.7	11.5	8.9	12.0
19/08/2017	5.8	10.6	6.8	11.5	7.0	10.8	7.2	11.6
20/08/2017	4.9	11.0	5.9	11.5	6.2	10.9	6.4	11.3
21/08/2017	7.0	10.6	7.7	10.7	8.0	10.5	8.2	10.6
22/08/2017	6.3	12.4	6.9	12.5	6.9	11.7	7.2	12.2
23/08/2017	6.3	12.2	6.9	12.3	7.1	11.5	7.3	12.1
24/08/2017	6.7	12.0	7.3	11.9	7.5	11.3	7.7	11.8
25/08/2017	5.7	12.3	6.3	12.2	6.4	11.4	6.7	12.0
26/08/2017	6.2	12.9	6.8	12.8	7.1	11.9	7.3	12.5

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
27/08/2017	6.6	9.1	7.3	9.4	7.2	9.1	7.5	9.4
28/08/2017	4.5	11.2	5.3	11.2	5.6	10.4	5.9	11.1
29/08/2017	6.1	12.1	6.6	11.8	6.7	11.1	7.0	11.6
30/08/2017	5.3	12.7	5.9	12.3	6.1	11.4	6.4	11.9
31/08/2017	6.1	12.8	6.6	12.5	6.7	11.6	7.1	12.4
1/09/2017	5.8	13.5	6.3	12.8	6.3	11.8	6.7	12.5
2/09/2017	6.3	12.7	6.7	12.1	6.8	11.6	7.2	11.8
3/09/2017	7.8	13.4	8.0	12.9	8.2	12.2	8.4	12.6
4/09/2017	8.0	12.3	8.3	12.2	8.4	11.8	8.7	12.2
5/09/2017	7.7	12.7	8.0	12.1	8.3	11.7	8.5	12.1
6/09/2017	8.0	14.3	8.2	13.4	8.3	12.8	8.7	13.3
7/09/2017	9.2	14.0	9.2	13.5	9.6	13.0	9.8	13.4
8/09/2017	8.9	14.9	9.1	14.3	9.6	13.8	9.8	14.4
9/09/2017	7.6	15.5	7.9	14.3	8.4	13.5	8.7	14.1
10/09/2017	7.8	16.5	7.9	15.0	8.1	13.9	8.5	14.6
11/09/2017	8.1	16.5	8.2	15.2	8.4	14.0	8.8	14.7
12/09/2017	10.0	17.4	9.8	15.9	10.1	14.8	10.3	15.4
13/09/2017	11.5	17.3	11.3	15.9	11.4	15.1	11.6	15.6
14/09/2017	10.3	16.4	10.2	15.5	10.5	14.8	10.9	15.4
15/09/2017	10.5	15.5	10.4	14.9	10.7	14.3	11.0	14.8
16/09/2017	11.1	17.3	10.9	16.2	11.2	15.5	11.5	16.2
17/09/2017	8.3	18.1	8.4	16.1	9.0	15.1	9.5	15.9
18/09/2017	8.3	18.6	8.2	16.6	8.8	15.2	9.2	16.1
19/09/2017	10.9	18.7	10.3	17.0	10.7	15.9	11.0	16.7
20/09/2017	9.3	19.2	9.0	17.0	9.6	15.7	10.0	16.6

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
21/09/2017	10.4	20.1	10.0	18.0	10.3	16.5	10.8	17.3
22/09/2017	11.2	20.9	10.7	18.7	11.1	17.2	11.4	18.0
23/09/2017	11.7	22.2	11.1	19.8	11.6	18.0	11.9	18.9
24/09/2017	14.8	21.8	14.1	19.8	14.0	18.5	14.4	19.3
25/09/2017	13.4	21.3	12.9	19.5	13.0	18.2	13.6	19.2
26/09/2017	12.4	22.9	12.0	20.4	12.3	18.8	12.9	19.8
27/09/2017	12.7	22.1	12.1	20.6	12.5	18.7	13.0	19.8
28/09/2017	15.9	23.0	15.2	20.7	15.2	19.7	15.7	20.6
29/09/2017	13.4	21.7	13.1	19.8	13.5	18.9	14.1	19.9
30/09/2017	13.0	20.7	12.8	19.0	13.2	18.3	13.9	19.4
1/10/2017	11.4	22.8	11.2	20.2	12.1	19.0	12.6	20.0
2/10/2017	12.5	23.8	12.1	21.3	12.7	19.7	13.2	20.7
3/10/2017	14.0	25.1	13.3	22.6	13.7	20.8	14.1	21.7
4/10/2017	14.3	25.2	13.5	22.8	14.0	21.0	14.4	21.9
5/10/2017	16.8	22.6	15.9	21.3	15.8	20.1	16.2	20.9
6/10/2017	16.3	25.1	15.7	22.9	15.8	21.3	16.3	22.3
7/10/2017	14.5	25.1	14.0	22.6	14.5	21.1	14.9	21.8
8/10/2017	16.1	21.0	15.4	19.8	15.6	18.9	16.0	19.5
9/10/2017	16.5	23.8	16.2	22.1	16.3	21.3	16.6	22.2
10/10/2017	14.6	25.0	14.0	22.3	14.6	21.7	14.9	22.6
11/10/2017	17.3	26.3	16.7	23.9	16.8	23.3	17.2	24.1
12/10/2017	18.1	25.7	17.5	22.9	17.3	22.7	18.0	23.6
13/10/2017	15.0	25.2	14.5	22.6	15.4	22.3	15.8	23.1
14/10/2017	17.3	20.3	16.6	19.1	17.0	19.2	17.5	19.5
15/10/2017	15.8	25.9	15.3	23.7	15.8	22.8	16.1	23.4

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
16/10/2017	16.4	27.4	15.8	24.8	16.2	23.8	16.6	24.4
17/10/2017	16.8	28.4	16.1	25.6	16.5	24.4	16.9	24.9
18/10/2017	17.9	29.0	17.1	26.3	17.4	24.9	17.7	25.5
19/10/2017	19.2	26.5	18.2	24.7	18.3	23.4	18.7	24.1
20/10/2017	18.8	23.1	18.2	21.6	18.6	20.9	19.0	21.4
21/10/2017	14.4	25.2	14.1	22.8	15.1	22.1	15.3	23.0
22/10/2017	16.9	22.0	16.3	20.8	16.9	20.4	17.2	21.2
23/10/2017	14.1	25.7	13.6	23.4	14.5	22.5	14.9	23.4
24/10/2017	15.2	22.2	14.5	20.6	15.2	20.2	15.7	20.6
25/10/2017	17.4	23.8	16.7	22.3	17.1	21.6	17.5	22.2
26/10/2017	17.7	23.6	17.1	22.1	17.4	21.5	17.9	21.9
27/10/2017	16.4	24.2	15.9	22.2	16.5	22.0	16.8	22.3
28/10/2017	17.1	24.8	16.5	22.9	16.9	22.4	17.1	22.8
29/10/2017	18.0	26.4	17.4	24.2	17.8	23.7	18.1	24.3
30/10/2017	17.2	26.4	16.4	24.4	17.2	24.0	17.5	24.8
31/10/2017	15.6	23.7	15.0	21.9	16.1	21.5	16.5	22.7
1/11/2017	14.9	24.6	14.3	22.8	15.4	22.2	15.9	23.4
2/11/2017	15.6	27.1	14.8	24.8	15.9	23.8	16.3	24.8
3/11/2017	16.7	24.4	15.8	22.3	16.7	22.0	17.1	22.5
4/11/2017	17.5	27.8	16.7	25.4	17.3	24.4	17.7	25.0
5/11/2017	18.2	23.9	17.4	22.2	18.0	21.8	18.4	22.2
6/11/2017	14.7	19.7	15.3	18.8	15.1	19.2	15.3	19.5
7/11/2017	13.4	23.4	13.4	21.1	14.1	21.1	14.3	21.8
8/11/2017	15.7	25.8	15.4	22.6	16.0	22.8	16.5	23.4
9/11/2017	15.7	27.2	15.3	24.0	15.9	23.9	16.2	24.4

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
10/11/2017	16.3	26.9	15.7	24.2	16.4	24.1	16.7	24.6
11/11/2017	18.5	24.7	17.8	22.6	18.2	22.4	18.6	23.2
12/11/2017	18.7	26.5	18.1	24.3	18.3	24.1	18.8	24.8
13/11/2017	18.6	26.0	18.1	23.7	18.5	22.9	18.9	23.6
14/11/2017	18.1	29.1	17.5	26.1	18.0	25.7	18.4	26.4
15/11/2017	18.9	30.5	18.1	27.4	18.7	26.7	19.1	27.5
16/11/2017	20.6	22.8	19.6	21.6	19.9	21.9	20.5	22.4
17/11/2017	18.4	23.0	18.3	21.5	17.2	21.2	16.7	21.6
18/11/2017	18.7	20.6	18.2	19.6	18.4	19.9	18.6	20.1
19/11/2017	17.2	26.4	17.0	23.5	17.5	23.7	17.7	24.0
20/11/2017	17.4	28.7	17.1	25.3	17.6	25.4	17.9	25.8
21/11/2017	18.6	29.6	18.1	26.1	18.7	26.2	18.9	26.6
22/11/2017	19.0	30.4	18.2	27.1	18.9	26.7	19.1	27.4
23/11/2017	21.2	29.4	20.1	26.4	20.6	25.0	20.8	25.9
24/11/2017	19.2	28.4	18.4	26.1	18.9	25.5	19.3	26.5
25/11/2017	19.6	30.4	18.8	27.8	19.3	27.2	19.7	27.9
26/11/2017	21.0	25.7	20.0	23.6	20.4	23.1	20.8	23.7
27/11/2017	20.7	26.6	20.1	24.3	20.3	24.5	20.6	24.6
28/11/2017	19.5	29.5	19.1	26.5	19.5	26.4	19.7	26.9
29/11/2017	21.8	31.3	21.2	28.0	21.4	28.0	21.7	28.4
30/11/2017	21.6	29.9	21.0	27.3	21.4	27.0	21.7	27.6
1/12/2017	22.3	28.8	21.6	26.4	21.8	25.9	22.1	26.5
2/12/2017	20.6	23.6	20.6	22.8	20.8	22.9	21.2	23.4
3/12/2017	19.0	26.0	18.8	23.9	19.2	23.7	19.5	24.0
4/12/2017	18.4	20.1	18.2	19.7	18.7	20.2	19.0	20.6

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
5/12/2017	17.0	21.4	17.1	20.5	17.6	20.7	17.7	21.1
6/12/2017	17.8	21.6	17.7	20.7	18.2	20.8	18.5	21.2
7/12/2017	16.3	26.9	16.3	24.1	17.2	24.0	17.4	24.5
8/12/2017	18.8	27.6	18.5	25.0	19.2	25.0	19.7	25.6
9/12/2017	18.8	28.9	18.5	25.6	19.2	25.5	19.7	26.2
10/12/2017	19.4	30.5	19.0	27.0	19.7	26.6	20.1	27.3
11/12/2017	20.7	31.7	20.1	28.2	20.6	27.6	21.1	28.1
12/12/2017	22.9	33.2	21.9	29.6	22.3	29.0	22.7	29.3
13/12/2017	22.6	34.0	21.5	30.2	21.9	29.5	22.2	29.6
14/12/2017	23.4	29.6	22.0	27.0	22.5	26.5	22.5	26.6
15/12/2017	23.7	31.9	22.7	28.8	22.9	28.4	23.0	28.7
16/12/2017	22.6	33.9	21.8	30.4	22.3	29.7	22.7	30.2
17/12/2017	23.9	34.2	22.8	30.7	23.3	30.1	23.6	30.6
18/12/2017	24.5	30.8	23.3	28.5	23.8	27.9	24.1	28.3
19/12/2017	24.3	32.8	23.2	30.1	23.5	29.0	23.8	29.8
20/12/2017	24.0	27.7	23.1	26.2	23.5	26.2	23.9	26.7
21/12/2017	20.1	31.5	19.5	28.7	20.3	28.1	20.5	28.6
22/12/2017	23.0	33.0	22.0	30.0	22.4	29.1	22.7	29.6
23/12/2017	23.2	35.1	22.0	31.7	22.6	30.4	22.8	31.1
24/12/2017	24.1	31.8	22.7	29.4	23.3	28.3	23.7	29.1
25/12/2017	23.8	29.6	22.6	27.1	23.0	27.1	23.5	27.3
26/12/2017	22.5	29.1	21.5	26.8	22.1	26.3	22.6	26.8
27/12/2017	23.4	33.9	22.4	30.8	22.7	29.9	23.3	30.1
28/12/2017	24.0	33.4	22.9	31.0	23.4	29.5	23.9	30.4
29/12/2017	25.6	32.3	24.4	30.4	24.7	29.1	25.2	30.1

	1a		1b		2a		2b	
	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)
30/12/2017	22.7	32.8	23.5	29.7	23.9	29.7	24.2	30.7

Appendix H Meteorological Data: Canberra Airport (2013-2016)

Year	Month	Monthly Precipitation (mm)	Average Maximum Daily Air Temperature (°C)	Average Minimum Daily Air Temperature (°C)	Average Maximum Daily Soil Temperature (°C at 10 cm depth)	Average Minimum Daily Soil Temperature (°C at 10 cm depth)
2013	January	72.6	32.3	13.9	33.2	23.8
2013	February	30.0	27.4	12.8	30.0	21.4
2013	March	197.2	25.7	9.6		
2013	April	9.8	22.1	5.5		
2013	May	19.8	17.4	1.3		
2013	June	85.2	13.9	1.6		
2013	July	42.8	13.4	1.7	10.5	6.2
2013	August	27.0	14.8	2.4	12.1	6.6
2013	September	91.0	19.9	4.0	17.8	10.8
2013	October	13.4	21.9	3.8	21.7	13.3
2013	November	105.6	23.8	6.7	25.3	16.3
2013	December	23.2	28.5	11.5	33.7	23.6
2014	January	4.8	31.6	12.1	35.7	24.8
2014	February	83.6	29.4	13.5	33.2	23.8
2014	March	88.0	24.2	12.2	25.0	18.7
2014	April	16.9	19.7	7.4	19.3	13.9
2014	May	14.4	17.6	2.7	14.7	9.5
2014	June	57.2	13.2	2.8	10.7	7.3
2014	July	34.9	12.2	0.0	9.1	4.9
2014	August	26.8	14.3	-0.8	11.8	5.7
2014	September	36.2	17.9	2.7	16.9	9.5
2014	October	53.4	22.5	5.4	22.5	13.9
2014	November	29.0	27.9	10.2	29.5	19.9
2014	December	102.0	27.7	12.7	29.5	20.4
2015	January	34.8	27.2	13.9	29.6	21.4
2015	February	30.2	28.3	13.0	30.0	21.4
2015	March	12.4	26.1	9.0	27.1	18.6
2015	April	91.8	19.1	7.1	17.7	12.6
2015	May	12.2	16.0	2.8	14.0	8.8
2015	June	55.2	13.7	-0.8	10.6	5.7
2015	July	37.2	11.6	-0.7	8.6	3.9
2015	August	66.8	13.7	1.0	10.7	5.3
2015	September	13.6	17.7	1.5	17.3	8.7
2015	October	26.6	24.8	8.3	24.6	16.2
2015	November	67.6	25.6	10.9	26.1	17.9
2015	December	34.8	29.3	11.4	32.3	21.9

2016	January	106.4	28.5	14	29.0	21.5
2016	February	23.4	29.3	13.3	31.5	22.6
2016	March	28.4	27.7	12.6	28.1	20.2
2016	April	6.8	23.8	8.3	22.8	16.3
2016	May	47.6	17.4	4.8	15.0	9.9
2016	June	144.2	13.0	3.0	10.4	6.6
2016	July	71.0	12.7	2.2	10.2	5.8
2016	August	46.2	14.3	1.1	11.9	5.8
2016	September	149.2	15.8	4.8	14.7	8.7
2016	October	43.6	18.5	5.2	19.5	11.0
2016	November	56.8	24.8	8.6	28.0	17.6
2016	December	64.6	28.7	13.5	29.8	21.4
2017	January	8.4	32.8	14.9	33.71613	24.92258
2017	February	20.6	30.1	12.9	31.52069	22.44138
2017	March	85.2	25.9	12.8	25.17419	18.99677
2017	April	31.6	19.9	5.5	18.9	12.95
2017	May	34.2	16.4	1.6	13.97419	8.590323
2017	June	2.4	13.6	-1.4	10.55	5.523333
2017	July	17.0	12.9	-2.3	9.416129	4.354839
2017	August	49.2	13.9	0.5	11.66452	5.570968
2017	September	13.4	18.1	2.7	17.13	9.55
2017	October	58.4	23.2	7.1	23.7	15.25484
2017	November	70.4	24.3	9.6	27.15333	17.77
2017	December	95.2	27.8	13.9	27.91613	20.95806

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Prepared for Section 22 Barton Pty Ltd
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Executive Summary

SMEC Australia Pty Ltd has prepared this monitoring report on behalf of Section 22 Barton Pty Ltd to meet the requirement for the Golden Sun Moth (GSM) *Synemon plana* flying moth survey, pupae case search and vegetation condition assessment conducted in 2018, in accordance with the *Potential shading impacts on York Park golden sun monitoring plan* (RJPL 2014a).

The key results are:

- No statistically significant difference was found in GSM numbers at York Park across the years of study. This finding suggests that there has not been a decline in the GSM population as a result of shading, or that the design and analysis was inadequate to be able to detect change.
- Temperature and survey month were found to significantly influence the number of GSM detected.
- We found no statistically significant difference in vegetation condition at York Park over the years of study.
- Data soil loggers indicate that temperatures are more extreme within the shaded area at York Park compared to the non-shaded area. However, there is no evidence at this stage that this is adversely impacting GSM populations or vegetation.

The key recommendations are:

- On-going monitoring of the population of GSM York Park
- The control of weeds at York Park, particularly perennial exotic grasses and St John's Wort.

This report fulfils the reporting requirements for GSM monitoring at York Park for year 6, as specified in the monitoring plan (RJPL 2014a).

1. Introduction

SMEC Australia Pty Ltd prepared this monitoring report, on behalf of Section 22 Barton Pty Ltd, to meet the 2018 annual reporting requirements of the *Potential shading impacts on York Park. Golden Sun Moth monitoring plan* (RJPL 2014a).

The monitoring plan was developed to meet Commonwealth *Environment Protection Biodiversity Conservation 1999 Act* (EPBC Act) approval decision (EPBC 2012/6606) conditions for development of a hotel and carpark at Block 14 Section 22 Barton (14/22 Barton). The monitoring plan contains a detailed description of the site, proposed actions and monitoring procedures (RJPL 2014a).

This report presents the findings of 6 years of monitoring surveys undertaken at York Park during the Golden Sun Moth (*Synemon plana*) (GSM) flying season which consisted of GSM traverse and point counts, pupae case surveys and vegetation condition assessment. This includes the findings from the 2018/19 surveys.

Data from the first four years of monitoring are presented in the York Park Golden Sun Moth Monitoring reports as follows have been referenced for comparison:

- 2013 survey report (RJPL 2014b)
- 2014 survey report (RJPL 2015)
- 2015 survey report (SMEC 2016)
- 2016 survey report (SMEC 2017).
- 2017 survey report (SMEC 2018).

As recommended in the 2013 monitoring plan (RJPL 2014a), analysis of BACI data was undertaken following the 2018-2019 survey to compare potential differences in floristic scores and pupae case numbers as caused by shading impacts of the development of Block 14 Section 22 Barton. This was achieved by comparing data collected prior to the development [2013-2014 surveys] with the data collected following the development [2015-2016 to 2018-2019 surveys]).

2. Methods

2.1. Regional GSM Observations

ACT researchers and consultants coordinate as an informal monitoring group and annually share information regarding the timing and location of GSM sightings. Informal communications were exchanged between group members regarding the start and finish of the annual flying moth season.

The start of the GSM flying season was confirmed using known reference sites in the ACT, including York Park, and consultation with the ACT GSM monitoring group. In practice, suitable daily weather conditions determine repeat survey timings and shorter survey return times of no less than 3 days may be applied. General observations on population numbers compared with previous seasons and current weather conditions were also conveyed.

2.2. Flying Moth Surveys

As specified in the monitoring plan (RJPL 2014a), flying GSM surveys were conducted in a manner consistent with the ACT Government (2010a) GSM survey guidelines and with the annual monitoring approach, as follows:

Transect surveys

The number of flying GSMs were counted along each of two 100 metre transects located along the long axis of York Park (Figure 1). The transect survey was undertaken three times approximately half an hour apart during each survey day.

Rotational point counts

To compare baseline GSM activity levels with post-shading GSM activity levels, two sets of rotational point counts, involving 10 repeated, 30 second rotational counts, were conducted at a site in the centre of the York Park GSM site (Figure 1). All GSM seen in a radius of 25 metres were recorded. Any individuals that re-crossed the observer's visual path were double counted. Averages were calculated from the ten rotations at each point to provide an average number of GSM per 30 second rotation. Given that this approach was repeated accurately each year, the data recorded provided comparable data over each of the year 1, year 2, year 3, year 4, and year 5 surveys (RJPL 2014b, RJPL 2015, SMEC 2016, SMEC 2017, SMEC 2018) - the period of time before and after the centre of York Park was shaded.

To compare shading effects and activity levels in the northern and southern ends of the York Park GSM site, two sets of rotational point counts, involving 10 repeated, 30 second rotational counts, were conducted at two sites approximately one third and two thirds of the way along the centre line of York Park GSM site between the transect surveys (Figure 1), i.e. approximately 25 metres from each end. All GSM seen in a radius of 25 metres were recorded. Any individuals that re-crossed the observer's visual path were double counted. Averages were calculated from the ten rotations at each point to provide the average number of GSM per 30 second rotation.

Weather Data

On-site weather data was recorded during all flying GSM field surveys to assist with interpreting the GSM survey results, with GSM activity being strongly tied to prevailing conditions. The following data was recorded during flying moth surveys:

- wind speed and direction
- air temperature
- cloud cover

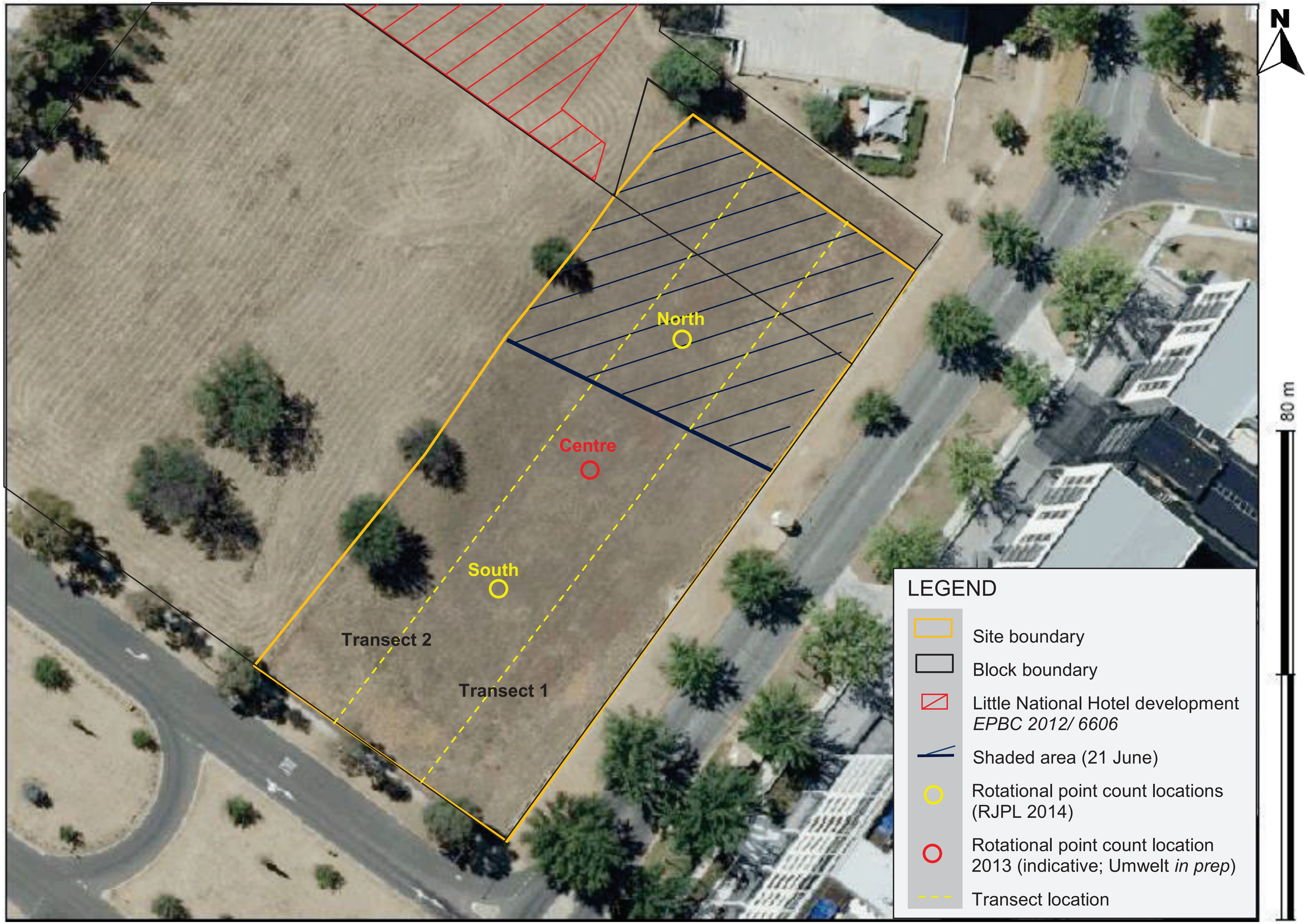

Figure 1. Location of flying GSM surveys at York Park.

2.3. Shading Zones and Quadrat Placement

The survey area defined in the monitoring plan (RJPL 2014a) incorporates the York Park GSM site, and excludes the area now developed for road access to 14/22 Barton and areas of exotic perennial grasses and native *Poa* and *Themeda* plantings (Rowell 2012). As specified in the monitoring plan, the site is stratified into the following four zones for the pupae case surveys and vegetation assessments (Table 1).

Table 1. Survey zone summary and quadrat distribution

Zone	Block Shading		Control/Impact	Area (m^2)	Number of Quadrats
	14/22 Barton	Part 3/22 Barton			
1a	Shaded	Unshaded	Impact zone	1,714	9
1b	Shaded	Shaded	Impact zone	374	3
2a	Unshaded	Unshaded	Control	1,800	9
2b	Unshaded	Shaded	Control	490	3

Quadrats

Twenty-four, 1 m^2 quadrats were established across the site at the beginning of the year 1 baseline survey season (RJPL 2014b). Each of these locations was approximately relocated using GPS locations and the map provided in the monitoring plan (RJPL 2014a). Plots were marked using wire pegs and plastic tags installed flush with the ground to permit relocation of the quadrats for repeat sampling during the season. All plot markers were removed at the end of the season. Figure 2 shows the York Park quadrat placement.

2.4. Pupae Case Monitoring

Pupae case surveys were conducted as specified in the monitoring plan (RJPL 2014a). Pupae cases were counted in each of the 24 quadrats approximately every two weeks over a six-week period (i.e. 3 times) during the GSM flying period from early-to-mid November until late December. All cases detected were removed for identification, also ensuring that individual pupa cases were not double counted.

2.5. Vegetation Monitoring

Data recorded for each quadrat consisted of:

- All flora species present
- The dominant flora species
- Cover / abundance (%) using the Braun-Blanquet cover / abundance classes outlined in ACT Government (2010b).

Annual floristic value scores were calculated from abundance data based on Rehwinkel (2007), consistent with ACT Government (2010b). The method to calculate floristic value scores, which underpin the classification of native grassland quality, was revised in 2015 (Rehwinkel 2015); however, to allow comparisons with previous years, the 1 x 1 metre quadrats were assessed using the previous floristic value score method of Rehwinkel (2007).

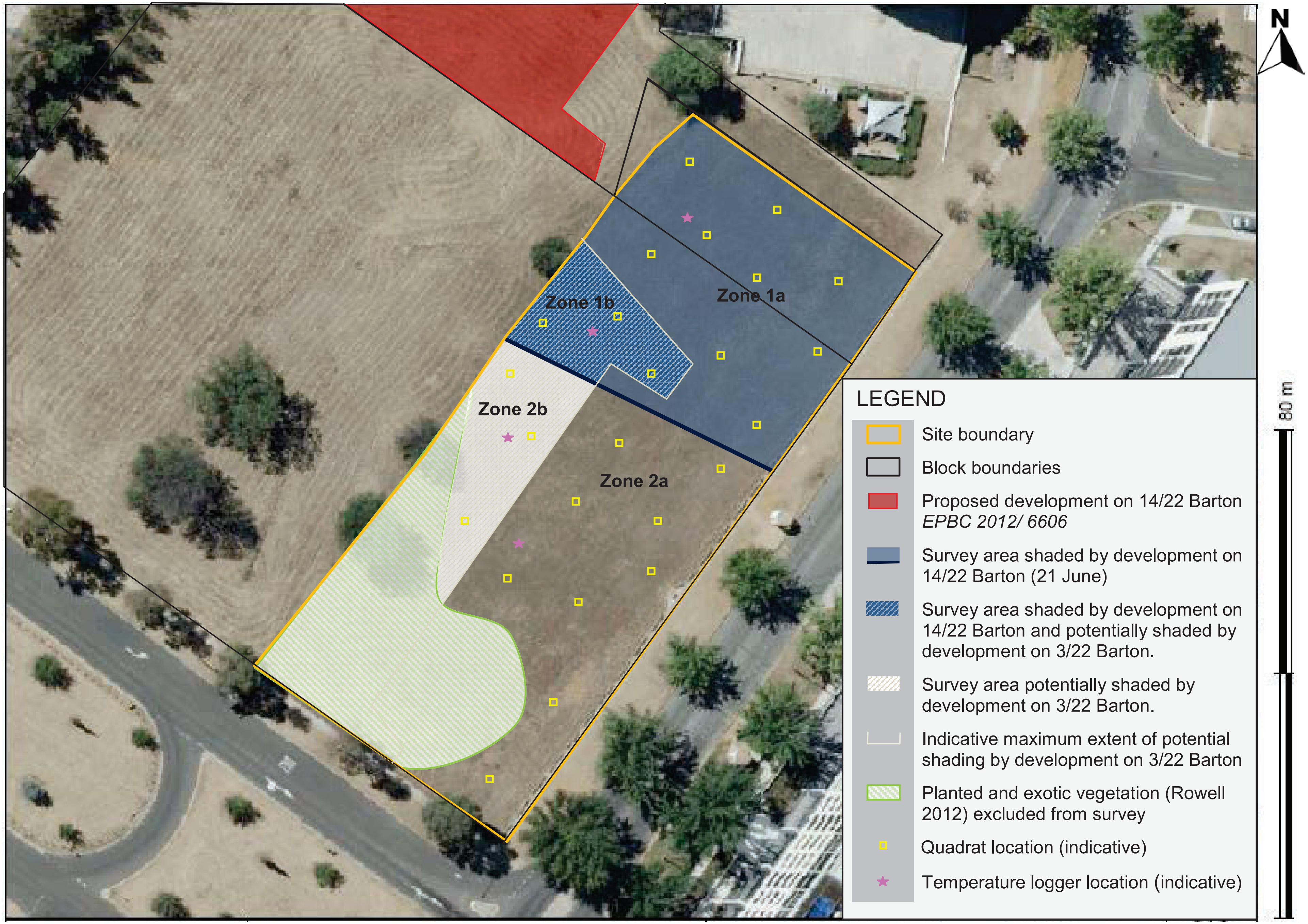

Figure 2. York Park GSM site pupae case and vegetation plot locations.

2.6. Analysis of Monitoring Data

Prior to analysis, we assessed our explanatory variables for collinearity, the presence of extreme outliers, and leverage effects in the explanatory variables using pairwise scatterplots, correlation coefficients and boxplots (Bjornstad and Falck 2001; Cliff and Ord 1981). We found the explanatory variables were not strongly collinear (r > 0.5), contained no extreme outliers, and had no strong multi-collinearity. Therefore, all variables were initially included in the regression models

In order to assess the monitoring data for the previous 12 months against the baseline conditions we modelled the response of flying GSM abundance along the linear transect as a function of the five main effects (year, month, cloud cover, and temperature) using a Poisson generalised linear model. All data was model using the R statistical software (R Core Team 2012). We used a Poisson distribution in our model because this distribution is most appropriate for count data (Zuur et al. 2009). We tested all possible subsets (i.e. combinations of the explanatory variables) and ranked all models in the 95 % confidence set using the Akaike information criterion (AIC) within the MuMIn package in R (R Core Team 2012). Models with the lowest AIC, and thus highest Akaike weight (interpreted as the relative likelihood of the model being the best), were considered to have the best fit with the data. We considered any models that had AIC differences ≤2 of the final model to have comparable support (Burnham and Anderson 2002). To calculate the relative importance of each variable we summed the Akaike weight of all comparative models that included that variable (Zuur et al. 2009). We were unable to model the pupae case data as the models were to data inflated.

The final flying GSM abundance model (model 1) that we preferred included temperature and survey month. We tested the final model for over-dispersion by inspecting both the Pearson and deviance residuals (McCullagh and Nelder 1989). Our models found no evidence for over-dispersion. Therefore, we did not further consider over-dispersion in the estimation of parameters.

2.7. Soil Temperature Monitoring

On-site soil temperature monitoring in shaded and un-shaded areas commenced using in-ground TidbiT v2 Temperature Loggers on 28 June 2016. Thermocron iButton temperature loggers previously installed had demonstrated a high failure rate and became unusable following a conflict with upgraded Thermocron software and were subsequently replaced. Temperature logger data was recovered on 25 February 2019 and loggers were then reinstalled.

2.8. Meteorological Data

Meteorological data from Canberra Airport was obtained for the period 2013 to 2018 to assist in the interpretation of potential shading impacts.

3. Results

3.1. Regional GSM Observations for 2018/2019

The first report of GSM during the 2018/2019 season was of 6 males and one female flying at Jerra East on 28th October 2018. By the 30th of October 2018 GSM were flying at several sites in the ACT. The start date of the 2018/2019 flying season is slightly earlier than the previous seasons. GSM were detected flying in northern ACT until the 11th of January 2019.

3.2. Flying Moth Surveys

All surveys were conducted whilst wind speeds were below 15 km/h and air temperature between 22 and 32°C. Raw data from the 2018 flying moth surveys are presented in Appendix A and Appendix B.

The GLM analysis found no statistically significant differences in GSM abundance at York Park across the years of study. Temperature and survey month were found to significantly influence the number of flying GSM detected. High temperatures were found to have a significant negative effect on the abundance of GSM. Furthermore, significantly higher numbers of GSM were found to occur in November than in December.

Table 2. Site conditions during flying GSM surveys.

Date	Max temperature (ºC)	Last rainfall (mm)	Wind Speed (km/h)	Cloud cover (%)
2/11/2018	26.0	11 (22/10)	10	99
13/11/2018	24.0	23 (7/11)	10	20
7/12/2018	24.0	5 (29/11)	8	2

Table 3. Summary of flying GSM numbers - Transect surveys.

Transect	Transect location	Average number of moths
1	East	9.8
2	West	12.4
Combined		11.1

Table 4. Summary of flying GSM numbers - Point count surveys.

Location	Average number of moths	Range
North East Point	0.8	0-3
Centre Point	0.8	0-5
South West Point	0.5	0-6

3.3. Pupae Case Monitoring

Pupae case surveys were undertaken on 2/11/2018, 13/11/2018 and 7/12/2018. Four pupae cases were located in 2018. The locations of pupae cases detected are shown in Figure 3. A summary of the pupae case survey results for the control and impact zones is presented in

Table *5*.

Table 5. Summary of the pupae case surveys within control and impact sites.

Zone	Number of pupae cases	Average pupae cases per plot
Zone 1a	2	0.22
Zone 1b	0	0.00
Zone 1 (impact)	**2**	**0.17**
Zone 2a	2	0.22
Zone 2b	0	0.00
Zone 2 (control)	**2**	**0.17**

3.4. Vegetation Monitoring

Vegetation summary statistics for each of the four zones are presented in Table 6. A list of dominant species per quadrat is presented in Appendix C in relation to the overall York Park flora species list collated by Rowell (2012) and RJPL (2014a). Figure 3 shows the locations of quadrats with floristic value scores of greater than 4.

Table 6. Vegetation survey summary for the control and impact sites.

Zone	Floristic score		Native species	Exotic species	Cover (%)
	Average	**Maximum**	**Average number**		**Average**
Zone 1a	3.72	7.38	3.89	4.11	77.78
Zone 1b	5.80	9.11	5.00	3.33	80.00
Zone 1 (impact)	**4.24**	**9.11**	**4.16**	**3.91**	**78.33**
Zone 2a	4.00	7.78	3.67	4.67	80.00
Zone 2b	4.35	7.26	5.00	0.67	81.67
Zone 2 (control)	**4.09**	**7.26**	**3.66**	**4.75**	**80.41**

Figure 3. Location of pupae cases and vegetation quadrats with the highest floristic diversity.

3.5. Multiple Year Analysis

3.5.1. Flying Moths

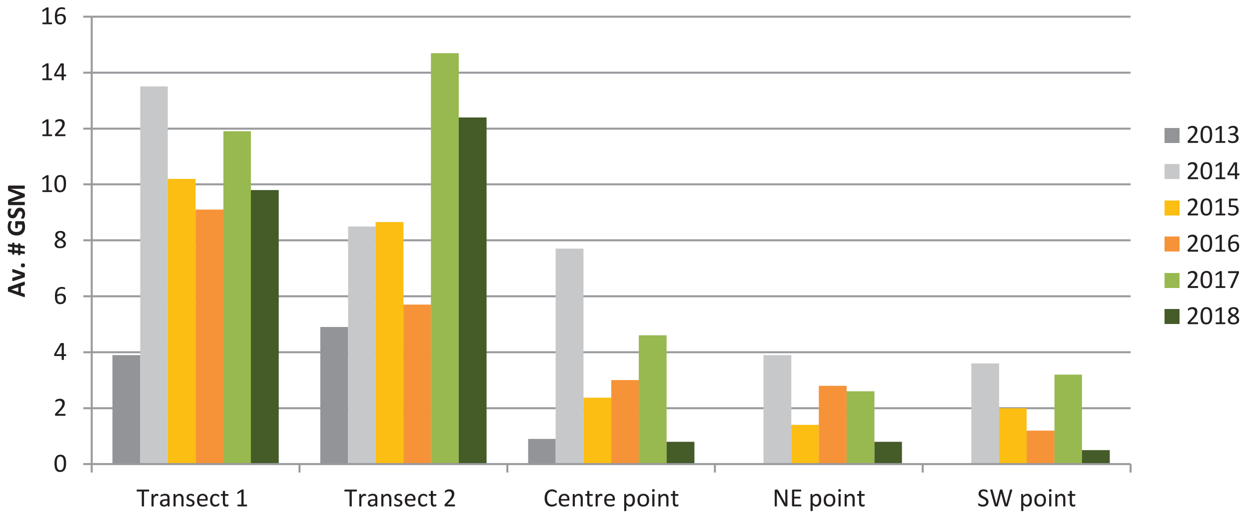

Figure 4. Average GSM numbers observed on transect and rotational point surveys, 2013 - 2018

** Note NE point and SW point were not surveyed in 2013.*

3.5.2. Pupae Cases

We were unable to statistically compare differences in pupae case numbers across years as the data is zero-inflated and is therefore unable to be analysed.

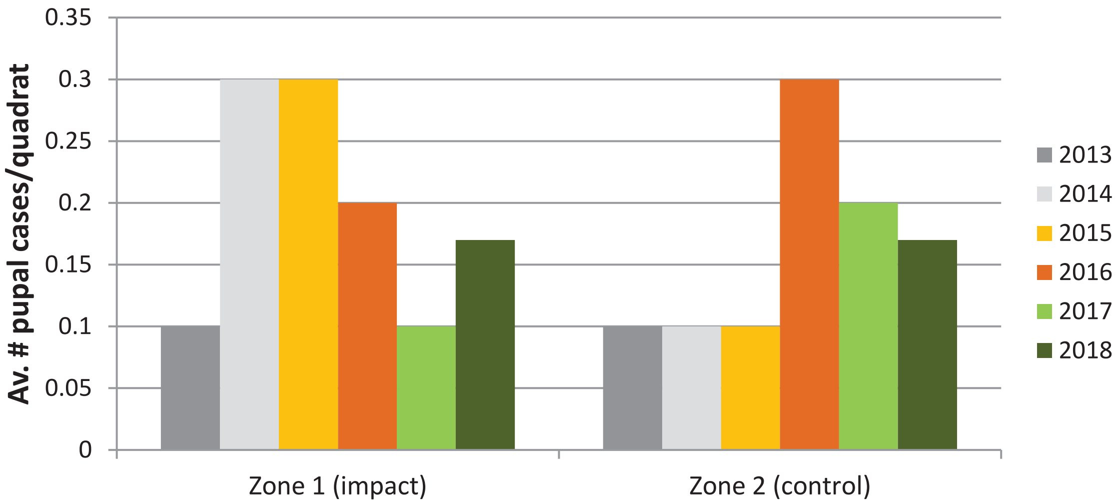

Figure 5. Average number of pupae cases recorded per quadrat in the impact and control zones.

Table 7. Number of pupae cases recorded in the impact and controls zones from 2013 to 2018.

Year	Zone	Total number of pupae cases
2013	Impact	1
2013	Control	1
2014	Impact	3
2014	Control	1
2015	Impact	4
2015	Control	2
2016	Impact	2
2016	Control	4
2017	Impact	1
2017	Control	2
2018	Impact	2
2018	Control	2

3.5.3. Vegetation

We found no statistically significant difference in floristic value attributes (vegetation condition) at York Park over the years of study.

Figure 6. Comparison of impact zone vegetation statistics from 2013 to 2018. Note: years 2013-2014 represent vegetation condition before potential shading. Years 2016-2018 represent vegetation condition after potential shading.

3.6. Soil Temperature Monitoring

Our soil temperature data in the most extreme months was more extreme within the impact zone than in the control zone. During the coldest winter month (July), when the sun angle in Canberra is at its lowest, and the impact zone is the most shaded the temperatures in zone 1a (i.e. the shade area) were lower (average minimum temperature was 5.4°C) than those in zones 1b, 2a and 2b (average minimum temperature was 6.5°C). In contrast, in the warmest summer month (February) daily maximum temperatures were 1.5 - 3.5°C greater in zone 1a than the other three zones.

3.7. Meteorological Data

In 2018/2019 the overall rainfall was below average across most of the ACT. Total rainfall for the ACT was 472.0 mm, which is 76% of the long-term average of 617.4 mm. It was the driest autumn since 2004, and driest winter since 1994 which contributed to a very dry year overall. February, November and December were wetter than average months. The average temperature was 1.3 °C above average and the warmest since 2009. The average maximum temperature was 22.0 °C, 1.7 °C above average and the warmest on record.

4. Discussion

4.1. Flying Moth Abundance

No statistically significant difference was found in GSM numbers at York Park across the years of study. This finding suggests that there has not been a significant decline in the GSM population at York Park as a result of shading when taking into local weather and survey conditions. However, temperature and survey month were found to significantly influence the number of flying GSM detected.

4.2. Vegetation Condition

We found no statistically significant difference in floristic value attributes (vegetation condition) at York Park over the years of study. This finding suggests that there has not been a significant change in the vegetation at York Park as a result of shading.

4.3. Pupae Case Abundance

We were unable to statistically compare differences in pupae case numbers across years as the data is zero-inflated and is therefore unable to be analysis currently. However, pupae cases were found in low numbers this year as in other years.

4.4. Data soil loggers

Data soil loggers indicate that temperatures are more extreme within the shaded area at York Park compared to the non-shaded area. However, there is no evidence at this stage that this is adversely impacting GSM populations or vegetation.

5. Compliance with the GSM Monitoring Plan

5.1. Survey Requirements

Transect surveys, pupae case surveys and vegetation surveys were conducted according to the methods specified in the monitoring plan (RJPL 2014a) and data from soil temperature loggers were successfully recovered and assessed.

5.2. Reporting Requirements

The GSM monitoring plan (RJPL 2014a) requires that annual monitoring reports meet the following specifications:

- Annual monitoring and compliance reports would be prepared in a timely manner each year meeting the EPBC Act approval requirements (Conditions 3, 8) by:
  - providing and assessing the monitoring data for the previous twelve months against the baseline conditions
  - concluding whether there has been a decline in the GSM population in the area of York Park shaded as a result of the action, taking into account regional population trends and local ecological conditions
  - reviewing the monitoring plan's applicability in achieving its objectives (Condition 8) to determine whether, under EPBC Act Approval Condition 10, the monitoring plan should be revised in consultation with the Commonwealth.

When preparing the report, reference would be made to the current NTGMP and any relevant management and monitoring changes relevant to a review of the monitoring plan.

The preparation of this report fulfils the reporting requirements for the 6th survey year as specified in the monitoring plan (RJPL 2014a).

5.3. Impact Thresholds

Detection of either of the following key thresholds of potential concern would trigger consultation with the Commonwealth and potentially a management response:

- 'a biologically and statistically significant decline in pupae case numbers or floristic value attributable to shading impacts over at least three consecutive post impact seasons.'
- 'a biologically and statistically significant decline in flying moth numbers at York Park correlated with the onset of shading over at least three consecutive post impact seasons that cannot be attributable to other factors, such as other developments or seasonal conditions.'

The analyses described in Section 3 did not detect:

- Any biologically and statistically significant declines in floristic value or in pupae case numbers attributable to shading impacts, as assessed by the BACI design and GLM analysis. Pupae case numbers could not be analysed.
- Any biologically or statistically significant decline in flying moth numbers at York Park correlated to the onset of shading, as assessed by linear regression analysis.

5.4. GSM Monitoring Plan Review

The current monitoring event addresses potential impacts over consecutive post impact seasons. Monitoring of flying moth numbers and vegetation condition has progressed according to the GSM monitoring plan.

Pupae cases have consistently been detected at very low rates in the quadrats, despite the substantially higher survey effort implemented relative to the recommendations of Richter *et al.* (2013). Given the very low numbers of pupae cases detected and the high levels of inter-annual variance in pupae case numbers statistical analysis under the current design would still not have produced a useable result. Considering these results, DoEE should review the effectiveness of how to best use pupae case monitoring data.

6. Conclusions and Recommendations

This report provides the results of the 2018-2019 flying GSM survey, pupae case survey and vegetation survey conducted in accordance with the *Potential shading impacts on York Park. Golden Sun Moth monitoring plan* (RJPL 2014a, the monitoring plan).

This report fulfils the reporting requirements for GSM monitoring at York Park for 2018, as specified in the monitoring plan (RJPL 2014a).

The analyses described in Section 3 & 4 did not detect:

- Any biologically and statistically significant declines in pupae case numbers or floristic value attributable to shading impacts, as assessed by the BACI analysis.
- Any biologically or statistically significant decline in flying moth numbers at York Park correlated to the onset of shading, as assessed by a GLM analysis.

The current monitoring event addresses potential impacts over multiple consecutive post impact seasons.

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Appendix A Flying GSM Survey 2018/2019 – Transect Data

YEAR	Date	Transect N (1East, 2West)	Repeat	#N GSM
2018	2/11/2018	1	1	0
2018	2/11/2018	1	2	0
2018	2/11/2018	1	3	0
2018	2/11/2018	2	1	0
2018	2/11/2018	2	2	2
2018	2/11/2018	2	3	2
2018	13/11/2018	1	1	4
2018	13/11/2018	1	2	33
2018	13/11/2018	1	3	42
2018	13/11/2018	2	1	26
2018	13/11/2018	2	2	27
2018	13/11/2018	2	3	44
2018	7/12/2018	1	1	1
2018	7/12/2018	1	2	3
2018	7/12/2018	1	3	5
2018	7/12/2018	2	1	2
2018	7/12/2018	2	2	1
2018	7/12/2018	2	3	7

Appendix B Flying GSM Survey 2018/2019 – Point Observations

Date	NE Point average	NE Point range	SW Point average	SW Point range	Centre Point average	Centre Point range	Centre Point average	Centre Point Observation 2 range
2/11/2018	0	0	0	0	0	0	0	0.00
13/11/2018	1.7	0-3	1.4	0-6	2	0-5	2.2	0-4
7/12/2018	0.7	0-2	0	0	0.1	0-1	0.5	0-1
2/11/2018	0	0	0	0	0	0	0.2	0-1
13/11/2018	1.1	0-3	0.6	0-1	0.5	0-2	2.1	0-4
7/12/2018	1.2	0-3	1.2	0-3	0.2	0-1	1.4	0-2

Appendix C Vegetation Survey 2018/2019 – Dominant Species Per Quadrat

Year	Quadrat	Control or Impact site	Zone	Dominant	Total Cover (%)
2018	1	Impact	1a	*Austrostipa bigeniculata*	95
2018	2	Impact	1a	*Austrostipa bigeniculata*	90
2018	3	Impact	1a	*Austrostipa bigeniculata*	70
2018	4	Impact	1a	*Austrostipa bigeniculata*	80
2018	5	Impact	1a	*Themeda australis*	55
2018	6	Impact	1a	*Austrostipa bigeniculata*	70
2018	7	Impact	1a	*Austrostipa bigeniculata*	70
2018	8	Impact	1a	*Austrostipa bigeniculata*	80
2018	9	Impact	1a	*Austrostipa bigeniculata*	90
2018	10	Impact	1b	*Austrostipa bigeniculata*	95
2018	11	Impact	1b	*Austrostipa bigeniculata*	75
2018	12	Impact	1b	*Austrostipa bigeniculata*	70
2018	13	Control	2b	*Austrostipa bigeniculata*	80
2018	14	Control	2b	*Bothriochloa macra*	75
2018	15	Control	2a	*Austrostipa bigeniculata*	80
2018	16	Control	2a	*Austrostipa bigeniculata*	90
2018	17	Control	2a	*Austrostipa bigeniculata*	85
2018	18	Control	2a	*Austrostipa bigeniculata*	85
2018	19	Control	2a	*Austrostipa bigeniculata*	80
2018	20	Control	2b	*Austrostipa bigeniculata*	90
2018	21	Control	2a	*Austrostipa bigeniculata*	85
2018	22	Control	2a	*Bothriochloa macra*	95
2018	23	Control	2a	*Dactylis glomerata*	75
2018	24	Control	2a	*Dactylis glomerata*	45

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NATURAL TEMPERATE GRASSLAND MAINTENANCE PLAN

Block 3 Section 22
Barton ACT

FINAL

March 2014

NATURAL TEMPERATE GRASSLAND MAINTENANCE PLAN

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March 2014

Prepared by
Umwelt (Australia) Pty Limited

on behalf of
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Report No. **8018a/R01/V2**
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Executive Summary

Block 3 Section 22 Barton, also known as York Park, contains an area of natural temperate grassland and golden sun moth (*Synemon plana*) habitat. The patch, consisting of approximately 0.5 hectares occurs within a fragmented landscape and is highly susceptible to threats such as weed invasion and genetic isolation. As such, the area requires strategic on-going management in order to maintain or improve ecological values on the site, as well as bring awareness to effective management of small sites with conservation value.

This report presents an update of the maintenance plan completed for the site by Parsons Brinckerhoff in 2008 (PB 2008), and includes contemporary assessment of the status and condition trends associated with the natural temperate grassland area and weed distribution. Additionally, it reports on golden sun moth population numbers, although population trends are not able to be predicted due to the highly ephemeral nature of larval hatchings across seasons.

This report concludes that the natural temperate grassland has changed somewhat since 2007 (the PB 2008 survey work was completed in late 2007), with a decrease in bare ground and increase in vegetation density due to favourable climatic conditions for grass sward growth. Native flora diversity appears to be stable, although there has been a notable increase in some weed species including St. John's wort (*Hypericum perforatum*), cocksfoot (*Dactylis glomerata*) and ribbed plantain (*Plantago lanceolata*). Wallaby grasses (*Rytidosperma* syn. *Austrodanthonia* spp.) important for golden sun moth larval fodder are presently at levels considered reasonable for population maintenance (7 per cent of proportional vegetation cover). Planted kangaroo grass (*Themeda triandra*) along the eastern boundary has expanded slightly into the natural temperate grassland area.

Key recommendations to maintain the natural temperate grassland and golden sun moth population are as follows:

1. Undertake weed control as recommended in this report (refer to **Table 3.2**);
2. As exotic grass distribution is reduced, reseed areas with native wallaby grasses;
3. Contain kangaroo grass to a two metre strip on the eastern boundary, adjacent to National Circuit;
4. Rake and remove slashed material (additional biomass) in areas where dense swards of native grass and exotic pastures are slashed;
5. Undertake annual monitoring of grassland condition and golden sun moth populations (this has previously been undertaken biennially, however annual monitoring will allow or greater flexibility and adaptive management of vegetation structure);
6. If required, undertake additional mowing in wetter years when biomass accumulates; and
7. Remove exotic trees from the western boundary, including service tree (*Sorbus domestica*) seedlings.

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APPENDICES

1.0 Background

1.1 The Project

This Maintenance Plan has been prepared for the Department of Finance and Deregulation (Finance). The intent of this Maintenance Plan is to provide a framework for ongoing best-practice management of the ecological values associated with development and use of Blocks 3 and 15 Section 22 Barton, in the ACT. The location of Block 3 is shown in **Figure 1.1;** Block 15 is directly north.

Figure 1.1 - Location of Block 3, Section 22, Barton

In 2007, Parsons Brinckerhoff (PB) prepared a Master Plan for Block 3, which is proposed to be partially developed north-west of an area of Natural Temperate Grassland (NTG). The Master Plan identified an area of Block 3 for ongoing conservation of the NTG and associated golden sun moth (GSM, *Synemon plana*) population, with a Maintenance Plan prepared for this area in 2008 (PB 2008)[1]. The Maintenance Plan integrated with the Master Plan in providing a framework for maintenance of the conservation area and an area of NTG on the adjoining Block 15. Vegetation on part of Block 15 is intended to be removed for an access road; Robert Jessop Pty Ltd Environmental Services is currently writing a plan to monitor the effects of the development approval EPBC 2012/6606 (Australian Government 2013[2]).

In October 2013, Umwelt (Australia) Pty. Limited was engaged to undertake monitoring for GSM and NTG, and use the results from this survey and knowledge of contemporary monitoring techniques to update the original Maintenance Plan. Accordingly, this report represents an update of the 2008 plan (refer to **Section 1.2** Acknowledgements).

The south-eastern portion of Block 3 and the eastern portion of Block 15 contain a population of GSM in about 0.5 ha of NTG, dominated by wallaby grasses (*Rytidosperma* syn. *Austrodanthonia* spp.) (ACT Government 1997[3], 1998[4], 2005[5]).

GSM are listed as Critically Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and Endangered under the ACT *Nature Conservation Act 1980* (NC Act). 'Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory' is listed as an endangered ecological community under the EPBC Act 1999; 'Natural temperate Grassland' is listed as an endangered ecological community under the NC Act 1980. It is these values for which this Maintenance Plan intends to conserve.

1.2 Acknowledgments

Umwelt acknowledges Parsons Brinckerhoff, and specifically sub-consultant Alison Rowell, for authorship of the original Maintenance Plan. Rather than re-write the entire Plan, Umwelt has adopted much of the original Plan and amended, updated and added new sections where appropriate.

The second version of the Maintenance Plan (this report) has been reviewed and updated by Alison Rowell and representatives from Department of Finance, ACT Environment and Sustainable Development Directorate, Department of Environment and National Capital Authority.

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[2] Australian Government (2013) Approval: hotel and carpark development, Block 14 Section 22, Barton, ACT – Stage 1 (EPBC 2012/6066). Approved October 4, 2013. [: http://www.environment .gov.au/epbc/notices/assessments/2012/6606/2012-6606-approval-decision.pdf, URL accessed 16/01/2014]

[3] ACT Government (1997) Natural Temperate Grassland: An endangered ecological community. Action Plan No. 1 (Environment ACT, Canberra).

[4] ACT Government (1998) Golden Sun Moth (*Synemon plana*): An endangered species. Action Plan No. 7. Environment ACT, Canberra.

[5] ACT Government (2005) A Vision Splendid of the Grassy Plains Extended: ACT Lowland Native Grassland Conservation Strategy. Action Plan No. 28 (Arts, Heritage and Environment, Canberra).

1.3 Aim of the Maintenance Plan

The intent of this Maintenance Plan is to conserve native plant diversity while maintaining the structure and species composition thought to be favourable to the survival of the GSM population. This involves retaining a high proportion of wallaby grasses (*Rytidosperma* spp.) in a relatively low grassland structure with areas of bare ground between tussocks. This will be achieved through biomass management and control of exotic species, with monitoring of plant diversity, vegetation structure and the GSM population to gauge the success of the Maintenance Plan.

1.4 History of the Site

Nearby remnant woodland (Capital Hill, West Block) indicates that the subject site was near an ecotone between woodland and grassland communities, as mapped in the 'ACT Lowland Native Grassland Conservation Strategy' (ACT Government 2005).

When the Federal Capital Territory was created in 1911, the area around the subject site appears to have been open grazing land with few trees. In the 1920s, the Provisional Parliament House and some of the associated roads were built. A 1933 map shows that the subject site was then part of a larger undeveloped area bounded by National Circuit, State Circle, Kings Avenue and Canberra Avenue (Marshall 2007)[6] (for an aerial photo taken circa 1940's refer to http://www.flickr.com/photos/archivesact/11074074125/sizes/l/in/photostream/). At this time, the nearest building was the Methodist Church diagonally opposite. The subject site would have maintained some connectivity to other grassland or native pasture until fairly recently, with surrounding blocks and roads being developed from the 1970s onwards.

The north-western part of Block 3 appears to have received fill during the construction of surrounding buildings, and is now dominated by exotic species.

[6] Marshall, D., Boden, R., Mann, A., Rowell, A. & Fogarty, P. (2007) Heritage Management Plan for the York Park North Oak Plantation, Barton ACT. Prepared for the National Capital Authority, Canberra.

2.0 Environmental Values of the Site

2.1 Natural Temperate Grassland

The NTG endangered ecological community is typically found between 560 and 1200 metres above sea level in valleys and broad plains. The dominant cover is native tussock grasses, with forbs such as daisies, lilies and native legumes in the inter-tussock spaces. It is estimated that approximately 5 per cent of the original area of the community in the ACT survives in moderate to good condition (ESSS 2000)[7], a figure which has most likely reduced further in recent years.

2.1.1 Site Values

The grassland on the subject site has been given a Botanical Significance Rating of 4 (Low), and a Conservation Rating of 2 (Complementary Conservation Site). Botanical Significance Ratings are shown in **Table 2.1**. The Conservation Rating reflects that the subject site has only a low to moderate Botanical Significance, but contains a population of a threatened species that is considered to be viable in the medium term (ACT Government 2005).

Table 2.1 - Botanical Significance Rating for Natural Temperate Grassland

Degree of disturbance	Ground layer species	Examples of characteristic species	Typical flora of the ground layer	BSR rating
Very low	Disturbance sensitive species	*Diuris* spp., *Caladenia* spp., *Thelymitra* spp.	Native species include orchids, lilies and other highly sensitive species, as well as more tolerant species.	1
Low	Moderately disturbance tolerant species	*Dichopogon* spp., *Bulbine bulbosa*, *Craspedia variabilis*, *Cryptandra amara*, *Themeda triandra*, *Pimelea* spp., *Wurmbea dioica*.	Species present include those moderately tolerant of disturbance, as well as more tolerant species.	2
Moderate	Disturbance tolerant species	*Chrysocephalum apiculatum*, *Convolvulus angustissimus*, *Plantago varia*, *Asperula conferta*, *Glycine* spp., *Hibbertia obtusifolia*.	Native species include those commonly found in a range of sites that have been subject to moderate disturbance; sensitive species are rarely present.	3, 4
High	Disturbance tolerant native grasses	*Poa* spp., *Rytidosperma* spp., *Austrostipa* spp., *Bothriochloa macra*, *Microlaena stipoides*.	Site may contain a variety of native grass species but few or no native forbs are present.	5[1]
Very high	Exotic species	Perennial and annual* weeds, introduced or adventitious species.	Either dominated by perennial exotic species or a low cover and diversity of native species, of which most are native grasses.	E[1]

[1] Not considered natural temperate grassland

Since 1992, the NTG on the subject site has been part of a long-term grassland monitoring program being undertaken by ACT Government and surveys commissioned by the

[7] ESSS (2000) Commonwealth Listing Advice on Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory. Advice to the Minister for the Environment and Heritage from the Endangered Species Scientific Subcommittee (ESSS) on a proposal to add an ecological community to Schedule 2 of the *Endangered Species Protection Act 1992*.

Department of Finance, and the vegetation quality in Block 3 has been previously been assessed and mapped (Davis & Hogg 1992[8], ERM 2005[9], Rowell 2007[10], Rowell 2012[11], numerous unpublished datasets from ACT Government). **Appendix 1** contains a summary of plant species recorded on the subject site across numerous surveys between 1991 and 2013, with **Appendix 2** and **Appendix 3** showing cumulative quadrat and step-point transect survey data respectively. These data are not strictly comparable from year to year, having been collected by a variety of methods. However, the list shows trends such as the apparent loss of some native species and the recent arrival of some undesirable exotic species, most notably St Johns wort (*Hypericum perforatum*).

The NTG area is dominated by tall speargrass (*Austrostipa bigeniculata*), red-leg grass (*Bothriochloa macra*), various wallaby grasses (*Rytidosperma* spp.) and forbs including *Chrysocephalum apiculatum*, *Goodenia pinnatifida*, *Calocephalus citreus* and *Tricoryne elatior*. This species assemblage is consistent with the plant community 'r5: *Rytidosperma* spp. – *Austrostipa bigeniculata* – *Chrysocephalum apiculatum* tussock grassland of the South Eastern Highlands bioregion' as described by Armstrong *et al.* (2013)[12]. This grassland type is broadly distributed across the northern ACT, with other main occurrences from around Bungendore to north of Goulburn. Across its range, this community has been extensively cleared and remnants are subject to weed invasion, small-scale clearing, grazing pressures and nutrient run-on from adjacent management activities (Armstrong *et al.* 2013).

2.2 Golden Sun Moth (*Synemon plana*)

2.2.1 Distribution

Prior to European settlement GSM were widespread in native grasslands in south-eastern Australia, from near Bathurst in New South Wales through the Australian Capital Territory and Victoria to Bordertown in South Australia (Edwards 1993[13], 1994[14]). This distribution was correlated with grasslands dominated by low-growing wallaby grasses (*Rytidosperma* spp.), and has contracted substantially over time (O'Dwyer & Attiwill 1999[15]). GSM are now only found in a few relatively small breeding areas due to habitat loss, fragmentation and degradation. Possibly less than one percent of the original habitat now remains, much of it degraded by weed invasion (Clarke & O'Dwyer 1997[16], O'Dwyer & Attiwill 1999, ACT Government 2005).

2.2.2 Description and Life History

The GSM is a medium sized day-flying moth in the family Castniidae. The male has a wingspan of about 34 millimetres, the female slightly less. The upper forewings of both are

[8] Davis, M. S. & Hogg, D. McC. (1992) York Park, Barton. Botanical Survey. Report to the National Capital Planning Authority by David Hogg Pty. Ltd.
[9] ERM (2005) Strategic advice on the development potential of Block 3, Section 22: York Park, Barton. Report prepared for Department of Finance and Administration by Environmental Resources and Management, Australia.
[10] Rowell, A. M. (2007) Survey and impact assessment at Golden Sun Moth *Synemon plana* site, Blocks 3 and 7, Section 22 Barton (York Park). Report prepared for Parsons Brinckerhoff and Department of Finance.
[11] Rowell, A. (2012) Block 3, Section 22 Barton ACT: Five-year monitoring event for Golden Sun moth and condition Assessment of Natural Temperate Grassland. Repor to Department of Finance and Deregulation by Alison Rowell, May 2012.
[12] Armstrong, R.C., Turner, K.D., McDougall, K.L., Rehwinkel, R. and Crooks, J.I. (2013) Plant communities of the upper Murrumbidgee catchment in New South Wales and the Australian Capital Territory. *Cunninghamia* **13**(1): 125-266.
[13] Edwards, E. D. (1993) The Golden Sun Moth *Synemon plana* – an endangered species. ANIC News No. 2: 7-8.
[14] Edwards, E. D. (1994) Survey of lowland grassland sites in ACT for the Golden Sun Moth *Synemon plana*. CSIRO Report to the Wildlife Research Unit, ACT Parks and Conservation Service, Canberra.
[15] O'Dwyer, C. & Attiwill, P. M. (1999) A comparative study of habitats of the Golden Sun Moth *Synemon plana* Walker (Lepidoptera: Castniidae): implications for restoration. *Biol. Cons.* **89**: 131-141.
[16] Clarke, G.M. and O'Dwyer, C. (1997) A survey of native grassland sites in south-eastern New South Wales for the endangered Golden Sun Moth, *Synemon plana*. A report prepared for the Threatened Species Unit, NSW National Parks and Wildlife Service, southern zone.

grey/brown with paler patterns. The male has dark brown upper hindwings, and in the female these are bright yellow/orange edged with black spots (ACT Government 1998).

GSM larvae feed on the subterranean parts of wallaby grasses (Edwards 1993, O'Dwyer & Attiwill 1999), and may sometimes feed on other native and introduced C3 grasses (Braby & Dunford 2006[17], Richter *et al.* 2010[18]). Larval development time is unknown and may vary between one and three years.

The adults live for only one to four days after emerging during late spring to early summer, and do not feed as they have no functional mouth parts. In the middle of the day when conditions are sunny and warm, males patrol the grassland in search of the females, which have reduced hind-wings and are poor fliers. The starting date and duration of the flight season vary from year to year, probably depending on spring weather conditions, with the season starting earlier in a warm dry spring (Cook & Edwards 1993[19]). The limited flight ability of the female moths adds to the species' vulnerability to extinction on small sites, and makes natural re-colonisation from other sites unlikely.

2.2.3 Site Values

Although small, the subject site is rated as having a Moderate Conservation Value rating, because of the previous scientific work undertaken (ACT Government 1998). Clarke & O'Dwyer (1998[20]) also considered that the subject site warranted special attention due to its 'high profile and considerable research focus in past years'.

The area of the GSM habitat is about 5600m², and the population has been intensively surveyed in the past. The previous studies include six mark-release-recapture surveys, producing estimates of population size (Cook & Edwards 1993 and 1994, Edwards 1994[21], Harwood *et al.* 1995[22], Rowell 2007, Rowell 2012), and genetic analysis of the population (Clarke & O'Dwyer 1998). Provisional management recommendations were prepared for the subject site (Frawley 1995[23], Edwards 1995[24]), including rehabilitation of the vegetation by translocation of soil and grassland plants from a nearby area which was being developed (Davis & Hogg 1992, Harwood *et al.* 1995). **Appendix 4** contains a summary of the GSM population studies to date.

[17] Braby, M. F. & Dunford, M. (2006) Field observations on the ecology of the Golden Sun Moth, *Synemon plana* Walker (Lepidoptera: Castniidae). *Australian Entomologist* **33**, 103-110.

[18] Richter A, Osborne W & Traugott M (2010) Dietary specialisation in the Golden Sun Moth *Synemon plana* – the key to understanding habitat requirements and site rehabilitation for this critically endangered species. Final report to Biodiversity and Programs Branch, Department of Sustainability and Environment (Victoria).

[19] Cook, L. & Edwards, E. D. (1993) Population Monitoring of Endangered Moth *Synemon plana* 1992-93, York Park, Barton. CSIRO Australia. Report to the National Capital Planning Authority.

[20] Clarke, G. M. & O'Dwyer, C. (1998) Genetic analysis of populations of the endangered Golden Sun Moth, *Synemon plana*. Report for Threatened Species Unit, NSW National Parks and Wildlife Service, Southern Zone, and the Wildlife Research and Monitoring Unit, Environment ACT. CSIRO Division of Entomology, Canberra.

[21] Cook, L. & Edwards, E. D. (1994) Population Monitoring of Endangered Moth *Synemon plana* 1993-94, York Park, Barton. CSIRO report to the National Capital Planning Authority.

[22] Harwood, T., Narain, S. & Edwards, E. D. (1995) Population Monitoring of Endangered Moth *Synemon plana* 1994-95, York Park, Barton. CSIRO Australia. Report to the National Capital Planning Authority.

[23] Frawley, K. (1995) Planning for urban native grassland conservation: York Park, Barton, ACT. *In* Management of relict lowland grasslands. Proceedings of a workshop and public seminar. September 24 and 25, 1993.

[24] Edwards, E. D. (1995) Provisional Management Recommendations for York Park Moth Site. Report to the National Capital Planning Authority. CSIRO Division of Entomology, Canberra.

2.2.4 Other Important Species

Active burrows of the uncommon Canberra raspy cricket (*Cooraboorama canberrae*) were observed in scattered locations across the site in 2007 (PB 2008). Additionally, Anett Richter (formerly of University of Canberra) and Emma Cook (ACT Environment and Sustainable Development Directorate) observed this species during surveys in 2006 and 2007. No observations of active burrows were made in 2013; this may be a function of increased biomass in post-drought conditions and the cricket may still potentially occur on site. This is a large wingless cricket, known only from relatively undisturbed grasslands in the lower parts of the Majura, Jerrabomberra and Molonglo valleys, and a small number of other locations in the ACT and nearby NSW (Queanbeyan-Bungendore). Much of its known habitat has been lost to housing in the ACT, and it is vulnerable to habitat fragmentation because it is flightless. It makes distinctive vertical burrows with a round cross-section, a clay and silk cap and a circle of bare soil around the entrance. Information about this cricket could be included in interpretative signage on the subject site.

The grassland earless dragon (*Tympanocryptis pinguicolla*) is known to generally use the abandoned burrows of this species as shelter sites. This species is endangered under the EPBC Act 1999 and NC Act 1980. This species has not been recorded on site.

3.0 Maintenance Requirements

3.1 Weed Management

Weeds are recognised as one of the most significant threats to biodiversity in the ACT. They displace native species, reduce habitat quality, modify vegetation structure and alter ecological functions (TaMS 2007[25]).

Figure 3.1 shows a vegetation map of the site, delineated into vegetation associations based on fine-scale on-site classification. Associations were determined based on dominant species, with areas considered to be exotic if they contain ≥50 per cent of exotic species cover/composition. The NTG corresponds with the best GSM habitat, and chemical weed control in this area should be undertaken with caution and sparingly, as the effect of herbicides on GSM are unknown.

Several weeds of concern on the subject site are perennial grasses. These include exotic grasses and forbs, as well as two native species which have been planted on the subject site. These species, kangaroo grass (*Themeda triandra*) and poa tussock (*Poa labillardierei*), are not considered a useful food source for GSM larvae, and they should be prevented from spreading beyond the original areas of planting (refer to **Figure 3.1**). Despite this, it is worth noting that these species provide a useful service in their current location: the Kangaroo Grass reduces opportunities for weeds to establish from seeds washing off the path, and similarly, the Poa Tussock protects a low-lying patch which may also be susceptible to seed invasion.

The weedy area at the southern end of the subject site results from attempted translocation of soil and native grasses from an area which was developed nearby. Other weed patches have developed where trees have been removed from the subject site, and where trees around the boundary shade the native grassland (PB 2008).

If weed management is to be undertaking during the GSM flying period, generally late October to late December, this should be completed preferably in the morning hours through careful spot-spraying. It is highly undesirable that any management practices be undertaken after 11:00 hours in order to reduce the risk of disturbing egg-laying females.

[25] TaMS (2007) Draft ACT Weeds Strategy, 2007-2017. July 2007. Department of Territory and Municipal Services, Canberra.

Figure 3.1 - Current Vegetation Associations on the Site

3.1.1 Objectives

The objectives of weed management of individual species are summarised in **Table 3.1**. They include:

- Eradication: no plants of the target species remain on subject site
- Suppression: reduce density of target species within infested area and prevent infestation from spreading
- Containment: define the boundary of existing infestation of target species and prevent spread beyond that line.

3.1.2 Procedures

Table 3.2 summarises control methods and timing for weed species of concern. This table is indicative only, and timing can be varied to suit seasonal conditions or based on local experience of site managers. Triggers for weed management are discussed in **Section 4.1.1.1**.

The subject site should be visited to treat weeds and assess the effectiveness of previous control in spring, summer and autumn. Attention should be paid to the plants listed **Table 3.1**.

- A record should be kept of methods, area / numbers and species of weeds treated.

3.1.2.1 Herbicide use (spot-spray)

The following are key directions relating to the use of <u>non-residual</u> herbicides:

- operators/contractors should have significant prior experience (minimum of two years) in selective weed management in NTG, and demonstrated expertise in the identification and successful treatment of the key weed species;
- the appropriate herbicide registered for use on particular species, the methods and rates of application, licensing requirements and other relevant aspects should be checked annually with ACT Territory and Municipal Services;
- residual herbicides should <u>not</u> be used;
- treatments should be timed to maximise results i.e. prior to seeds forming and during active growth phases;
- risks to non-target species should be minimised by avoiding the spread of herbicides on footwear and equipment, using spray hoods and shields, spraying under appropriate weather (low wind) conditions etc;
- woody weeds should be treated by the cut-and-paint method, and regrowth should be spot-sprayed. Roots should not be dug out in order to avoid unnecessary soil disturbance; and
- the effectiveness of all herbicide spraying should be monitored the following month, and follow-up spraying carried out if required.

3.1.2.2 Other Methods

Hand-pulling (the Bradley method)

Small infestations of some weeds can be removed by hand-pulling after rain when the soil is soft, ensuring that all parts of the plant are removed. This method, also known as 'the Bradley method' (Bradley 2002[26]) is suitable for smaller St John's wort (*Hypericum perforatum*) and Paterson's curse (*Echium plantagineum*) plants (i.e. not larger/mature ones) and can be carried out during site inspections or monitoring visits. Uprooted material should be bagged on site and removed to be disposed of appropriately.

Targeted slashing

Wild oats (*Avena* spp.), cocksfoot (*Dactylis glomeratum*), tall fescue (*Festuca* spp.) and phalaris (*Phalaris aquatica*) can be slashed before the seed heads form. The plants often grow earlier and taller than surrounding native species, in response to soil moisture. In particular, the infestation of wild oats on the slight slope at the south end of the subject site should be treated by high slashing (e.g. with a brushcutter/line trimmer) as required, and the slashed material removed. In particular, wild oats can have multiple flowering events per season is conditions are favourable, so this should be monitored in wetter spring periods.

If some Paterson's curse (*Echium plantagineum*) plants have begun to flower when spraying of rosettes is taking place, these flower stems also can be slashed and removed from the subject site.

Removal of mulch

The deciduous trees around the boundary cause dead leaf deposits to build up on parts of the subject site at times. This is particularly prominent along the southern boundary. This mulch is likely to alter soil moisture, pH and nutrients in ways that will favour the growth of weeds, as well as smother or prevent recruitment of native grasses and forbs. The problem is most noticeable near the oak trees on National Circuit. The leaves should be removed annually, at the end of autumn, by careful raking.

[26] Bradley, J. (2002) Bringing back the bush: the Bradley method of bush regeneration. Reed New Holland, Sydney.

Table 3.1 - Main Plant Species Posing Threat to the Natural Temperate Grassland and/or Golden Sun Moth Habitat, and Management Aims

Common name	Species	WoNS[27]	Declared Pest Plant (ACT)[28]	Aim of Management
Exotic species (grasses)				
Wild oats	*Avena* sp.			Suppression
Cocksfoot	*Dactylis glomerata*			Suppression
African lovegrass	*Eragrostis curvula* [1]		yes	Eradicate
Tall Fescue	*Festuca* sp.			Suppression
Chilean needlegrass	*Nassella neesiana*	yes	yes	Eradication
Serrated tussock	*Nassella trichotoma*	yes	yes	Not present, requires vigilance
Paspalum	*Paspalum dilatatum*			Suppression
Phalaris	*Phalaris aquatica*			Eradication
Exotic species (forbs)				
Paterson's curse	*Echium plantagineum*		yes	Not present, requires vigilance
St. John's wort	*Hypericum perforatum*		yes	Eradication
Flatweed, Cat's ear	*Hypochaeris radicata*			Suppression
Ribbed plantain	*Plantago lanceolata* [2]			Suppression
Exotic species (trees)				
Service tree	*Sorbus domestica*		yes	Eradication
Native species				
Poa tussock	*Poa labillardierei*			Containment
Kangaroo trass	*Themeda triandra*			Containment

[1] present in roadside verge on National Cct.
[2] not to be confused with the native variable plantain (*Plantago varia*).

[27] Weeds of National Significance. [http://www.weeds.org.au/WoNS/, URL Accessed 27/12/2013].
[28] Pest Plants and Animals (Pest Plants) Declaration 2009 (No 1) Disallowable instrument DI2009-67 made under the Pest Plants and Animals Act 2005, s7 (Declaration of pest plants) . [http://www.legislation.act.gov.au/di/2009-67/current/pdf/2009-67.pdf, URL Accessed 27/12/2013].

Table 3.2 - Summary of Weed Control Methods and Timing

Species	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wild oats									Slash and remove stems			
Cocksfoot									Slash and remove stems			
									spot spray n/s or g/s			
Paterson's curse	Hand cut and remove seeding stems				Spot-spray rosettes						Hand cut and remove seeding stems	
African lovegrass	Spot spray								Spot spray			
Tall fescue									Slash and remove stems			
									Spot spray			
St John's wort	Hand-pull small plants after rain								Hand-pull small plants after rain			
									Spot-spray bl/s or n/s			
Chilean needlegrass	Spot-spray							Spot-spray				
Serrated tussock	Spot-spray								Spot-spray			
Paspalum									Spot-spray			
Phalaris									Slash and remove stems			
Ribbed Plantain	Spot-spray							Spot-spray				
Flatweed	Spot-spray							Spot-spray				
Service tree	Hand-pull small plants after rain (at this stage as they are only seedlings)											

n/s = non-selective non-residual herbicide; g/s = grass-selective non-residual herbicide; bl/s = broadleaf-selective non-residual herbicide

3.2 Biomass Management

Biomass removal (defoliation) at appropriate levels and times is beneficial to many grasslands. Generally, higher levels of biodiversity are to be found at intermediate levels of disturbance and at intermediate time spans following the disturbance. It maintains an open structure, which enables native plants to flower and set seed, and allows their seedlings to become established. In natural and pastoral systems, biomass removal generally occurs through grazing or burning; at this site slashing is the only realistic option. On the subject site, there is the additional requirement of maintaining a moderate proportion of wallaby grasses in the sward as food plants for GSM, and retaining open spaces between tussocks for basking and mating.

The subject site has been managed by slashing for many years. The population estimate for GSM in 2006 suggested that this regime has favoured GSM, and the 2007 baseline vegetation composition data from the 20 metre x 20 metre quadrat can be used as a guide to appropriate proportions of bare ground and grasses (PB 2008; refer to **Appendix 2**). This will vary from year to year with variations in temperature and rainfall (refer to **Section 4.0**).

Slashing on the subject site should observe the following guidelines:

- sward to be cut using a flail mower to mulch and spread litter and reduce windrows. Any patches of mulched material should be removed from the subject site. The blade set height of the flail mower should be 12 centimetres, ensuring sward is not cut lower than 10 centimetres in height;

- machinery not to be used when the ground is wet in order to avoid soil compaction and damage to the cryptogams (soil crust);

- machinery to be washed down before entering the subject site, to remove soil and seeds. The least weedy part of the subject site should be mown first, then the margins planted with native grasses, and the weedier areas last, to avoid spreading weed seeds;

- slashing to be carried out annually in August-September, before the emergence of adult GSM. This will help maintain the low open grassland favoured by GSM. In parts of the subject site dominated by tall weeds (e.g. wild oats), the slashed material should be removed (by raking or use of a grass-catcher) rather than left in windrows; and

- slashing to be repeated in February <u>if necessary</u> (if the average vegetation height exceeds 15 centimetres. Note: average vegetation height is determined as the bulk of the grass tussock, not the seed head).

3.3 Other Management Prescriptions

3.3.1 Record Keeping

A diary of management actions and any other relevant occurrences should be kept. This can be in the form of notes in the work program and management checklist (refer to **Table 3.3**).

Table 3.3 - Work Program and Management Record (Activities are to be undertaken annually unless otherwise indicated)

Activity	Season				Reporting
	Spring	**Summer**	**Autumn**	**Winter**	
Weed management	Slash and remove early flowering stems of Wild Oats, Cocksfoot, Fescue and Phalaris; Cut-and-paint woody weeds; Hand-pull smaller exotic St. John's Wort after rain; Follow-up treatments.	Follow-up treatments; Remove aerial parts of Paterson's curse (if present); Spot spray exotic perennial grasses, Plantain; Hand-pull smaller exotic St. John's Wort after rain.	Spot-spray Plantain and Chilean needlegrass; Cut-and-paint woody weeds.	Spot-spray Plantain and Paterson's curse (if present);	Annually: Provide weed management record to the Department of the Environment, Department of Finance, National Capital Authority and ACT Government.
Weed monitoring		Assess success of management			Annually: Provide results of monitoring to the Department of the Environment, Department of Finance, National Capital Authority and ACT Government.
Biomass management	Slash to no shorter than 8 cm (Aug-Sept)	Slash again in February if average height >15cm in native grassland area			
NTG monitoring	Photographs from reference points, transects and quadrat				Annually: Provide results of monitoring to the Department of the Environment, Department of Finance, National Capital Authority and ACT Government.
GSM monitoring	****Aim for middle of GSM flight season, assuming appropriate climatic conditions (a broader spread is preferable for capture-release**** Point counts and transects; Every 5 years: capture-release survey for population estimation (next late 2016)				
Site inspection	Note condition, damage.	Note condition, damage.	Note condition, damage.	Note condition, damage.	
Plan Review	Every five years (***next review due at end of 2018***)				

3.3.2 Memorandum of Understanding

There are several key stakeholders that must be represented in the Memoranda of Understanding. These are:

- Lessor (Commonwealth):
  - interest in ongoing use of Block 3 Section 22

- Lessee (owner):
  - role as the land manager

- National Capital Authority:
  - consent authority for development

- ACT Government (Territory and Municipal Services):
  - management of road network and verges that adjoin Block 3 Section 22

- ACT Government (ACT Planning and Land Authority):
  - consent Authority for development on the adjoining Block 15

- ACT Government (Conservation, Planning and Research):
  - role in reviewing the ongoing maintenance of the conservation area

The Memoranda should include agreement about activities such as construction, maintenance, landscaping, shading, irrigation and drainage which may affect Block 3 Section 22, and specifically the conservation area. Any proposal to extend or increase the height of the buildings in the neighbouring area (Territory land) should consider the potential impact on the Natural Temperate Grasslands and GSM.

3.3.3 Construction Phase

The subject site should be protected from damage during the construction phase. It should be securely fenced, with signs on all fences stating that it is an environmentally sensitive site. There should be no activities associated with construction on the subject site, including (but not limited to):

- vehicle or pedestrian access through the subject site;
- dumping of debris;
- parking of vehicles;
- storage of machinery or materials; and
- trenching for pipes or cables, or other earthworks.

These restrictions should be noted in the works program.

3.3.4 Rehabilitation

No soil should be brought onto the subject site. Areas bared through control of large areas of weeds, or inadvertently damaged, should be rehabilitated using native weed-free seed or thatch collected from the subject site (note: do not collect more that 10 per cent of a population in order to allow the majority to set seed naturally). Grasses sourced for thatch should <u>not</u> include Kangaroo Grass or Poa Tussock.

3.3.5 Adjacent Vegetation

Deciduous trees on the boundary of the subject site have degraded the adjacent grassland, as well as providing perches and nest sites for birds that feed on GSM. The size and location of any trees or landscape features on the western portion of Block 3 should be such that the shadow they cast does not extend beyond the shadow of the buildings, as proposed in the Master Plan.

Landscaping should be designed to have low to nil impact on the grassland. Specifically, it should have low irrigation and fertiliser needs, and not be a significant source of mulch or seeds. Adjacent landscaping should not include non-local native grassland species or exotic grass species.

The use of pesticides on adjacent vegetation is undesirable, given the presence of rare/endangered insect species on the subject site. In the event of this being required, a works plan should be developed with consideration of the Maintenance Plan, and reviewed by an appropriately qualified ecologist or entomologist familiar with the biology of GSM and Canberra raspy cricket.

3.3.6 Drainage

Development on the western portion of Block 3 should avoid increase in drainage onto the subject site. Similarly, repair or replacement of the footpaths on National Circuit and Sydney Avenue should avoid an increase in drainage discharge onto the subject site.

3.3.7 Fencing, Signs and Paths

Interpretive signs have been placed on the boundary of the subject site. Additional fencing and signs should avoid a significant shadow and the creation of perches for birds. There should be no paths, landscaping, seating or other structures within the conservation area. Pedestrian access from the western boundary or opportunities to be used as a thoroughfare should also be prevented. If a new fence is constructed, associated materials and vehicles should be kept off-site as far as practicable during construction.

Spot cleaning of the fencing and signage should be undertaken as necessary with products that pose no risk of impacting on the NTG and the GSM.

3.3.8 Site Access and Induction guidelines

Access to the subject area should be restricted to tasks essential for the ongoing maintenance tasks, as detailed in this Maintenance Plan. All personnel accessing the area must be appropriately inducted.

Induction information

It is anticipated that there will be varying levels of induction, dependent on the role of the personnel to the conservation area. These groups of personnel include:

- construction and development workers during the construction phases:
    - require a direct induction.

- facility management and associated site contractor personnel for the ongoing management of completed development:
    - require a direct induction.
- all building occupants:
    - awareness information should be made available to this personnel group.

The intent of this information is to identify with the inductees the strategic importance of this conservation area, and ensure a level of awareness for those working on Block 3 (during construction and for the ongoing management). This information can be specifically tailored for the different levels of induction, and includes:

- the subject site contains a population of the critically endangered GSM, whose survival relies on the protection of its NTG habitat;
- although the GSM is only noticeable when the adults fly in a few weeks in late spring to early summer, it is present as eggs, larvae and pupae in the soil throughout the year; and
- access to the subject site should only be for activities related to its study or maintenance, and should take place according to the restrictions prescribed the Maintenance Plan.

Conservation and education-related visits

As the subject site is sensitive, very small and can be viewed from all sides, educational visits by school and university classes should be restricted to viewing of GSM and their habitat from the edge of the subject site.

The potential need for referral and approval under the EPBC Act should be considered for any conservation activities that are not specifically nominated in this Maintenance Plan, and that the planning of such activities should first involve consultation with ACT Conservation Planning and Research (within Environment and Sustainable Development Directorate).

A licence under the *Nature Conservation Act 1980* (formerly known as a 'Permit to Take') should also be sought for all actions which interfere with the GSM, including physical handling, trapping or activities that have the potential to directly interact with adult or larval individuals. This includes the mark/recapture survey as detailed in this Maintenance Plan.

Activities should be planned to minimise foot traffic and site disturbance, and should especially avoid disturbing egg-laying females. This can be achieved by minimising activities on the subject site after 11:00 hours during the flying period, which may take between late October and late December.

Monitoring

Monitoring should be carried out by appropriately qualified personnel, with supervisors having at least five years experience in the assessment and management of NTG and GSM populations.

4.0 Monitoring

4.1 Methodology

4.1.1 Natural Temperate Grasslands

The condition of the grassland should be monitored annually in spring, starting from 2013.

Monitoring was previously recommended to be undertaken biennially however the benefits of increased sampling would include a reduction in the impact of data anomalies borne from infrequent observations. From a data analysis perspective, when a monitoring event in a biennial sampling regime is undertaken in conditions which are not typical of other years, it is more difficult to rationalise the variation if there is no monitoring event in a previous or following year. **Appendices 1**, **2** and **3** contain the floristic results of grassland monitoring from 2007, 2009, 2011 and 2013.

Mapping of vegetation associations

Vegetation associations were previously mapped by PB (2008) and Rowell (2012). Rowell (2012) notes that since 2007, dominant grasses were clearly less confined to one category, possibly due to the effect of wetter years on species distribution. Biennially, vegetation associations are to be mapped to determine any changes in extent as per the following categories:

high quality native-dominated grassland: >75% of vegetation cover is native, dominated by tall speargrass (*Austrostipa bigeniculata*) and wallaby grasses (*Rytidosperma* species), with a diversity of native forbs. These include species less tolerant of disturbance, such as:

- Rock fern (*Cheilanthes sieberi* subsp. *sieberi*)
- Common onion orchid (*Microtis unifolia*)
- Bulbine lily (*Bulbine bulbosa*)
- Early nancy (*Wurmbea dioica* subsp. *dioica*)
- Curved rice-flower (*Pimelea curviflora*)
- Creamy candles (*Stackhousia monogyna*)
- Blue devil (*Eryngium ovinum*)
- Lemon beauty heads (*Calocephalus citreus*)

lower quality native-dominated grassland: >50% of vegetation cover is native, dominated by redleg grass (*Bothriochloa macra*) and wallaby grasses, with fewer native forbs. These include disturbance-tolerant species such as:

- Swamp dock (*Rumex brownii*)
- Australian bindweed (*Convolvulus angustissimus*)
- Tufted bluebell (*Wahlenbergia communis*)
- Fuzz-weed (*Vittadinia* spp.)
- Yellow buttons (*Chrysocephalum apiculatum*)

exotic-dominated grassland: >50% of vegetation cover is exotic. Species of particular concern are listed in **Table 3.1**.

Annual checking of the vegetation association boundaries in spring will provide information on the effectiveness of weed control. An aim of the Maintenance Plan is to contain or reduce the exotic-dominated areas, and to maintain or enlarge the high quality native-dominated areas.

Refer to **Figure 3.1** for an updated extent of the vegetation associations in 2013.

Species list

Annually in spring, all plant species noted on the subject site during management and monitoring activities are recorded on a cumulative annual species list (**Appendix 1**). This list records the arrival of species of weeds, or their eradication and the loss of native species. In combination with the assessments below, it will measure changes in species richness and site condition over time. A major aim of management of the subject site is to retain native species and eliminate or contain exotic species. Any observations of fauna of interest (e.g. Canberra raspy cricket) should be recorded at the same time.

Quadrat assessment

A 20 x 20 metre quadrat in the middle of the subject site has been assessed in Spring 2007, 2009, 2011 and 2013 (**Appendix 2**). This sector was chosen as it had a high number of GSM captures in 2006 and even in 2013, remains the highest quality grassland area on site. An aim of the Maintenance Plan is to maintain the native plant diversity in this area.

Within the quadrat area, each species is recorded with an associated scaled cover/abundance rating as per Braun-Blanquet (1932[29]). This information is then entered into the 'Grassy Site Quality Assessment Tool' spreadsheet developed by Rehwinkel (2007[30]) to provide a 'Floristic Value Score' (FVS). Using this scoring system, each species is assigned a value ranging from one to five based on their relative rarity as determined by regional grassland assessment data. Species are categorised as follows:

- Common or increaser species, which do not add much to the value of a site;
- 'Indicator species, level 1', which indicated that a site has value; and
- 'Indicator species, level 2', which are highly significant species; these are the rarest of grassy ecosystem species and have the highest significance scores.

The sum of values for each species within a quadrat provides a FVS. This is considered more valuable than conventional species richness scores as it provides each quadrat with a relative value score based on the presence of rare or regionally significant species that are often not present in sites of lesser quality. Additionally, it does not reward common or increaser native species which often thrive in highly disturbed sites. This scoring system is generally used to characterise grassland condition, and has been used by ACT government to monitor the effects of macropod grazing in grassy ecosystems (Armstrong 2013[31]).

Step-point transects

This method assesses the relative abundance of plant species, and gives an indication of the dominant species, degree of weed invasion and amount of bare ground (see Sharp *et al.* 2005[32]). Two transects are surveyed along the long axis of the subject site, starting and finishing 10 metres from the external boundary to avoid edge effects (refer to **Figure 4.1**). At each step, a long vertical wire is place ahead of the observer, and a record is made of which species touch the wire (a 'hit'). 'Hits' on rock, bare ground, cryptogams and litter are also recorded. Results of the 2007, 2009, 2011 and 2013 transects are in **Appendix 3**. The number of 'hits' may vary depending on observer stride length, and should be converted to a percentage value for each variable.

[29] Braun-Blanquet, J. (1932) Plant sociology. McGraw Hill, New York.

[30] Rehwinkel, R. (2007) A method to assess grassy ecosystem sites: using floristic information to assess a sites' quality. Version 2. NSW Department of Environment and Climate Change, Queanbeyan.

[31] Armstrong, R. (2013) Interim analysis of relationships between vegetation condition and kangaroo density in grassy ecosystems of the northern ACT: data collected in Spring-Summer 2009/2012. A report prepared for ACT government, Environment and Sustainable Development Directorate, Canberra. February 2013.

[32] Sharp, S., Dorrough, J., Rehwinkel, R., Eddy, D. & Breckwoldt, A. (2005) Grassy Ecosystems Management Kit: A Guide to Developing Conservation Management Plans. Environment ACT, Canberra.

An aim of the Maintenance Plan is to maintain a balance between bare ground and vegetation, and to keep the cover of presumed GSM food plants at current or increased levels. For the life of the current Maintenance Plan, the aim is for bare ground to be kept at 5-25 per cent, the main native grasses at about 60 per cent of the vegetation cover (proportional to native forbs and exotic species) and 8-20 centimetres height, with wallaby grasses contributing 7 per cent or more of the proportional vegetation cover.

Note that these percentage figures relate to vegetation cover only, rather than total cover which includes litter, bare ground and cryptogams. While these values are important and should still be collected and analysed, they are excluded from proportional vegetation cover calculations as they can vary significantly due to slashing management, moisture conditions and other variation in prevailing weather conditions.

Photographic record

A photographic record is to be made each spring, from the points indicated in **Figure 4.1**. The photographs from 2013 are in **Appendix 5**. They give a general indication of vegetation structure on various parts of the subject site. In following years, photographs should be captured in accordance with **Figure 4.1** and **Appendix 5**.

Figure 4.1 shows the location of the step-point survey transects, quadrat and photographic record locations.

4.1.1.1 Weeds

Biennially, every second summer, the need for weed control should be compared with the previous year's activity, and assessed against the objectives in **Table 3.1**. This should be undertaken for individual species, and compared to previous years activities to determine successes and failures. Successful weed management will result in eradication of some target species, suppression or containment of others, and the identification and treatment of new weed infestations. Areas where treatment has been less effective should be noted, and future treatments adjusted accordingly.

Any increase in the area of vegetation dominated by exotic species measured in the mapping exercise described above should be a trigger for an increase in weed control effort, as should repeated or continuing infestations of weeds listed for eradication, or the spread of species required to be contained (including native grass species previously planted on the subject site).

Figure 4.1 - Location of the Step-Point Survey Transects, Quadrat and Photographic Record Locations

4.1.2 Golden Sun Moth

4.1.2.1 Annual monitoring

The subject site is too small for standard transect surveys (e.g. Clarke & Dunford 1999[33]) to be strictly comparable with larger sites. However, its size provides an opportunity for ongoing comparisons of observational data collection methods. Due to the small area to be surveyed and the potential for double counting, observational surveys will not give absolute numbers for a site, but provide an indication of density and activity of flying males (refer to Appendix B of Hogg 2010[34]). Repetition of counts allows averaging to reduce the variability that can arise from changes in wind speed or sunshine intensity between short counts on the same day.

Review of the original Maintenance Plan indicates that the survey guidelines for GSM (EPBC Act Policy Statement 3.12; DEWHA 2009[35]) are not consistent with that of the Plan. This is understandable considering the original Maintenance Plan was developed prior to the release of the GSM survey guidelines. Under the EPBC survey guidelines, survey is required to be undertaken over four (4) non-consecutive days, with optimal conditions targeted based on seasonal conditions rather than rigid timeframes outlined in the existing Plan. For instance, throughout the ACT, the flying season can vary between early November to mid-December and late November to early January. The following survey parameters should be used for selecting appropriate days to undertake monitoring:

- a warm to hot day (above 20°C by 10:00am);
- the warmest part the day (i.e. between 10:00am and 2:00pm);
- clear or mostly cloudless sky;
- still or relatively still wind conditions during the survey period;
- ≥ 2 days since rain; and
- staggered to increase the likelihood of detection given the short adult life span (1-4 days between surveys).

As per the original Maintenance Plan, the following methods are to be used to undertake GSM survey on site:

- *Transect surveys*: on each visit at 1130, 1200 and 1230 hours, observer to walk steadily on a 100 metre transect along the long axis of the subject site, , starting and finishing 10 metres from the external boundary to avoid edge effects. All GSM seen flying ahead and on each side of the observer on each pass should be recorded on a hand- counter. Double counting of individuals to be avoided as far as possible. Results to be recorded as number of GSM per 100 metre transect.
- *Point observations*: to be undertaken twice on each visit in sets of ten, between the transect survey sessions. Observer to stand in centre of subject site (in the high

[33] Clarke, G.M. & Dunford, M. (1999) Survey of the Belconnen Naval Transmitting Station for the Endangered Golden Sun Moth, *Synemon plana*. A report prepared for Wildlife Research and Monitoring, Environment ACT.
[34] Hogg, D. (2010) A strategic approach to the conservation and environmental assessment of Golden Sun Moth sites in the Canberra area. Interim revised report. Prepared on behalf of the ACT Land Development Agency.
[35] DEWHA (2009) EPBC Act Policy Statement 3.12 - Significant Impact Guidelines for the Critically Endangered Golden Sun Moth (*Synemon plana*) Department of the Environment. [http://www.environment.gov.au/epbc/publications/pubs/golden-sun-moth.pdf, URL Accessed 27/09/2013]

condition grassland area), and rotate slowly (360º in 30 seconds). All GSM seen in a radius of 25 metres during rotation to be recorded, including double counting of individuals that change track and recross the observer's visual path. Results from ten rotations to be recorded in each of the two sessions, with the range and average calculated for each session (number of GSM per 30 second rotation).

- GSM seen will be mostly flying males; any females should be recorded separately.

4.1.2.2 Five yearly monitoring

Population estimation

Note: mark-recapture surveys involve repeated handling of animals, and require the prior issue of a 'Permit to Take' by the Commonwealth Department of the Environment. The personnel involved in the survey should be appropriately qualified and experienced in such work, and the application for the permit should be lodged three months prior to commencement of the proposed survey.

Previous population estimation surveys have involved daily capture of males (and females in some years) throughout the flying period. The impact of this on survival and breeding of GSM is not known, although numbers were not reduced when the procedure was carried out over three consecutive seasons in the 1990s. However, it is a very intrusive procedure, and could be damaging to the population in years when numbers are already low for other reasons.

An alternative method using a nested sampling structure is outlined below (designed by Anett Richter, University of Canberra; cited in PB 2008, Rowell 2012). It allows population estimation with less interference, while also recording the ratio of males to females captured (recommended for larger populations only; in 2006, females were not captured to reduce interference to egg-laying). Capture, marking and release methods should be as described in Rowell (2012), although capture of females should be avoided as per the 2006 survey due to the intrusive nature of the method (A. Rowell, personal communication).

The Robust Design

This mark-recapture method allows population estimation without daily captures. It features a nested sampling structure, timed to take account of the short life-span of adult GSM (one to four days). The first level consists of primary sampling sessions. The population experiences mortality (and potentially immigration) between primary sessions, allowing application of open population models. The secondary level of sampling involves a short mark-recapture study within each primary session. Closed population models are used at this stage to estimate the animal abundance at each primary session.

The design of the mark-recapture study (primary and secondary sampling sessions) depends on the biology of the study species. Due to the short life span of GSM (average two days), secondary sampling sessions should take place within two days. It is suggested to have at least four secondary sessions within one primary session to obtain an appropriate number of captured and recaptured individuals. To verify a closed population (no immigration, emigration, birth and deaths) four secondary sessions need to take place within two days (see design in **Figure 4.2**).

The first primary session should begin as soon as flying males are detected, and should be repeated every eight days until there are no new captures. Observational surveys of the subject site should be undertaken weekly from late October to determine the beginning of the flying period. Analysis is to be carried out using the software package 'MARK'. The package includes the estimation of total population size of closed and open populations based on the Robust Design. It also provides estimates of daily survival rates and recapture probabilities.

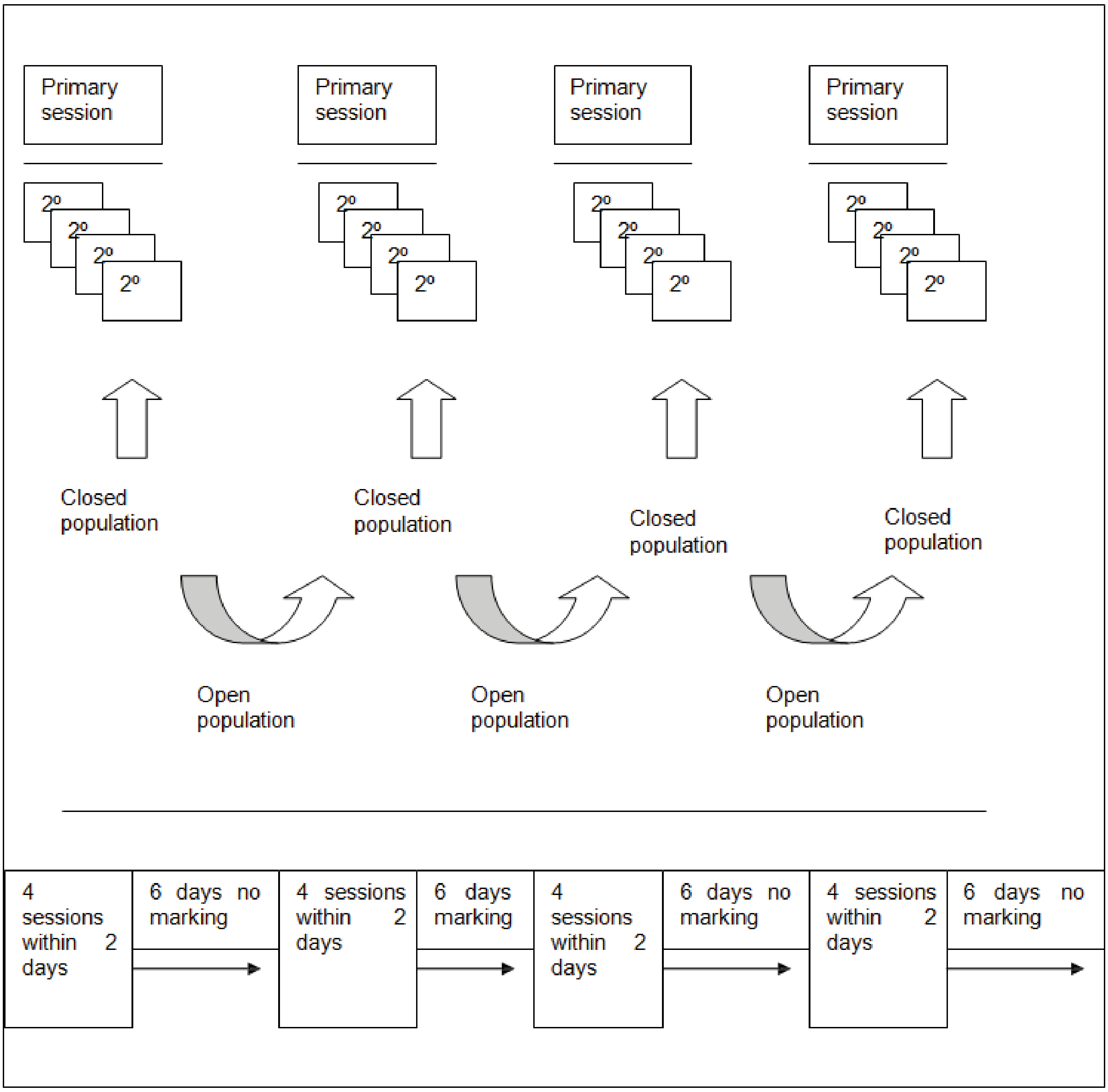

Figure 4.2 - Experimental Design for Golden Sun Moth Population Estimation
Source: Anett Richter, University of Canberra, 2006 (cited in PB 2008, Rowell 2012)

4.1.3 Recording and Reporting

4.1.3.1 Management Checklist

The annotated work program and data from periodic monitoring will provide a record of management actions and outcomes that can be submitted to the lessee (National Capital Authority), the Commonwealth Department of the Environment and the ACT Government biennially or as required.

A report should be prepared in the final year of the five year Maintenance Plan, detailing the results of management and monitoring, with recommendations for variations in the reviewed Maintenance Plan.

4.2 Results and Discussion (2007-2013 data)

4.2.1 Vegetation

4.2.1.1 Vegetation mapping and weed distribution

Vegetation mapping undertaken by Rowell (2012) was validated as part of the updated Maintenance Plan, and determined to be accurate with the exception of slight boundary changed in areas containing planted poa tussock (*Poa labillardierei*) and exotic dominated pastures in southern portions of the site. As these changes are minor, it is not apparent that these species have spread; small variations can be accounted for through variance in field mapping methodologies.

In comparing current mapping with that undertaken as part of the original Maintenance Plan (PB 2008), there appears to have been a reduction in the dominance of perennial exotic pasture grasses in the south-east of the subject site. At the time of the 2013 survey, much of the wild oats (*Avena* spp.) on the southern boundary were slashed. If native seed is able to be set in this area, they will provide competition of wild oats next year and with continued management, may be returned to native grassland.

Rowell (2012) observed that, as part of surveys undertaken in December 2011, weeds were more common and more extensive across the site than in previous years. This was also confirmed as part of November 2013 survey. These included perennial exotic grasses such as phalaris (*Phalaris aquatica*), paspalum (*Paspalum dilatatum*), tall fescue (*Festuca* sp.), Chilean needlegrass (*Nassella neesiana*) and cocksfoot (*Dactylis glomerata*). These were particularly prominent in the wetter southern third of the site, although cocksfoot and Chilean needlegrass in particular are distributed in lower abundance through native grassland areas.

On the bank adjacent to Sydney Avenue where disturbance from road widening and possibly replanting is evident, annual and perennial grasses were dominant. Along the western boundary, perennial exotic grasses and ribwort plantain (*Plantago lanceolata*) were abundant particularly beneath exotic deciduous trees. St. Johns wort (*Hypericum perforatum*) is scattered across the site. Three small service tree (*Sorbus domestica*) seedlings were observed on the north-western fenceline.

Refer to **Figure 3.1** for updated vegetation mapping for the site.

4.2.1.2 Species List

The number of native and exotic grasses and forbs recorded since 2006 has remained relatively stable, with infrequently recorded species accounting for mild fluctuations in species richness. Prior to 2006, full-site species lists were not recorded. Notes on changes in abundance of species of interest are found in **Section 4.2.1.3**.

The species list across years since 1991 is found in **Appendix 1**.

4.2.1.3 Condition Trend Analysis

Analysis was undertaken on floristic data collected from four periods between 2007 and 2013: November 9 2007 (late Spring); January 8 2010 (mid Summer); January 4 2012 (mid Summer); and November 19 2013 (late Spring).

Analysis of step-point transect survey data

A graph presented in **Figure 4.3** demonstrating changes in vegetation cover over time are based on data generated from the two step-point vegetation transects running north-south across the site (**Figure 4.1**). While step-point data is a useful means of quantifying changes in grassland composition over time, it is worth noting that even with the same observer, the exact same observation points are not sampled across years. As such, minor fluctuations in observations may not be significant; rather it is a useful way of exploring trends over time. Floristic value scores were generated from the 20 x 20 metre quadrat (location of quadrat shown in **Figure 4.1**).

As shown in **Figure 4.3**, step-point data indicates that native vegetation cover is relatively stable, with total native vegetation cover across the site ranging from 53 per cent to 56 per cent (±1.3%) across four years.

However, total exotic vegetation cover has risen from 18 per cent on January 2010 to 31 per cent in November 2013, due to an increased cover of both exotic grasses and forbs. This may be due to favourable rainfall conditions for weed growth in the past few years, but once established these exotic species require diligent control. Each of the two step-point transect surveys cover high quality grassland areas dominated by native grasses and forbs, as well as areas dominated by exotic grasses. Without stratifying transects by vegetation condition, it is difficult to report on relative cover in native and exotic condition grasslands. However, as a guide it is estimated that native grassland areas are generally comprised of 80-90 per cent native species; similarly, areas dominated by exotic pastures are generally 80-90 per cent exotic species.

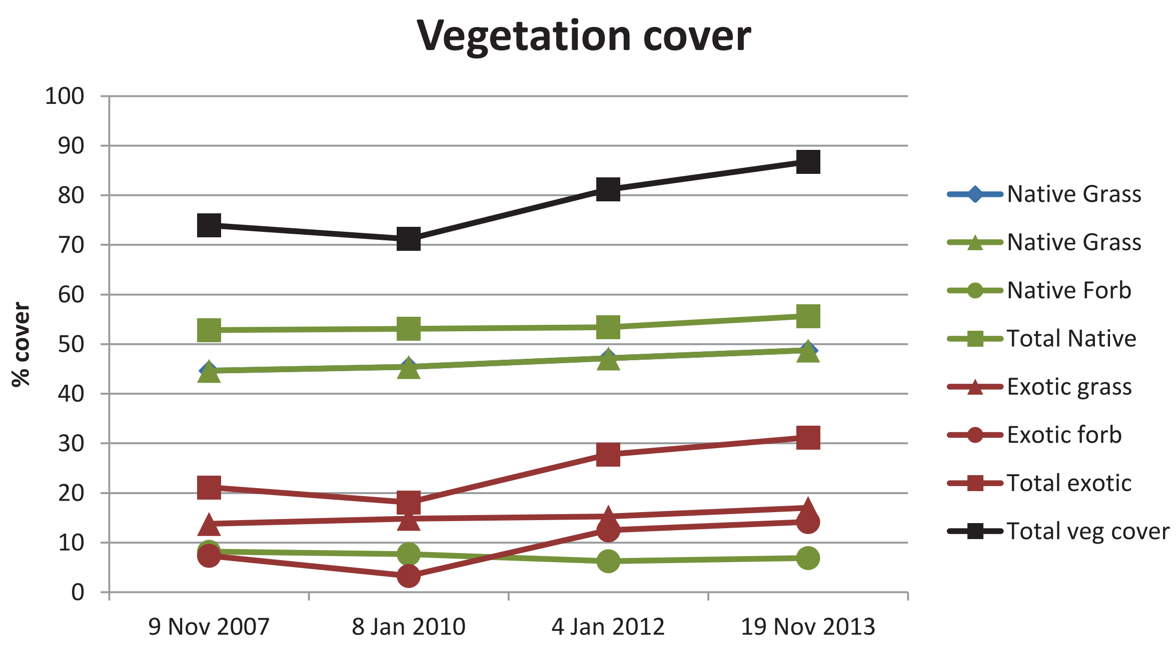

Figure 4.3 - Changes in Native and Exotic Vegetation Cover Over Time

A stated aim in managing the site is to retain native grasses at ≥60 per cent vegetation cover proportional to other vegetation (necessary to remove variation related to site management activities such as slashing – refer to **Section 4.1.1**). When vegetation cover is analysed independent of non-vascular cover such as litter, bare ground and cryptograms, the proportional native grass cover relative to other vegetation cover has dropped below 60 per cent to 56.1 per cent in 2013, as shown in **Figure 4.4**. While grass cover on site has not reduced *per se* (**Figure 4.3**), exotic forb abundance has increased and should be controlled in order to maintain grassland health and a proportional cover of ≥60% of native grasses relative to other vegetation. For further information on the increase of exotic grasses and forbs, refer to **Section 4.2.1.4** below.

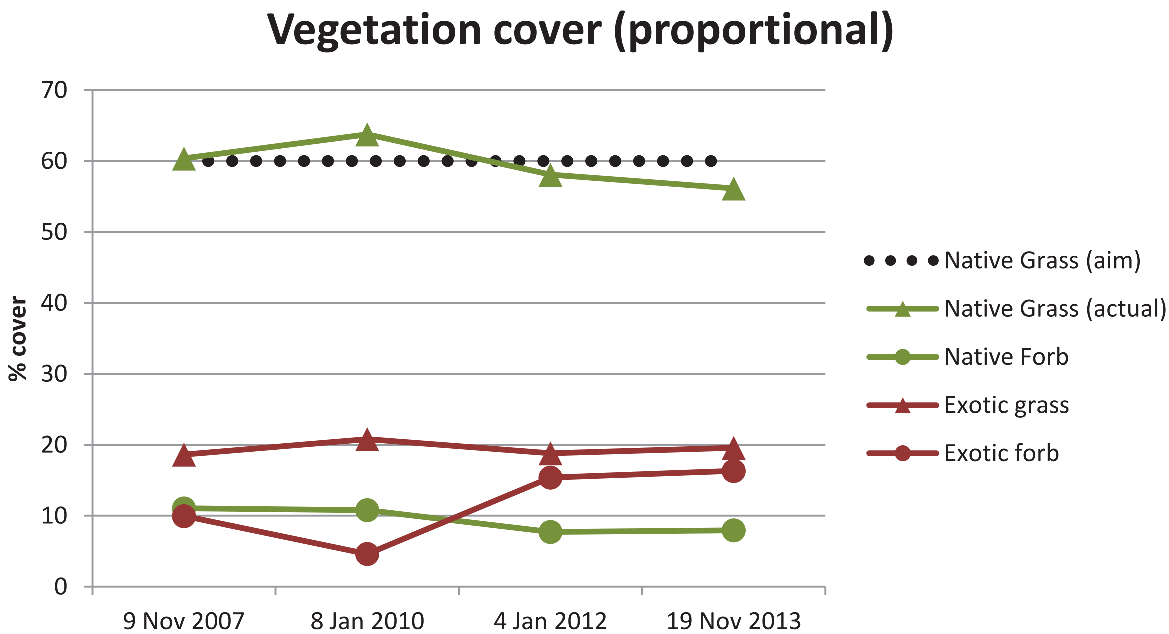

Figure 4.4 - Proportional Vegetation Cover (Non-Vascular Cover Excluded)

Kangaroo grass (*Themeda triandra*) that has been planted on the eastern footpath edge is gradually spreading across the site. This should be closely monitored and spot-sprayed if necessary. Kangaroo grass should be maintained along the edge of the path however, as it has formed an effective barrier to weed seed dispersal adjacent to the footpath.

Figure 4.5 demonstrates that litter cover across the site has been fluctuating between 11 per cent and 16 per cent (±2.3%) since 2007. Significant reductions in bare ground and litter since January 2010 are likely to be a result of spread of exotic grasses and forbs into inter-tussock spaces during favourable seasons for weed establishment.

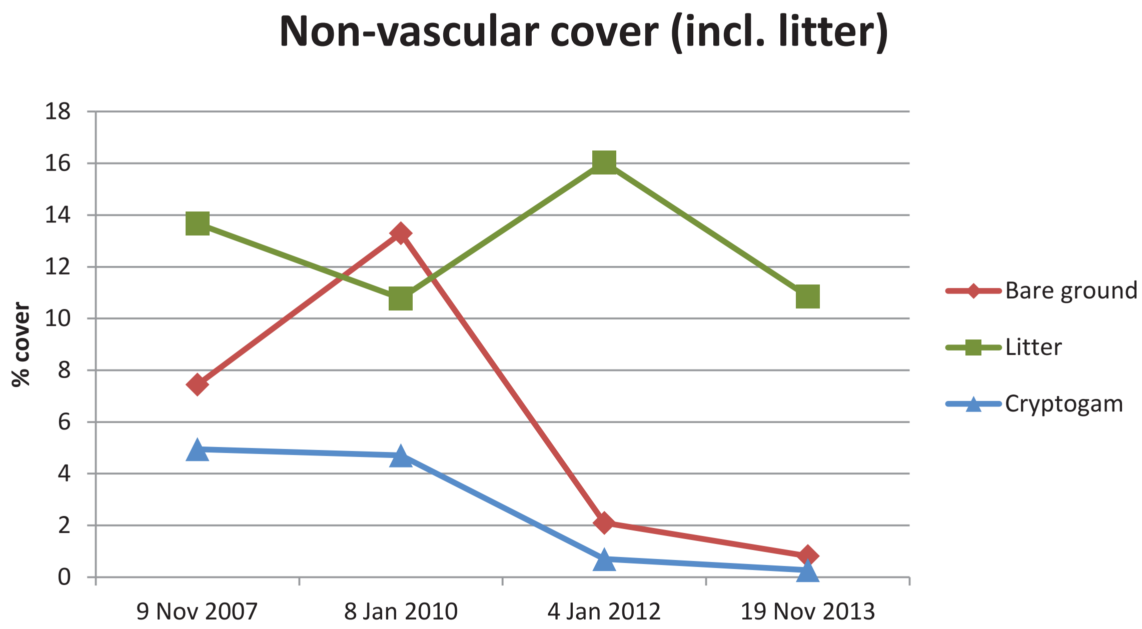

Figure 4.5 - Changes in Non-Vascular Cover Over Time

Analysis of quadrat data

Within the 20 x 20 metre quadrat area, floristic values as defined by Rehwinkel (2007) have remained relatively stable over time, with a lowest value of '16' in January 2010 and a highest value of '22' in November 2013 (**Figure 4.6**). Low to moderate levels of variance using this scoring system are not considered noteworthy, as while based on the presence of 'significant' or 'indicator' species it is unlikely that floristic this information was unable to be collected in the exact same plot area as the plot corners were not permanently marked. In any case, if a 'significant' or 'important' species occurs just outside the plot it does not contribute to the floristic value score, but contributes to the overall floristic integrity of the site, which is of greater importance. However, the presence of exotic species are not factored in using this floristic value score method. Should exotic species need to be factored into the analysis in the future, data collected to-date can be used for retrospective analyses.

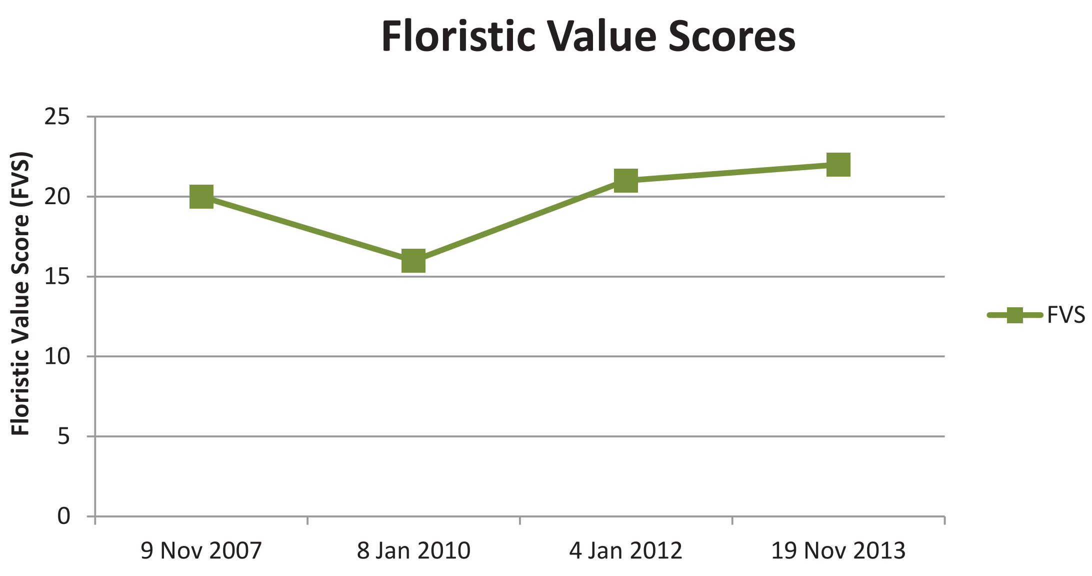

Figure 4.6 - Changes in Floristic Values Over Time

4.2.1.4 Changes in Weed Cover

Figure 4.7 shows the weeds of concern which have increased significantly since 2007. Generally, step-point vegetation transects record species which are of higher abundance across a site; recent observations indicate that these highly invasive weeds has increased considerably across the site in recent years.

While St. John's wort (*Hypericum perforatum*) has been known to be present on the site since 2003, it was not recorded as part of the step-point vegetation transects until January 2012. In the November 2013 survey it was observed to be scattered across the majority of the site. Similarly, cocksfoot (*Dactylis glomerata*) and ribbed plantain (*Plantago lanceolata*) appear to be coming far more common, perhaps due to favourable growth conditions in the past few years. These species should be monitored closely in subsequent years.

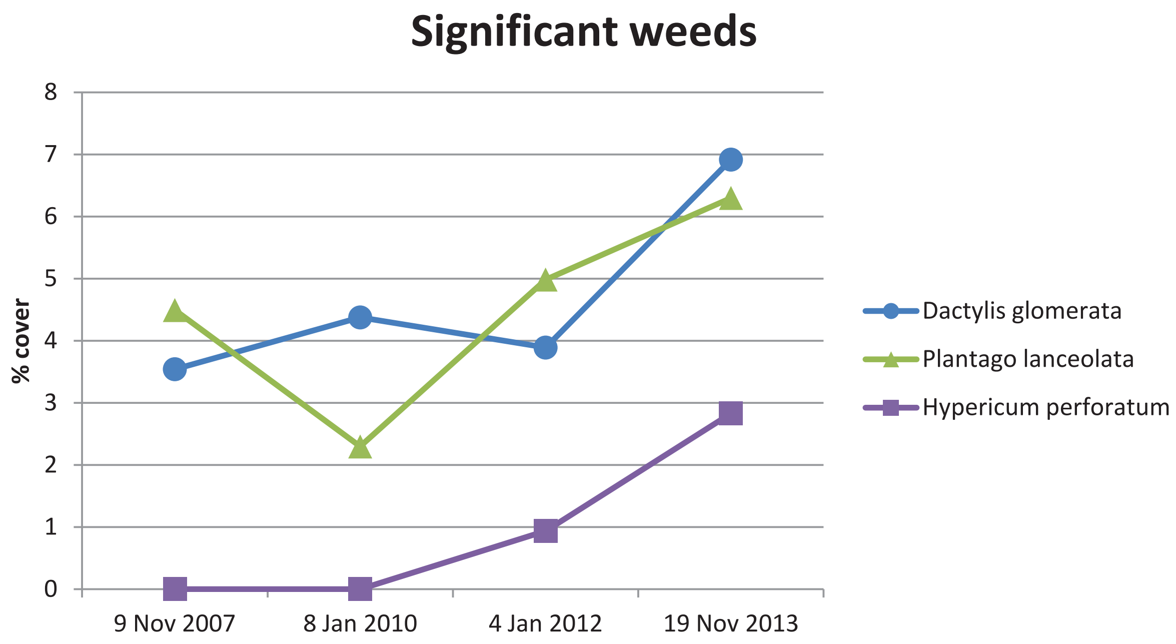

Figure 4.7 - Increases in Significant Weed Cover Over Time

Other significant weeds listed in **Table 3.1** are not shown in **Figure 4.7** as they are either considered stable, or are in a low enough abundance to not be recorded using the step-point transect survey method. Chilean needlegrass (*Nassella neesiana*), wild oats (*Avena* species), flatweed (*Hypochaeris radicata*) and tall fescue (*Festuca* sp.) appear relatively stable, but should be controlled as they may increase after a disturbance event. Flaxleaf fleabane (*Conyza bonariensis*) was not observed in the November 2013 surveys. However it was noted by Rowell (2012) to be occurring across the site; this species is known to fluctuate considerably depending on climatic conditions.

4.2.2 Golden Sun Moth

Quantification of GSM populations at a given site is problematic due to variance in suitable flying weather and the potential for 'double-counting'. As such, low interference 'mark-capture-release' methods such as that developed by Dr Anett Richter (formerly of University of Canberra) and adopted as part of five-yearly monitoring in this Maintenance Plan by Rowell (2012) are preferable in determining long term population trends.

A sustained annual monitoring effort has not been undertaken at the site, with survey undertaken broadly in line with annual monitoring protocols completed in the November 2009 to January 2010 period, and again in November and December 2013. Exploratory analysis of this data (shown in **Table 4.1**) is not presented; assuming annual monitoring events are maintained it may be more appropriate to analyse population trends when the Maintenance Plan is up for review in 2018. In any case, analysis should be undertaken with consideration of general population trends across the ACT and Southern Tablelands to partially account for variation in larval survival based on seasonal and annual climatic variation (noting differences in this site compared with those of part of larger non-isolated remnants). Future monitoring efforts should follow guidelines as per DEWHA (2009) (refer to **Section 4.1.2.1**).

In 2013, surveys commenced during the known flight season, based on Umwelt's prior reconnaissance and observations of GSM at nearby sites, as well as advice on observations from other ecologists.

Table 4.1 - Monitoring Data for Golden Sun Moth, 2009-10 and 2013

Survey Date and Time	Weather Conditions *	Observations
November 2009 to January 2010		
09/11/2009; middle of day	Temp: Max 32-35°C Rainfall: Unknown Wind: Unknown	Nil. Two male GSM observed on Sydney Ave. Median strip
25/11/2009; 1320-1350		T1 – 25; T2 – 19; T3 – 19. Point observation (north) – ave = 5.5; range = 2 to 7 Point observation (south) – ave = 3.6; range = 2 to 5
08/12/2009; 1150-1220		T1 – 1; T2 – 9; T3 – 0. Point observation (north) – ave = 0.8; range = 0 to 3 Point observation (south) – ave = 1.3; range = 0 to 4
08/01/2010; middle of day		Nil.
November to December 2013		
19/11/2013; 1130, 1200, 1230.	Temp: Max 28°C Rainfall: 0 mm Wind: Low, SSW	T1 – 4, 4, 5 (ave = 4.67); T2 – 1, 4, 1 (ave = 2). Point observation (1145) – ave = 0.7; range = 0 to 3 Point observation (1215) – ave = 0.5; range = 0 to 2
27/11/2013; 1130, 1200, 1230.	Temp: Max 29°C Rainfall: 0 mm Wind: 13km/hr, WNW	T1 – 3, 10, 5 (ave = 6); T2 – 2, 12, 9 (ave = 7.7). Point observation (1145) – ave = 0.3; range = 0 to 1 Point observation (1215) – ave = n/a; range = 0 to 0
12/12/2013; 1130, 1200, 1230.	Temp: Max 26.4°C Rainfall: 0 mm Wind: 19km/hr, WNW	T1 – 1, 0, 2 (ave = 1); T2 – 1, 5, 9 (ave = 5). Point observation (1145) – ave = 0.2; range = 0 to 1 Point observation (1215) – ave = 3.6; range = 0 to 6

* In 2009/10 weather conditions were reported as a range, with all days being favourable.

While survey undertaken in 2013 were in line with climatic requirements for GSM flight, the 2009-10 surveys were undertaken in slightly hotter conditions. This may explain the higher count for the 25/11/2009 survey in particular.

The five-year monitoring event was undertaken by Alison Rowell in December 2011 (Rowell 2012). Across three primary capture sessions totals of 50, 32 and 12 month were achieved. Based on analysis undertaken by Dr Anett Richter, the GSM population at this time were estimated to be as shown in **Table 4.2** (from Rowell 2012).

Table 4.2 - Primary Session Golden Sun Moth Population Estimates (Mark-Recapture), December 2011

Primary session	Dates	Position in flying season	Estimated population size during session	95% confidence interval
1	9-10/12/2011	Mid	66	57-85
2	23-24/12/2011	Mid to late	49	39-75
3	31/12/2011-1/1/2012	Late	12*	-

* Minimum number alive, population estimate not possible due to lack of recaptures.

At the subject site the presence of wallaby grasses (*Rytidosperma* spp.) is important for the survival of GSM. Additionally, other C3 grasses such as tall speargrass (*Austrostipa bigeniculata*) and the exotic Chilean needlegrass (*Nassella neesiana*) provide fodder value for GSM (Richter *et al.* 2010). A stated aim of the Maintenance Plan is to maintain wallaby grasses at 7 per cent or more vegetation cover (proportional to vegetation only). Analysis of step-point transect survey data indicate that wallaby grasses are presently at 7.2 per cent, having ranged from 3.7 per cent to 7.4 per cent (±1.9) since November 2007 (**Figure 4.8**). As a perennial native grass in a site that is likely to be rarely subjected to macropod grazing, it is unlikely that wallaby grass cover has varied this amount since 2007. Rather, it may be a function of variance of the step-point transect survey method (noting there is probably no better way to quantify across the site), or time since slashing (which can temporarily reduce the surface area of grass tussocks).

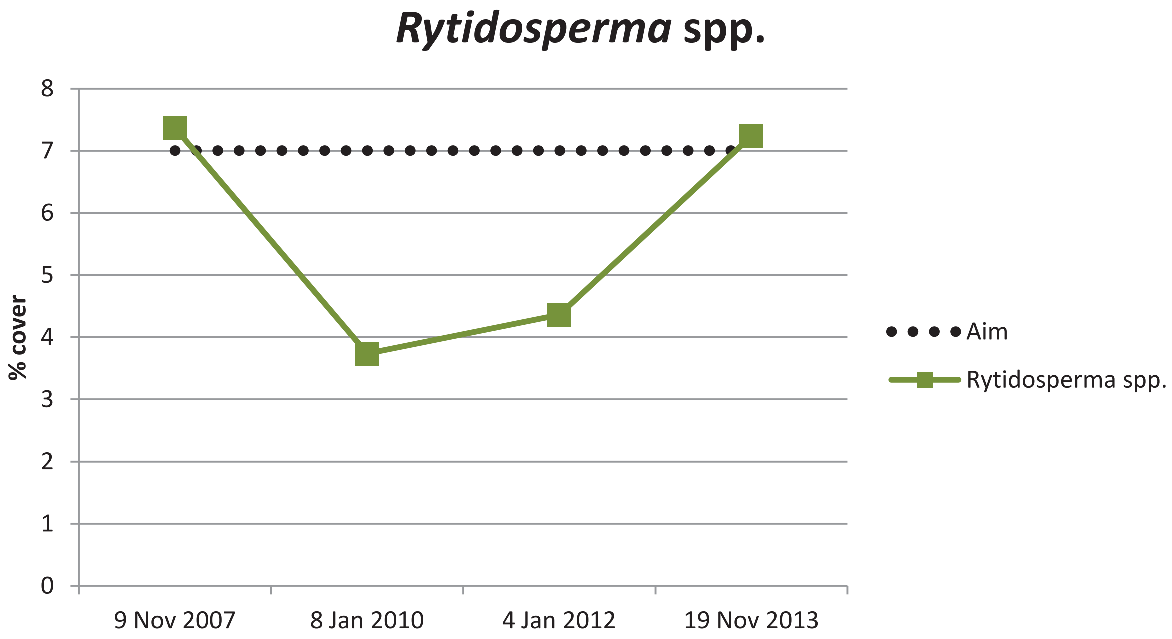

Figure 4.8 - Changes in Wallaby Grass (*Rytidosperma* spp.) Cover Over Time

Kangaroo grass (*Themeda triandra*) has been planted on the eastern footpath edge, and it is gradually spreading across the site (refer to Rowell 2012). Additionally, exotic pasture species such as cocksfoot (*Dactylis glomerata*) are present in all but the highest quality areas, and these species may displace C3 grasses that provide food for GSM larvae (refer to Richter *et al.* 2010). Rowell (2012) noted that in late 2011, grasses were longer and denser than desirable for GSM habitat, perhaps as they hadn't been mown twice in wetter years (the Plan recommends once a year with follow-up mowing in wetter years to reduce biomass). At the time of the November 2013 surveys the structure (height) was considered reasonable, perhaps due to a relatively dry spring-summer period. While inter-tussock spaces have reduced, this is more likely to vary based on climatic conditions rather than management actions such as slashing.

5.0 Review and Implementation

5.1 Review of the Maintenance Plan

The Maintenance Plan should be reviewed again at the end of five years (i.e. 2018). A new draft Plan should be prepared by an appropriately qualified person, and be presented for review and approval by the National Recovery Teams for GSM and NTG, or a committee of specialists from bodies such as ACT Government, NSW Office of Environment and Heritage, the Commonwealth Department of the Environment, University of Canberra, Australian National University, CSIRO Department of Entomology etc.

This report represents the first review of the Maintenance Plan. Review of the updated plan was undertaken by local biologist and author of the original Plan Alison Rowell, and representatives from Territory and Commonwealth Government Departments. Refer to **Section 1.2** (Acknowledgements) for further information.

5.2 Implementation of the Maintenance Plan

The leaseholder of the site will be responsible for the implementation and ongoing management of the Maintenance Plan and all associated costs.

All aspects of the Maintenance Plan should be carried out by:

- suitably qualified operators/contractors with demonstrated experience in NTG management, to be engage directly by the leaseholder of the site; or
- a recognised authority (e.g. the ACT Government), subject to an agreement, arrangement or Memorandums of Understanding with the recognised authority, with all expenses to be funded by the leaseholder.

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APPENDIX 1

Plant Species Recorded on Site

Appendix 1: Plant Species Recorded on Site

Species	(p = present) Common Name	1991-2 WRM	1992 Davis Hogg	1993 WRM	1994 WRM	1995 WRM	1996 WRM	1999 WRM	2000 WRM	2003 WRM	2006 Rowell	2007 Rowell	2009 Rowell	2011 Rowell	2013 Umwelt
Native grasses															
Aristida ramosa	Wiregrass											p	p		
Rytidosperma auriculata	Lobed Wallaby Grass		p						p			p	p	p	p
Rytidosperma bipartitum	A Wallaby Grass										p	p	p		
Rytidosperma caespitosum	Ringed Wallaby Grass	p											p	p	
Rytidosperma carphoides	Short Wallaby Grass	p	p							p	p	p	p	p	p
Rytidosperma fulvum	A Wallaby Grass												p	p	
Rytidosperma laeve	Smooth Wallaby Grass	p	p								p	p	p	p	p
Rytidosperma spp.	Wallaby Grasses			p	p	p	p	p	p	p	p	p		p	p
Austrostipa bigeniculata	Tall Speargrass	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Austrostipa densiflora	A Speargrass			p											
Austrostipa scabra	Rough Speargrass		p									p		p	p
Bothriochloa macra	Redleg Grass	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Chloris truncata	Windmill Grass	p					p					p			
Elymus scaber	Wheatgrass	p	p	p			p	p	p		p	p	p	p	p
Eragrostis brownii	A Lovegrass	p													
Eragrostis trachycarpa	A Lovegrass					p	p						p	p	
Microlaena stipoides	Weeping Grass											p		p	
Panicum effusum	Hairy Panic Grass	p	p			p		p	p		p	p	p	p	p
Poa labillardieri	Tussock Grass										p	p		p	p
Themeda triandra	Kangaroo Grass									p	p	p	p	p	p
TOTAL		**9**	**8**	**5**	**3**	**5**	**6**	**5**	**6**	**5**	**10**	**15**	**13**	**15**	**11**
Native forbs															
Acaena ovina	Sheeps Burr	p	p								p	p		p	
Asperula conferta	Common Woodruff	p	p	p		p		p			p	p	p	p	p
Bulbine bulbosa	Golden Lily	p	p	p			p					p	p	p	p
Calocephalus citreus	Lemon Beauty Heads	p	p	p			p			p	p	p	p	p	p
Carex sp.	A sedge														p
Chamaesyce drummondii	Caustic Weed	p													
***Cheilanthes* sp.**						p									
Cheilanthes sieberi	Rock Fern		p								p	p	p	p	p

Species	(p = present) Common Name	1991-2 WRM	1992 Davis Hogg	1993 WRM	1994 WRM	1995 WRM	1996 WRM	1999 WRM	2000 WRM	2003 WRM	2006 Rowell	2007 Rowell	2009 Rowell	2011 Rowell	2013 Umwelt
Cheilanthes tenuifolia				p											
Chenopodium pumilio	Small Crumbweed													p	
Chrysocephalum apiculatum	Yellow Buttons	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Convolvulus angustissimus	Australian Bindweed	p	p		p					p	p	p	p	p	p
Crassula sieberiana	Australian Stonecrop												p		
Cymbonotus lawsonianus	Bear's Ears		p												
Drosera peltata	Sundew		p												
Eryngium rostratum	Blue Devil	p	p	p			p	p			p	p	p	p	p
Euchiton sp.	A Cudweed					p		p	p						
Euchiton gymnocephalus	A Cudweed											p	p		
Euchiton sphaericus	A Cudweed													p	p
Glycine tabacina	Vanilla Glycine										p			p	
Gonocarpus tetragynus	Raspwort					p									
Goodenia pinnatifida	Scrambled Eggs	p	p	p	p	p	p			p	p	p	p	p	p
Hypericum gramineum	Small St John's Wort		p	p			p							p	
Juncus sp.	A Rush		p												
Lomandra bracteata	A Matrush											p	p	p	p
Lomandra filiformis	A Matrush	p	p				p				p				
Lomandra multiflora	A Matrush		p												
***Lomandra* sp.**	A Matrush			p	p	p	p	p	p		p				
Microtis unifolia	Common Onion Orchid		p										p		p
Oxalis perennans	Soursob	p	p	p	p	p	p	p	p			p		p	p
Pimelea curviflora	Curved Rice-flower		p	p		p					p	p		p	p
Plantago varia	Variable Plantain	p	p								p	p	p	p	p
Rumex brownii	Swamp Dock	p									p				
Schoenus apogon	Bog-rush		p												p
Sebaea ovata			p												
Senecio quadridentatus	Cotton Fireweed													p	
Solenogyne dominii	Smooth Solenogyne	p	p												
Stackhousia monogyna	Creamy Candles		p					p				p			p
Tricoryne elatior	Yellow Rush Lily	p	p	p	p		p	p	p	p	p	p	p	p	p
Triptilodiscus pygmaeus	Austral Sunray	p	p	p		p	p	p	p			p		p	p
Vittadinia muelleri	Fuzzweed									p		p		p	

Species	(p = present) Common Name	1991-2 WRM	1992 Davis Hogg	1993 WRM	1994 WRM	1995 WRM	1996 WRM	1999 WRM	2000 WRM	2003 WRM	2006 Rowell	2007 Rowell	2009 Rowell	2011 Rowell	2013 Umwelt
Wahlenbergia sp.	A Bluebell			p	p	p	p	p						p	
Wahlenbergia communis	Tufted Bluebell	p	p								p	p	p	p	p
Wahlenbergia luteola	A Bluebell										p	p	p	p	p
Wahlenbergia stricta	Tall Bluebell		p												
Wurmbea dioica	Early Nancy		p												
Xerochrysum viscosum	Sticky Everlasting													p	
TOTAL		**17**	**28**	**14**	**7**	**11**	**12**	**10**	**6**	**6**	**17**	**20**	**16**	**25**	**21**
Exotic grasses															
Aira sp.	A Hairgrass	p	p	p		p	p	p	p	p		p	p		p
Aira elegantissima	A Hairgrass											p			
Avena sp.	Wild Oats		p	p							p	p	p	p	p
Avena barbata	Bearded Oats											p			
Briza maxima	Blowfly Grass	p	p	p		p	p	p	p	p		p	p	p	p
Briza minor	Shivery Grass	p	p	p		p	p	p	p	p		p	p	p	p
Bromus sp.	A Brome Grass			p	p	p	p	p	p		p				
Bromus catharticus	A Brome Grass		p									p		p	
Bromus diandrus	A Brome Grass		p												
Bromus hordeaceus	A Brome Grass		p									p	p	p	p
Bromus mollis	Soft Brome	p													
Cynodon dactylon	Couch			p								p		p	
Dactylis glomerata	Cocksfoot		p		p		p		p		p	p	p	p	p
Eleusine tristachya	Goose Grass							p							
Eragrostis curvula	African Lovegrass	p													
Festuca sp.	A Fine-leaved Fescue		p				p				p				p
Festuca arundinacea	Tall Fescue								p	p	p	p		p	
Lolium perenne	Perennial Ryegrass											p			p
Lolium rigidum	Ryegrass		p	p											
Lophochloa cristata	Annual Cat's Tail											p			
Nassella neesiana	Chilean Needlegrass	p	p						p		p	p	p	p	p
Nassella trichotoma	Serrated Tussock							p			p	p			p
Paspalum dilatatum	Paspalum			p		p	p	p	p	p	p	p	p	p	p
Phalaris aquatica	Phalaris	p	p	p		p	p					p		p	p
Vulpia sp.	Rat's-tail Fescue		p	p	p	p	p	p	p		p	p	p	p	p

Species	Common Name (p = present)	1991-2 WRM	1992 Davis Hogg	1993 WRM	1994 WRM	1995 WRM	1996 WRM	1999 WRM	2000 WRM	2003 WRM	2006 Rowell	2007 Rowell	2009 Rowell	2011 Rowell	2013 Umwelt
TOTAL		**7**	**13**	**10**	**3**	**7**	**9**	**8**	**9**	**5**	**9**	**18**	**9**	**12**	**13**
Exotic forbs															
Acetosella vulgaris	Sorrel	p													
Anagallis arvensis	Scarlet Pimpernel			p											
Arctotheca calendula	Capeweed											p			
Centaurium erythraea	Pink Stars			p		p	p		p		p		p	p	p
Cerastium glomeratum	Chickweed		p												
Cirsium vulgare	Spear Thistle			?			?								
Conyza bonariensis	Flax-leaf Fleabane					p	p							p	p
Echium plantagineum	Paterson's Curse											p			
Erodium cicutarium	Common Crowfoot			p				p					p		
Galium divaricatum	A Bedstraw					p	p								
Gamochaeta purpurea	A Cudweed						p		p	p	p	p		p	p
Gnaphalium sp.	A Cudweed		p	p											
Hirschfeldia incana	Hoary Mustard		p									p		p	p
Hypericum perforatum	St John's Wort									p	p	p	p	p	p
Hypochaeris glabra	Smooth Catsear	p								p		p			p
Hypochaeris radicata	Catsear	p	p	p	p	p		p	p	p	p	p	p	p	p
Lactuca serriola	Prickly Lettuce						p	p		p	p	p	p	p	p
Lepidium africanum	A Peppercress											p			
Parentucellia latifolia	Common Bartsia		p				p								
Petrorhagia nanteulii	Proliferous Pink		p							p				p	p
Plantago lanceolata	Ribwort Plantain	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Romulea rosea	Onion Grass											p			
Salvia verbenaca	Wild Sage		p									p			
Silene gallica	French Catchfly						p					p			
Sonchus oleraceus	Common Sow-thistle					p						p			
Tragopogon porrifolius	Salsify										p			p	p
Trifolium angustifolium	Narrow leaf Clover													p	p
Trifolium arvense	Haresfoot Clover		p												p
Trifolium campestre	Hop Clover	p	p									p	p	p	p
Trifolium dubium			p							p					
Trifolium glomeratum	Clustered Clover		p												

Species	(p = present) Common Name	1991-2 WRM	1992 Davis Hogg	1993 WRM	1994 WRM	1995 WRM	1996 WRM	1999 WRM	2000 WRM	2003 WRM	2006 Rowell	2007 Rowell	2009 Rowell	2011 Rowell	2013 Umwelt
Trifolium striatum			p												
Trifolium spp.	Clovers			p		p	p	p							
TOTAL		**5**	**13**	**8**	**2**	**7**	**10**	**5**	**4**	**8**	**7**	**15**	**7**	**12**	**14**
Exotic shrubs and trees															
Cotoneaster sp.	Cotoneaster											p			
Crataegus monogyna	Hawthorn									p					
Ligustrum sinense	Small-leaved Privet														
Populus nigra var. *italica*	Lombardy Poplar		p												
Prunus sp.	Plum											p	p		p
Sorbus domestica	Service Tree											p	p	p	p
TOTAL		**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**3**	**2**	**1**	**1**

Indicator 1 (Rehwinkle 2007)
Indicator 2 (Rehwinkle 2007)
p = present

APPENDIX 2

Cumulative Step-Point Transect Survey Data

Appendix 2: Cumulative Step-Point Transect Survey Data

TRANSECT 1	2007 Hits/100 metres (% frequency)	2009-10 Hits/100 metres (% frequency)	2011-12 Hits/100 metres (% frequency)	2013-14 % veg (% frequency)	2007 % veg composition (230 veg hits)	2009-10 % veg composition (201 veg hits)	2011-12 % veg composition (225 veg hits)	2013-14 % veg composition (158 hits)
Date	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**Nov-07**	**8-Jan-10**	**10-Jan-12**	
Easting start (WGS84)	**693810**							
Northing start	**6090258**							
Easting finish	**693877**							
Northing finish	**6090335**							
Bare ground	**20**	**30**	**3**	**0**	**8.7**	**14.9**	**1.3**	**0.0**
Litter	**30**	**21**	**40**	**19**	**13.0**	**10.4**	**17.8**	**12.0**
Cryptogam	**14**	**10**	**1**	**0**	**6.1**	**5.0**	**0.4**	**0.0**
Native grasses								
Austrostipa bigeniculata	58	63	48	48	25.2	31.3	21.3	30.4
Bothriochloa macra	27	20	31	15	11.7	10.0	13.8	9.5
Rytidosperma spp.	13	4	2	8	5.7	2.0	0.9	5.1
Panicum effusum		4	5	1		2.0	2.2	0.6
Austrostipa scabra			2	1			0.9	0.6
Elymus scaber			1	1			0.4	0.6
Themeda triandra			1	1			0.4	0.6
Total native grasses	**98**	**91**	**90**	**75**	**42.6**	**45.3**	**40.0**	**47.5**
Native forbs								
Chrysocephalum apiculatum	4	1	4	6	1.7	0.5	1.8	3.8
Lomandra bracteata	1	1	1		0.4	0.5	0.4	0.0
Tricoryne elatior	1		2		0.4		0.9	
Goodenia pinnatifida	1	1	2	2	0.4	0.5	0.9	1.3
Triptilodiscus pygmaeus	1				0.4			
Oxalis perennans			1				0.4	
Total native forbs	**8**	**3**	**10**	**8**	**3.5**	**1.5**	**4.4**	**5.1**
TOTAL NATIVES	**106**	**94**	**100**	**83**	**46.1**	**46.8**	**44.4**	**52.5**
Exotic grasses								
Dactylis glomerata	13	12	10	10	5.7	6.0	4.4	6.3
Paspalum dilatatum	8		11	4	3.5		4.9	2.5
Avena barbata	7	9	14	6	3.0	4.5	6.2	3.8
Nassella neesiana	5	3	7	7	2.2	1.5	3.1	4.4
Aira sp.	2	2			0.9	1.0		
Cynodon dactylon	1				0.4			

TRANSECT 1	2007 Hits/100 metres (% frequency)	2009-10 Hits/100 metres (% frequency)	2011-12 Hits/100 metres (% frequency)	2013-14 % veg (% frequency)	2007 % veg composition (230 veg hits)	2009-10 % veg composition (201 veg hits)	2011-12 % veg composition (225 veg hits)	2013-14 % veg composition (158 hits)
Date	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**Nov-07**	**8-Jan-10**	**10-Jan-12**	
Easting start (WGS84)	**693810**							
Northing start	**6090258**							
Easting finish	**693877**							
Northing finish	**6090335**							
Bromus hordeaceus		1				0.5		
Briza minor		2		2		1.0		1.3
Vulpia sp.		6	1	1		3.0	0.4	0.6
Festuca sp.								
Total exotic grasses	**36**	**35**	**43**	**30**	**15.7**	**17.4**	**19.1**	**19.0**
Exotic forbs								
Plantago lanceolata	13	7	16	12	5.7	3.5	7.1	7.6
Hypochoeris radicata	8	1	13	5	3.5	0.5	5.8	3.2
Romulea rosea	2				0.9			
Hypochoeris glabra	1				0.4			
Trifolium campestre		2				1.0		
Trifolium angustifolium				1				0.6
Erodium cicutarium		1				0.5		
Tragopogon porrifolius			1				0.4	
Centaurium erythraea			7	3			3.1	1.9
Hypericum perforatum			1	4			0.4	2.5
Gamochaeta purpurea				1				0.6
Total exotic forbs	**24**	**11**	**38**	**26**	**10.4**	**5.5**	**16.9**	**16.5**
TOTAL EXOTICS	**60**	**46**	**81**	**56**	**26.1**	**22.9**	**36.0**	**35.4**

TRANSECT 2	2007 Hits/100 metres (% frequency)	2009-10 Hits/100 metres (% frequency)	2011-12 Hits/100 metres (% frequency)	2013-14 % veg composition	2007 % veg composition (210 veg hits)	2009-10 % veg composition (180 veg hits)	2011-12 % veg composition (210 veg hits)	2013-14 % veg composition (160 hits)
Date	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**
Easting start (WGS84)		**693810**						
Northing start		**6090258**						
Easting finish	**693877**							
Northing finish	**6090335**							
Bare ground	**13**	**21**	**6**	**3**	**6.2**	**11.7**	**2.9**	**1.9**
Litter	**30**	**20**	**30**	**19**	**14.3**	**11.1**	**14.3**	**11.9**
Cryptogam	**8**	**8**	**2**	**1**	**3.8**	**4.4**	**1.0**	**0.6**
Native grasses								
Austrostipa bigeniculata	57	56	62	49	27.1	31.1	29.5	30.6
Bothriochloa macra	29	14	38	17	13.8	7.8	18.1	10.6
Rytidosperma spp.	11	6	13	12	5.2	3.3	6.2	7.5
Elymus scaber	1	1		2	0.5	0.6		1.3
Panicum effusum		3	1			1.7	0.5	
Aristida ramosa		2				1.1		
Total native grasses	**98**	**82**	**114**	**80**	**46.7**	**45.6**	**54.3**	**50.0**
Native forbs								
Chrysocephalum apiculatum	18	15	10	7	8.6	8.3	4.8	4.4
Lomandra bracteata	1	1	1		0.5	0.6	0.5	
Tricoryne elatior	3	3		1	1.4	1.7		0.6
Goodenia pinnatifida	3		1	2	1.4		0.5	1.3
Oxalis perennans				1				0.6
Asperula conferta	1	1			0.5	0.6		
Wahlenbergia luteola	1		1		0.5		0.5	
Calocephalus citreus		3	3	2		1.7	1.4	1.3
Cheilanthes sieberi		1	1			0.6	0.5	
Bulbine bulbosa		1		1		0.6		0.6
Total native forbs	**27**	**25**	**17**	**14**	**12.9**	**13.9**	**8.1**	**8.8**
TOTAL NATIVES	**125**	**107**	**131**	**94**	**59.5**	**59.4**	**62.4**	**58.8**
Exotic grasses								
Dactylis glomerata	3	5	7	12	1.4	2.8	3.3	7.5
Paspalum dilatatum	1	1	6	2	0.5	0.6	2.9	1.3
Avena barbata	11	8	4	4	5.2	4.4	1.9	2.5
Nassella neesiana	7	2	6	1	3.3	1.1	2.9	0.6
Bromus hordeaceus	1	1	1	1	0.5	0.6	0.5	0.6

TRANSECT 2	**2007 Hits/100 metres (% frequency)**	**2009-10 Hits/100 metres (% frequency)**	**2011-12 Hits/100 metres (% frequency)**	**2013-14 % veg composition**	**2007 % veg composition (210 veg hits)**	**2009-10 % veg composition (180 veg hits)**	**2011-12 % veg composition (210 veg hits)**	**2013-14 % veg composition (160 hits)**
Date	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**
Easting start (WGS84)		**693810**						
Northing start		**6090258**						
Easting finish	**693877**							
Northing finish	**6090335**							
Aira sp.	1	5		2	0.5	2.8		1.3
Vulpia sp.				1				0.6
Cynodon dactylon	1				0.5			
Briza minor				1				0.6
Festuca sp.								
Total exotic grasses	**25**	**22**	**24**	**24**	**11.9**	**12.2**	**11.4**	**15.0**
Exotic forbs								
Plantago lanceolata	7	2	6	8	3.3	1.1	2.9	5.0
Hypochoeris radicata	2		6	2	1.0		2.9	1.3
Tragopogon porrifolius				1				0.6
Lactuca serriola								
Centaurium erythraea			2	2			1.0	1.3
Hirschfeldia incana				1				0.6
Hypericum perforatum			3	5			1.4	3.1
Total exotic forbs	**9**	**2**	**17**	**19**	**4.3**	**1.1**	**8.1**	**11.9**
TOTAL EXOTICS	**34**	**24**	**41**	**43**	**16.2**	**13.3**	**19.5**	**26.9**

APPENDIX 3

Cumulative Central Quadrat Data

Appendix 3: Cumulative Central Quadrat Data

Central quadrat data		2006*	2007	2009	2011	2013
		Rowell	Rowell	Rowell	Rowell	Umwelt
Cover Abundance Key:	**Date**	**14 Jan 2007**	**9 Nov 2007**	**8 Jan 2010**	**4 Jan 2012**	**19 Nov 2013**
r: <5% and solitary (1-3 plants)*	**Easting (WGS 84)**	centre of	693832	693832	693832	693832
+: <5% and few (4-15 plants)*	**Northing**	site	6090303	6090303	6090303	6090303
1: <5%, common (>15 plants)	**Bare ground (CA)**	2	3	2	1	1
2: 5-25%	**Litter (CA)**	2	3	1	2	2
3: 25-50%	**Cryptogams (CA)**	1	2	1	+	+
4: 50-75%	**Biomass removal**			unmown		
5: 75-100%	**Comments**			Hare some weed spraying		
*combined in 2006 survey						
	Common Name					
Native grasses						
Austrodanthonia auriculata	Lobed Wallaby Grass		1	1	+	+
Austrodanthonia caespitosa	Ringed Wallaby Grass			+		
Austrodanthonia carphoides	Short Wallaby Grass	2	1	1		+
Austrodanthonia laevis	Smooth Wallaby Grass	1		1	1	1
Austrodanthonia spp.	Wallaby Grasses		+			
Austrostipa bigeniculata	Tall Speargrass	2	3	3	4	3
Austrostipa scabra	Rough Speargrass		+			
Bothriochloa macra	Redleg Grass	2	2	2	2	3
Elymus scaber	Wheatgrass	r/+	+	+		r
Eragrostis trachycarpa	A Lovegrass			1	r	
Panicum effusum	Hairy Panic Grass	r/+	1	1	1	+
Themeda triandra	Kangaroo Grass	r/+				r

Native forbs						
Bulbine bulbosa	Golden Lily		r	+	r	+
Calocephalus citreus	Lemon Beauty Heads	r/+	1	1	1	1
Cheilanthes sieberi	Rock Fern		1	+	1	1
Chrysocephalum apiculatum	Yellow Buttons	2	2	2	2	1
Convolvulus angustissimus	Australian Bindweed		+	r	+	+
Crassula sieberiana	Australian Stonecrop			r		
Eryngium ovinum	Blue Devil	r/+	r	r	r	r
Euchiton gymnocephalus	A Cudweed			+		
Euchiton sphaericus	A Cudweed				r	
Goodenia pinnatifida	Scrambled Eggs	r/+	2	1	1	1
Hypericum gramineum	Small St John's Wort				r	
Lomandra bracteata	A Matrush		1	1	1	+
Lomandra filiformis	A Matrush	r/+				
***Lomandra* sp.**	A Matrush	1	1			
Oxalis perennans	Soursob				+	+
Pimelea curviflora	Curved Rice-flower	r/+	1		+	1
Schoenus apogon						+
Senecio quadridentatus	Cotton Fireweed		r		r	
Stackhousia monogyna						1
Tricoryne elatior	Yellow Rush Lily	1	1	r	1	r
Triptilodiscus pygmaeus	Austral Sunray				r	
Wahlenbergia communis	Tufted Bluebell	1	1	1	+	+
Wahlenbergia luteola	A Bluebell	1	+	r	r	r
Floristic Value Score (FVS)	Rehwinkel (2007)	**-**	**20**	**16**	**21**	**22**
Exotic grasses						
Aira sp.	A Hairgrass			1		1
Aira elegantissima	A Hairgrass		1			
Avena sp.	Wild Oats		+		+	1
Briza maxima	Blowfly Grass		1	r		1
Briza minor	Shivery Grass		1		r	1
Bromus hordeaceus	A Brome Grass		+	r	r	1
Dactylis glomerata	Cocksfoot			r	+	+
Nasella neesiana	Chilean Needlegrass					+
Paspalum dilatatum	Paspalum			r		
Vulpia sp.	Rat's-tail Fescue	r/+	1	1	+	1

Exotic forbs						
Centaurium erythraea	Pink Stars			+	1	+
Conyza bonariensis	Flax-leaf Fleabane				1	
Echium plantagineum	Paterson’s Curse		r			
Gamochaeta purpurea	A Cudweed	r/+	+		1	1
Hypericum perforatum	St John’s Wort	r/+	r	r	1	1
Hypochaeris glabra	Smooth Catsear		1			1
Hypochaeris radicata	Catsear	1	2	1	1	1
Lactuca serriola	Prickly Lettuce	r/+		r		
Petrorhagia nanteulii	Proliferous Pink				r	+
Plantago lanceolata	Ribwort Plantain	1	1	1	1	2
Romulea rosea	Onion Grass		+			
Tragopogon porrifolius	Salsify	r/+				
Trifolium campestre	Hop Clover		+	r	r	

Indicator 1 (Rehwinkel 2007)
Indicator 2 (Rehwinkel 2007)

APPENDIX 4

Summary of Mark-Release-Recapture Results for Male Golden Sun Moths for All Surveys

Appendix 4: Summary of Mark-Release-Recapture Results for Male Golden Sun Moths for all Surveys

Year (period of captures)		**1992** (69 days)	**1993** (48 days)	**1994** (45 days)	**2006** (27 days)	**2011** (6 days)
Number of individuals captured		317	321	375	398	94
Total captures		354	389	419	423	35
Recaptures after	1 day	25	54	30	21	After 1 session: 23 After 2 sessions: 15
	2 days	8	8	10	4	After 3 sessions: 5
	3 days	2	2	2	0	
	4 days	1	1	1	0	
	5 days	1	0	0	0	
Estimated total male population during period of captures: Fisher-Ford method MARK method JOLLY method		**524**	**456**	**736**	**440** **1230**	**Daily population est.:** 1st primary session: **66** (57-85) 2nd primary session: **49** (39-75) 3rd primary session: **12*** (* minimum number alive)

(Source: Rowell 2012)

APPENDIX 5

Photographic Record of Site

Appendix 5: Photographic Record of Site

Photo 1 (Transect 1, facing south)

Photo 2 (Transect 2, facing south)

Photo 3 (Transect 1, facing north)

Photo 4 (Transect 2, facing north)

Photo 5 (Quadrat)

Other photos

Southern boundary, where the largest weed plumes persist

Southern boundary, showing areas of deciduous leaf build-up

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Block 3 Section 22 Barton ACT
Prepared for the Department of Finance
March 2015
Canberra

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Inspired people | Dedicated team

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NATURAL TEMPERATE GRASSLAND CONDITION ASSESSMENT AND GOLDEN SUN MOTH MONITORING EVENT

Block 3 Section 22
Barton ACT

FINAL

March 2015

NATURAL TEMPERATE GRASSLAND CONDITION ASSESSMENT AND GOLDEN SUN MOTH MONITORING EVENT

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Barton ACT

FINAL

March 2015

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Department of Finance

Project Director:	**Peter Cowper**
Project Manager:	**Rob Armstrong**
Report No.	**8018B/R01/V2**
Date:	**March 2015**

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Executive Summary

Block 3 Section 22 Barton, also known as York Park, contains an area of natural temperate grassland and golden sun moth (*Synemon plana*) habitat. The patch, consisting of approximately 0.5 hectares occurs within a fragmented landscape and is highly susceptible to threats such as weed invasion and genetic isolation. As such, the area requires strategic on-going management in order to maintain or improve ecological values on the site, as well as bring awareness to methods for effective management of small sites with conservation value.

This report presents results from a survey monitoring event for Natural Temperate Grassland (**Section 3.1**) and Golden Sun Moth (*Synemon plana*) (**Section 3.2**) as recommended by the 'Natural Temperate Grassland Maintenance Plan Block 3, Section 22, Barton' (Umwelt 2014), and includes a contemporary assessment of the status and condition trends associated with a range of vegetation and habitat values described in that report. Additionally, it reports on golden sun moth population numbers, although population trends are not able to be predicted due to the highly ephemeral nature of larval hatchings across seasons.

The report concludes that vegetation and habitat values are relatively stable and larger numbers of golden sun moth were observed this year, presumably on account of better survey conditions. However, diligent management of weeds should be maintained at the site, and contractors should adhere to weed management recommendations set out in the Maintenance Plan.

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1.0 Introduction

1.1 Background

Umwelt Pty Limited (Umwelt) was engaged by the Department of Finance (Finance) to undertake an annual monitoring event in accordance with the 'Natural Temperate Grassland Maintenance Plan Block 3 Section 22 Barton ACT' (Umwelt, 2014[1]) (hereafter referred to as the 'Maintenance Plan'). The location of the project area, also known as York Park, is shown in **Figure 1.1**.

This report describes results from the golden sun moth (*Synemon plana*) monitoring surveys. It also presents a condition assessment of the Natural Temperate Grassland.

The intent of the Maintenance Plan is to conserve the NTG and GSM values on the site. 'Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory' (NTG) is listed as an endangered ecological community under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).Further, 'Natural Temperate Grassland' is listed as an endangered ecological community under the ACT *Nature Conservation Act 1980* (NC Act) and under both Commonwealth and Territory legislation, the ecological characteristics of the listed communities are generally consistent. Golden sun moth (GSM) are listed as Critically Endangered under the EPBC Act and Endangered under the NC Act.

The project area contains a population of GSM in approximately 0.5 hectares of NTG, dominated by tall speargrass (*Austrostipa bigeniculata*) and wallaby grasses (*Rytidosperma* syn. *Austrodanthonia* spp.) (ACT Government 1997[2], 1998[3], 2005[4]).

Based on construction of an access track (Land Development Agency referral 2010/5548) into a development on the western section of the Maintenance Plan area for a hotel development, the Project Area has reduced by approximately 10 metres along the northern edge since the Maintenance Plan was developed (as measured in the field rather than through official surveyor information). This area contained a mosaic of perennial exotic grasses, natural temperate grassland (diverse and lower quality) and planted Kangaroo Grass (Themeda triandra). Effectively, this has reduced the Project Area by approximately 10 metres on the northern boundary, as shown in **Figure 1.1** and subsequent maps.

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[1] Umwelt (2014) *Natural Temperate Grassland Maintenance Plan, Block 33, Section 22, Barton ACT*. Prepared by Umwelt Pty Ltd for the Department of Finance and Deregulation, March 2014.

[2] ACT Government (1997) *Natural Temperate Grassland: An Endangered Ecological Community*. Action Plan No. 1 (Environment ACT, Canberra).

[3] ACT Government (1998) *Golden Sun Moth (Synemon plana): An Endangered Species*. Action Plan No. 7. Environment ACT, Canberra.

[4] ACT Government (2005) *A Vision Splendid of the Grassy Plains Extended: ACT Lowland Native Grassland Conservation Strategy*. Action Plan No. 28 (Arts, Heritage and Environment, Canberra).

Figure 1.1 – The Project Area

1.2 Scope of Works

This report has been prepared in order to satisfy Key Recommendation 5 of the Maintenance Plan. Under that recommendation, an appropriately experienced ecologist is required to ‘undertake annual monitoring of grassland condition and golden sun moth populations’ in accordance with the methodology set out in the Maintenance Plan involving for the purposes of the current engagement:

- a review of the methodologies outlined in the Maintenance Plan;
- NTG condition assessment during spring 2014; and
- GSM monitoring during the 2014 spring-summer flying season.

This report outlines the results of these surveys and provides an evaluation of the progress towards the objectives set out in the Maintenance Plan. It includes an updated species list and remapping of vegetation association boundaries to reflect the current condition of the project area. Remedial actions additional to that of the Maintenance Plan have also been recommended.

The extent of the Project Area is estimated based on field and GIS measurement of the recent access track development, and subsequent amendments to the Project Area from the Maintenance Plan (Umwelt 2014).

2.0 Methodology

2.1 Natural Temperate Grasslands

Monitoring of grassland condition began in 2006 and has been recommended to occur annually in spring (Umwelt).

Mapping of vegetation associations

Vegetation associations were previously mapped by PB (2008), Rowell (2012) and Umwelt (2014). Rowell (2012) noted that since 2007, dominant grasses were clearly less confined to one category, possibly due to the effect of wetter years on species distribution. This was also the case in spring 2014, where there had been significant annual exotic grass growth across the region (R. Armstrong pers. obs.). As recommended in Umwelt (2014), vegetation associations are to be mapped biennially to determine any changes in extent as per the following categories:

high quality native-dominated grassland: >75% of vegetation cover is native, dominated by tall speargrass (*Austrostipa bigeniculata*) and wallaby grasses (*Rytidosperma* species), with a diversity of native forbs. These include species less tolerant of disturbance, such as:	Rock fern (*Cheilanthes sieberi* subsp. *sieberi*) Common onion orchid (*Microtis unifolia*) Bulbine lily (*Bulbine bulbosa*) Early nancy (*Wurmbea dioica* subsp. *dioica*) Curved rice-flower (*Pimelea curviflora* subsp. *sericea*) Creamy candles (*Stackhousia monogyna*) Blue devil (*Eryngium ovinum*) Lemon beauty heads (*Calocephalus citreus*)
lower quality native-dominated grassland: >50% of vegetation cover is native, dominated by redleg grass (*Bothriochloa macra*) and wallaby grasses, with fewer native forbs. These include disturbance-tolerant species such as:	Swamp dock (*Rumex brownii*) Australian bindweed (*Convolvulus angustissimus*) Tufted bluebell (*Wahlenbergia communis*) Fuzz-weed (*Vittadinia* spp.) Yellow buttons (*Chrysocephalum apiculatum*)
exotic-dominated grassland:	>50% of vegetation cover is exotic.

While the Maintenance Plan recommends that mapping of vegetation associations occurs biennially, given the significant change in one area since the Umwelt (2014) assessment an updated map has been prepared as part of this report.

Refer to **Figure 3.1** for an updated extent of the vegetation associations in 2014.

Species list

During management and monitoring activities all plant species noted in the project area were recorded on a cumulative annual species list (**Appendix 1**). This list records the arrival or eradication of weed species, and the loss of native species. In combination with the assessments below and when used in subsequent surveys, it can be used to demonstrate changes in species richness and site condition over time.

Quadrat assessment

A 20 x 20 metre quadrat in the middle of the project area was assessed on 18 November 2014, in the general location as assessed in spring 2007, 2009, 2011, 2013 (**Appendix 2**). This area was chosen for permanent monitoring (although not with a permanent marker) as it had a high number of GSM captures in 2006, and remains the highest quality NTG on site. The location of the quadrat is shown in **Figure 2.1**.

Within the quadrat area, each species was recorded with an associated scaled cover/abundance rating as per Braun-Blanquet (1932[5]). This information was then entered into the 'Grassy Site Quality Assessment Tool' spreadsheet developed by Rehwinkel (2007[6]) to provide a 'Floristic Value Score' (FVS). Using this scoring system, each species was assigned a value ranging from one to five based on its relative rarity as determined by regional grassland assessment data. Within the FVS method as it currently stands, species are categorised as follows:

- Common or increaser species, which do not add much to the value of a site;
- 'Indicator species, level 1', which indicates that a site has value; and
- 'Indicator species, level 2', which are significant species; these are the least common grassy ecosystem species and have the highest significance scores.

The sum of values for each species within a quadrat provides a FVS. This is considered more valuable than conventional species richness scores as it provides each quadrat with a relative value score based on the presence of uncommon or regionally important species that are often not present in sites of lesser quality. Additionally, it does not reward common or increaser native species which often thrive in highly disturbed sites. This scoring system is generally used to characterise grassland condition, and has been used in other monitoring programs by ACT government (for example, to monitor the effects of macropod grazing in grassy ecosystems; Armstrong 2013[7]).

Step-point transects

This method assessed the relative abundance of plant species, and gives an indication of the dominant species, degree of weed invasion and amount of bare ground (see Sharp *et al.* 2005[8]). For the York Park site, two transects are surveyed along the long axis of the subject site, starting and finishing 10 metres from the external boundary to avoid edge effects.

Transect locations are shown in **Figure 2.1**. At each step, a long vertical wire was placed ahead of the observer, with a record made of the predominant species touching the wire (a 'hit'). 'Hits' of rock, bare ground, cryptogams and litter were also recorded. The number of 'hits' may vary depending on observer stride length, and should be converted to a percentage value for each variable. Results of the 2007, 2009, 2011, 2013 and 2014 transects are in **Appendix 3**.

Photographic record

A photographic record is to be made each spring from the points indicated in **Figure 2.1**. They give a general indication of vegetation structure on various parts of the subject site. The photographs from 2014 are in **Appendix 4** and have been taken in accordance with previous years' pictures.

[5] Braun-Blanquet, J. (1932) *Plant Sociology*. McGraw Hill, New York.

[6] Rehwinkel, R. (2007) *A Method to Assess Grassy Ecosystem Sites: Using Floristic Information to Assess a Sites' Quality*. Version 2. NSW Department of Environment and Climate Change, Queanbeyan.

[7] Armstrong, R. (2013) *Interim Analysis of Relationships Between Vegetation Condition and Kangaroo Density in Grassy Ecosystems of the Northern ACT: Data Collected in Spring-Summer 2009/2012*. A report prepared for ACT government, Environment and Sustainable Development Directorate, Canberra. February 2013.

[8] Sharp, S., Dorrough, J., Rehwinkel, R., Eddy, D. & Breckwoldt, A. (2005) *Grassy Ecosystems Management Kit: A Guide to Developing Conservation Management Plans*. Environment ACT, Canberra.

Figure 2.1 - Step-Point Survey Transects, Quadrat and Photographic Record Locations

2.2 Golden Sun Moth

It is noted in the Maintenance Plan (Umwelt, 2014) that the project area is too small for results of standard transect surveys to be strictly comparable with larger sites. Due to this, and the effect of double counting, observational surveys will not give absolute numbers for this site. Rather they will provide an indication of density and activity of flying males. Density criteria are outlined in Appendix B of Hogg (2010[9]).

In accordance with the EPBC survey guidelines (Australian Government 2009[10]) for GSM, survey was undertaken over four (4) non-consecutive days, targeting optimal conditions based on seasonal conditions rather than rigid timeframes. For instance, throughout the ACT, the flying season can vary between early November to mid-December and late November to early January. The following survey parameters were used for selecting appropriate days to undertake monitoring:

- a warm to hot day (above 20°C by 10:00am);
- the warmest part the day (i.e. between 10:00am and 2:00pm);
- clear or mostly cloudless sky;
- still or relatively still wind conditions during the survey period;
- ≥ 2 days since rain; and
- staggered across the survey season to increase the likelihood of detection given the short adult life span (1-4 days between surveys).

The following survey methods were used in accordance with the Maintenance Plan methodology for GSM surveys (Umwelt, 2014):

- *Transect surveys*: on each visit at 11:30, 12:00 and 12:30 hours, the observer walked steadily on a 100 metre transect along the long axis of the subject site, starting and finishing 10 metres from the external boundary to avoid edge effects. On each pass all GSM seen flying ahead and on each side of the observer were recorded on a hand-counter, avoiding double counting of individuals as far as possible. Results were recorded as the number of GSM per 100 metre transect.

- *Point observations*: were undertaken twice per visit, in sets of ten, between the transect survey sessions. The observer stood in the centre of the subject site (in the NTG quadrat area), and rotated slowly (360º in 30 seconds). All GSM seen in a radius of 25 metres during rotation were recorded, including double counting of individuals that change track and re-cross the observer's visual path. Results were recorded from ten rotations in each of the two sessions, with the range and average calculated for each session (number of GSM per 30 second rotation). Counts were repeated and averaged to reduce the variability that can arise from changes in wind speed or sunshine intensity between short counts on the same day.

- Any females should be recorded separately(note no females were observed).

[9] Hogg, D. (2010) *A Strategic Approach to the Conservation and Environmental Assessment of Golden Sun Moth Sites in the Canberra Area*. Interim Revised Report. Prepared on behalf of the ACT Land Development Agency.

[10] Australian Government (2009) *Significant Impact Guidelines for the Critically Endangered Golden Sun Moth (Synemon plana). Nationally Threatened Species and Ecological Communities EPBC Act Policy Statement 3.12*. Department of the Environment, Water, Heritage and the Arts, Canberra.

The location of the transect survey and point observations are shown in **Figure 2.2**.

Figure 3.2 - Golden Sun Moth Transect Survey and Point Observations Locations

2.2.1 Five Yearly Monitoring

According to the Maintenance Plan, capture-mark-recapture monitoring of GSM should occur every five years. The next monitoring event is due in late 2017, and should be conducted by appropriately qualified and experienced invertebrate specialists.

3.0 Results and Discussion

3.1 Vegetation

3.1.1 Vegetation Mapping and Weed Distribution

Vegetation mapping undertaken by Umwelt (2014) was validated and determined to be accurate with the exception of the area previously mapped as containing planted poa tussock (*Poa labillardierei*; refer to **Figure 3.1** of Umwelt 2014), along the National Circuit boundary and exotic dominated pastures in southern portions of the site. While planted, this area of poa tussock was having a positive effect in the control of weed spread, however the poa tussock in this area appears to have been sprayed and is now dominated by exotic pastures such as wild oats (*Avena* spp.) and fescue (*Festuca arundinella*). Areas of African lovegrass (*Eragrostis curvula*) on the road verge appear under control; however this area still appears on the updated map to ensure on-going diligence in the control of this species. Two African lovegrass individuals were recorded within areas mapped as 'Diverse Native Grassland (NTG)'.

The area of each vegetation type is shown in **Table 3.1**.

Table 3.1 – Vegetation of the Project Area

Vegetation	Area (hectares)	Area (metres^2)
Diverse Native Grassland (NTG)	0.208	2,082
Lower Quality Native Grassland (NTG)	0.140	1,404
Planted Kangaroo Grass	0.034	341
Exotic Dominated (mainly perennial grasses)	0.133	1,325
African Lovegrass on Verge[1]	0.014	135

[1] Under control but maintained in the map for on-going control if required

An updated vegetation map for the project area is shown in **Figure 3.1**.

Figure 3.1 – Vegetation of the Project Area (Updated)

3.1.2 Species List

The number of native and exotic grasses and forbs recorded since 2006 has remained relatively stable, with infrequently recorded species accounting for mild fluctuations in species richness. Prior to 2006, full-site species lists were not recorded. The species list across years since 1991 is found in **Appendix 1**.

3.1.3 Condition Trend Analysis

Analysis was undertaken on floristic data collected from five periods between 2007 and 2013:

1. 9 November 2007 (late Spring);
2. 8 January 2010 (mid Summer);
3. 4 January 2012 (mid Summer);
4. 19 November 2013 (late Spring); and
5. 18 November 2014 (late Spring).

Analysis of step-point transect survey data

The plot in **Figure 3.2** demonstrates the change in vegetation cover over time based on data generated from the two step-point vegetation transects running north-south across the site (**Figure 2.1**). While step-point data is a useful means of quantifying changes in grassland composition over time, it is worth noting that even with the same observer, the exact same observation points are not sampled across years. As such, minor fluctuations in observations may not be significant; rather it is a useful way of exploring broad trends over time. In order to account for variation inherent in the sampling method, a greater number of replicates would be needed for each sampling event.

Notwithstanding limitations in the step-point method, the plot in **Figure 3.2** indicates that native vegetation cover is relatively stable, with total native vegetation cover across the site ranging from 53 percent to 56 percent (±1.1%) across five measurements since November 2007.

However, total exotic vegetation cover has risen from 18 percent on January 2010 to 31 percent in November 2013 where it remained in November 2014 due to an increased cover of both exotic grasses and forbs. This may be due to favourable rainfall conditions for weed growth in the past few years, but once established these exotic species require diligent control. Each of the two step-point transect surveys cover high quality grassland areas dominated by native grasses and forbs, as well as areas dominated by exotic grasses. Without stratifying transects by vegetation condition, it is difficult to report on relative cover in native and exotic condition grasslands.

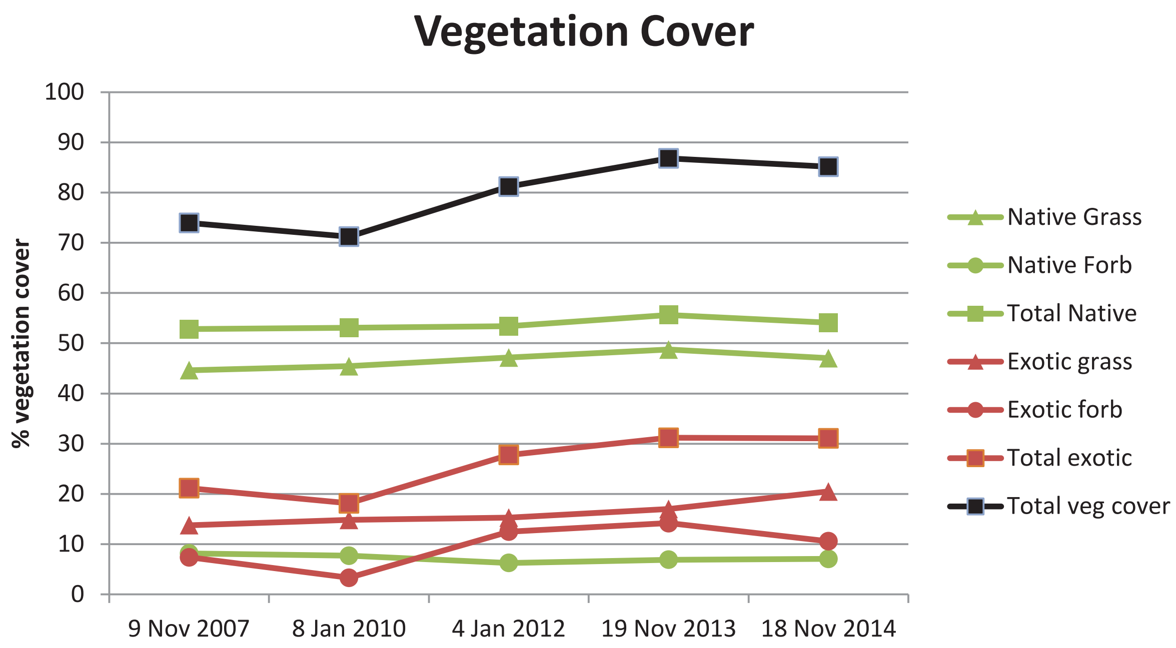

Figure 3.2 - Changes in Native and Exotic Vegetation Cover Over Time

A stated aim in managing the site is to retain native grasses at ≥60 percent vegetation cover proportional to other vegetation (Umwelt 2014). When vegetation cover was analysed independent of non-vascular cover such as litter, bare ground and cryptograms, the proportional native grass cover relative to other vegetation cover remains below 60 percent at 55.2 percent, as shown by the plot in **Figure 3.3**. While grass cover on site has not reduced *per se* (**Figure 3.2**), exotic grass abundance has increased in recent years and should be controlled in order to maintain grassland health and a proportional cover of ≥60% of native grasses relative to other vegetation.

While not captured in the transect surveys, kangaroo grass (*Themeda triandra*) that has been planted on the eastern footpath edge is gradually spreading across the site. This should be closely monitored and spot-sprayed if necessary. Kangaroo grass should be maintained along the edge of the path however, as it has formed an effective barrier to weed seed dispersal adjacent to the footpath.

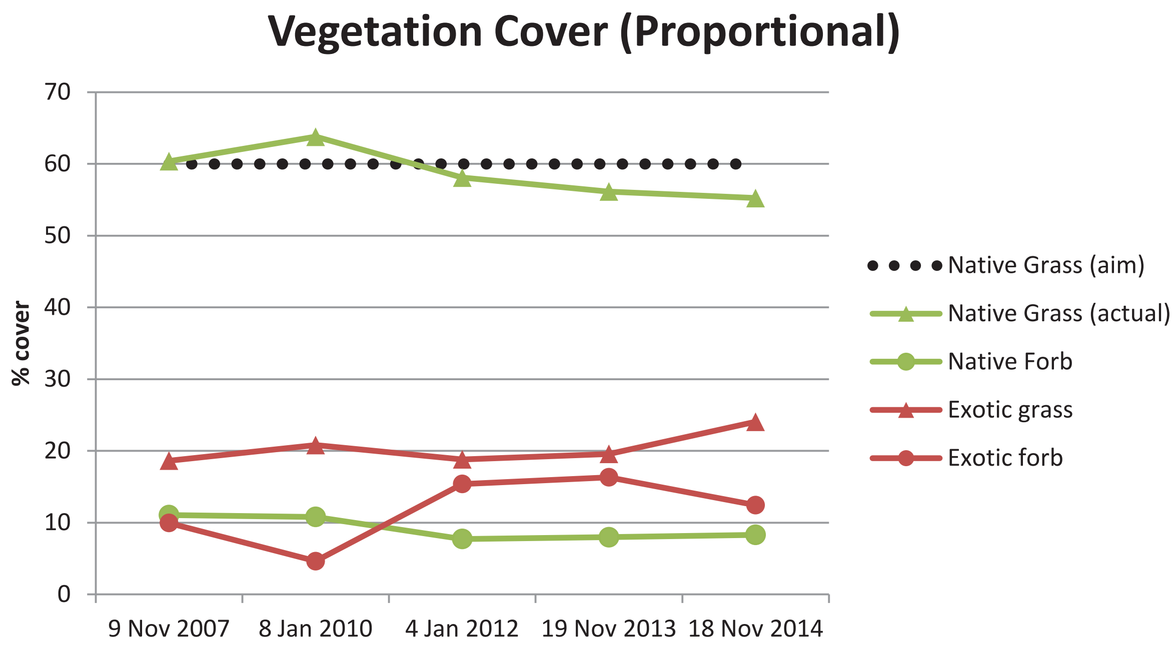

Figure 3.3 - Proportional Vegetation Cover (Non-Vascular Cover Excluded)

The plot in **Figure 3.4** demonstrates that litter cover across the site has been fluctuating between 11 percent and 16 percent (±2.0%) since 2007. Significant reductions in bare ground and litter since January 2010 are likely to be a result of spread of exotic grasses and forbs into inter-tussock spaces during favourable seasons for weed establishment. In favourable seasons for vegetation growth, bare ground and cryptogam cover in particular are reduced.

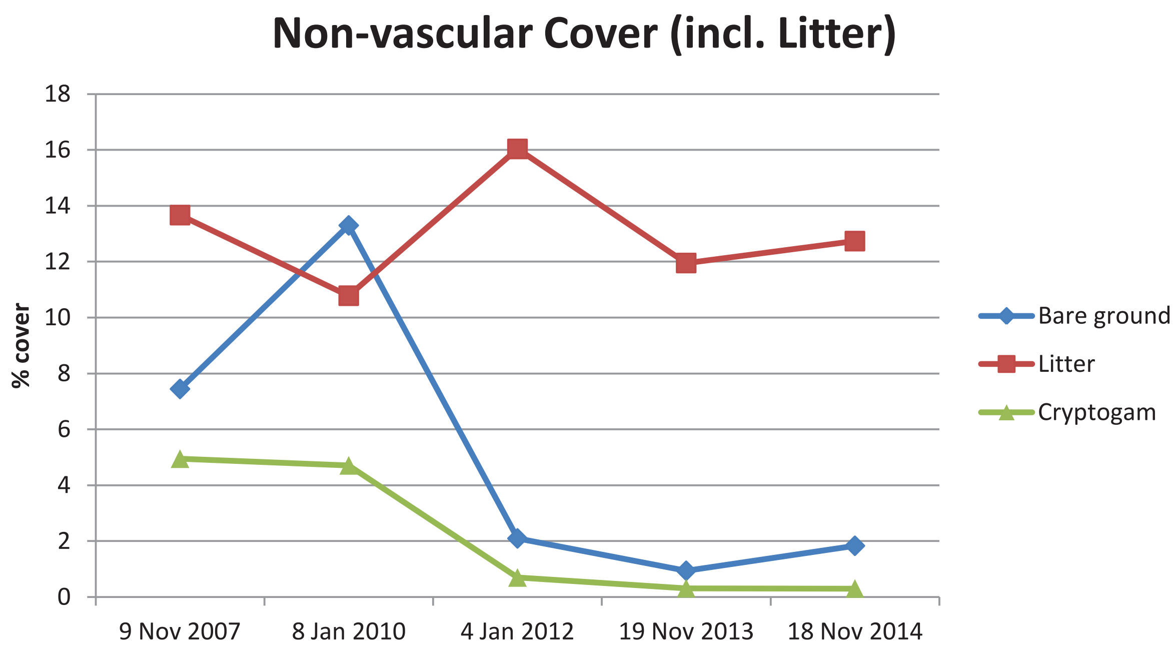

Figure 3.4 - Changes in Non-Vascular Cover Over Time

Analysis of quadrat data

Within the 20 x 20 metre quadrat area (**Figure 2.1**), floristic values as defined by Rehwinkel (2007) have remained relatively stable over time, with a lowest value of '16' in January 2010 and a highest value of '22' in November 2013 and November 2014 (**Figure 3.5**). Low to moderate levels of variance using this scoring system are not considered noteworthy due to the potential for the plot location to vary slightly from year to year based on a lack of permanent boundary markings: while based on the presence of 'significant' or 'indicator' species it is unlikely that floristic information was collected in the *exact* same plot area. In any case, if a 'significant' or 'important' species occurs just outside the plot it does not contribute to the floristic value score, but contributes to the overall floristic integrity of the site, which is of greater importance. However, the presence of exotic species are not currently factored in to the floristic value score method. Should exotic species need to be factored into the analysis in the future, data collected to-date can be used for retrospective analyses.

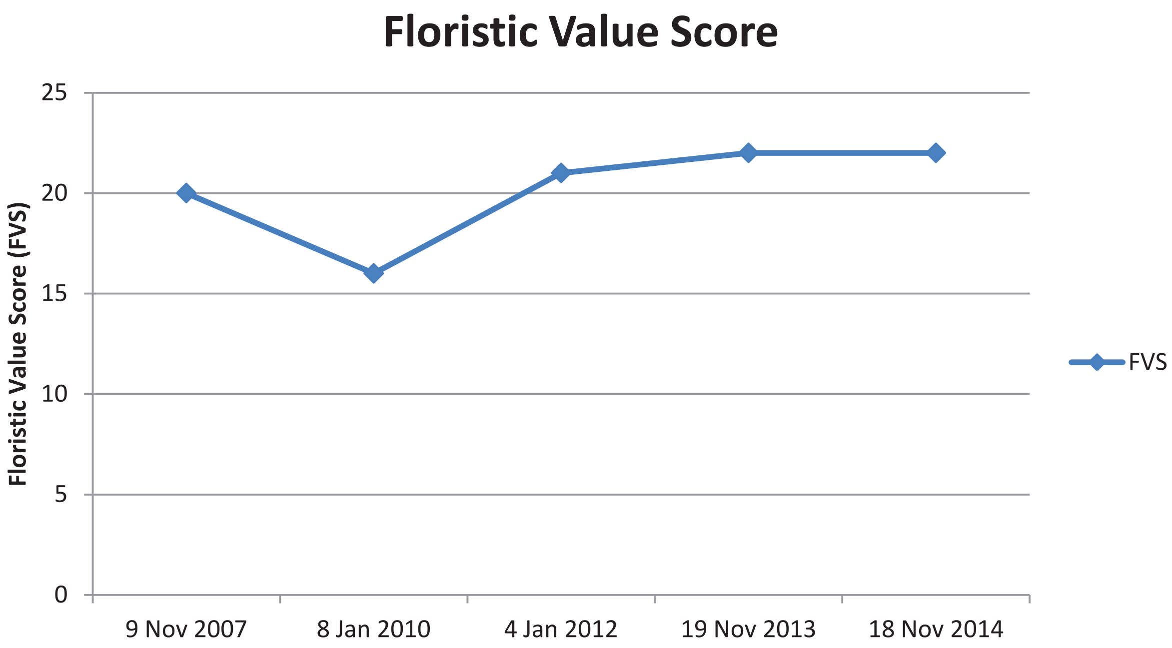

Figure 3.5 - Changes in Floristic Values Over Time

3.1.4 Changes in Weed Cover

The plot in **Figure 3.6** shows weeds of concern which have notably increased since 2007. Generally, step-point vegetation transects record species which are of higher abundance across a site; recent observations indicate that these highly invasive weeds have increased considerably across the site in recent years.

While St. John's wort (*Hypericum perforatum*) has been known to be present on the site since 2003, it was not recorded as part of the step-point vegetation transects until January 2012. In the November 2013 and November 2014 surveys it was observed to be scattered across the majority of the site. Similarly, cocksfoot (*Dactylis glomerata*) and ribbed plantain (*Plantago lanceolata*) appear to be becoming far more common, perhaps due to favourable growth conditions in the past few years. As recommended in the Maintenance Plan, these species should be monitored closely in subsequent years and control measures taken if necessary.

While not recorded in the transect, two African lovegrass individuals were noted within areas maped as Diverse Native Grassland (NTG)' (**Figure 3.1**) and should be eradicated. The location of these were not mapped due to the standard GPS location error (3-5 metres) on a small site, and the potential for further recruitment in between survey and implementation of weed control. An image of this species on Site is found in **Appendix 4**.

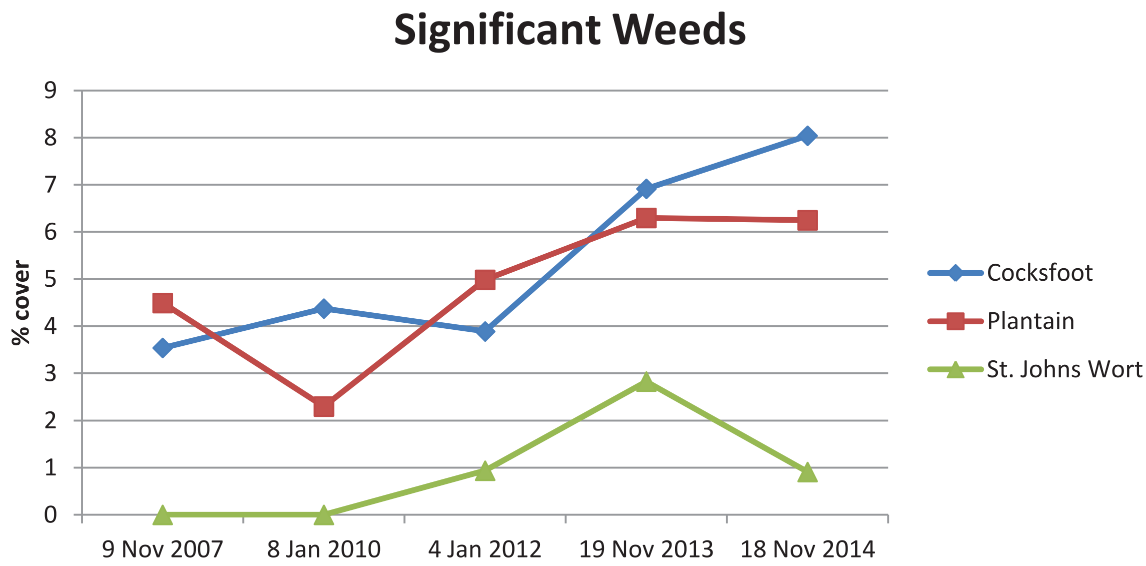

Figure 3.6 - Increases in Notable Weed Cover Over Time

Other weeds listed in the Maintenance Plan are not shown in **Figure 3.6** as they are either considered stable, or are in a low enough abundance to not be recorded using the step-point transect survey method. Chilean needlegrass (*Nassella neesiana*), wild oats (*Avena* species), flatweed (*Hypochaeris radicata*) and tall fescue (*Festuca* sp.) appear relatively stable, but should be controlled as they may increase after a disturbance event or favourable season.

Within the Project Area, the presence of wallaby grasses (*Rytidosperma* spp.) is important for the survival of GSM. Additionally, other C3 grasses such as tall speargrass (*Austrostipa bigeniculata*) and the exotic Chilean needlegrass (*Nassella neesiana*) provide fodder value for GSM (Richter *et al.* 2010). A stated aim of the Maintenance Plan is to maintain wallaby grasses at 7 percent or more vegetation cover (proportional to vegetation only). Analysis of step-point transect survey data indicate that wallaby grasses are presently at 7.2 percent, having ranged from 3.7 percent to 7.4 percent (±1.9) since November 2007 (**Figure 3.7**). As a perennial native grass in a site that is likely to be rarely subjected to macropod grazing, it is unlikely that wallaby grass cover has varied this amount since 2007. Rather, it may be a function of variance of the step-point transect survey method (noting there is probably no better way to quantify across the site), or time since slashing (which can temporarily reduce the surface area of grass tussocks).

Kangaroo grass (*Themeda triandra*) has been planted on the eastern footpath edge, and it is gradually spreading across the site (refer to Rowell 2012). Additionally, exotic pasture species such as cocksfoot (*Dactylis glomerata*) are present in all but the highest quality areas, and these species may displace C3 grasses that provide food for GSM larvae (refer to Richter *et al.* 2010). Rowell (2012) noted that in late 2011, grasses were longer and denser than desirable for GSM habitat, perhaps as they hadn't been mown twice in wetter years (the Maintenance Plan recommends once a year with follow-up mowing in wetter years to reduce biomass). At the time of the November 2013 surveys, the grassland structure (height) was considered reasonable, perhaps due to a relatively dry spring-summer period. While inter-tussock spaces have reduced, this is more likely to vary based on climatic conditions rather than management actions such as slashing.

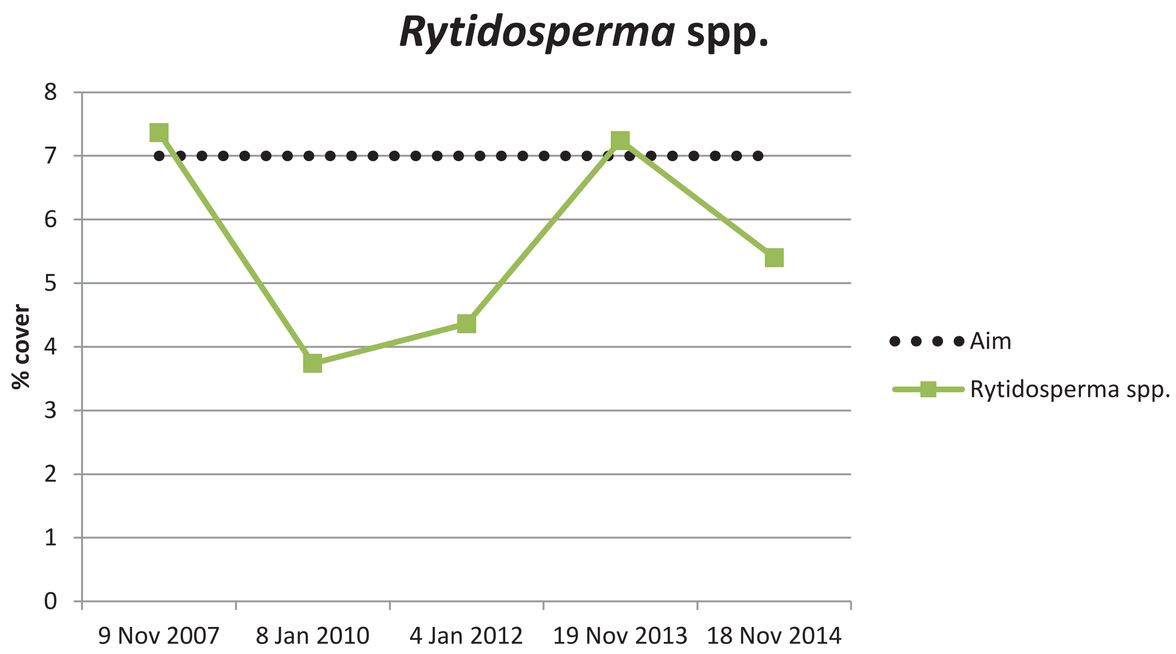

Figure 3.7 - Changes in Wallaby Grass (*Rytidosperma* spp.) Cover Over Time

3.2 Golden Sun Moth

Table 3.2 below outlines the results for the GSM surveys undertaken in spring/summer 2014. Surveys commenced during the known flight season, based on Umwelt's prior reconnaissance and observations of GSM at nearby sites, as well as advice on observations from other ecologists. All survey days were favourable in condition and all surveys were undertaken in accordance with the methodology outlined in **Section 2.2**.

Quantification of GSM populations at a given site is problematic due to variance in suitable flying weather and the potential for 'double-counting'. As such, low interference 'capture-mark-recapture' methods such as that developed by Dr Anett Richter (formerly of University of Canberra) and adopted as part of five-yearly monitoring in the Maintenance Plan are preferable in determining long term population trends. Due to the lack of consistent monitoring data being available for the site, uncertainties regarding the gestation period (believed to be between one and three years) and the relationship between gestation and site condition at the time of egg deposition, it may be more appropriate to analyse population trends when the Maintenance Plan is up for review in 2018. In any case, analysis should be undertaken with consideration of general population trends across the ACT and Southern Tablelands to partially account for variation in larval survival based on seasonal and annual climatic variation (noting differences in this site compared with those that are part of larger non-isolated remnants).

As indicated in **Table 3.2**, the most moths observed in a transect pair is 37 (based on the middle survey effort for T1 and T2 on 28 November 2014). Peak activity was spread across November, with a notable decline in GSM numbers in the 17 December 2014 survey. This is likely due to a combination of general decline in larvae hatchings toward the end of the survey season, and strong summer rains in the two weeks prior to the final survey.

Table 3.2 - Monitoring Data for Golden Sun Moth, 2014

Survey Date and Time	Weather Conditions	Observations
November to December 2014		
18/11/2014	Temp:19.6°C (start); 24.3°C (max) Wind: 6 km/hr WNW Cloud Cover: Clear	T1: 0, 11, 13 (ave = 8); T2: 1, 15, 17 (ave = 11) Point Observation (1145): ave = 0.9; range = 0-4 Point Observation (1215): ave = 6.2; range =3-11
22/11/2014	Temp:26.4°C (start); 31°C (max) Wind: 8 km/hr NE Cloud Cover: Clear	T1: 9, 17, 19 (ave = 15); T2: 6, 12, 16 (ave = 11.3) Point Observation (1145): ave = 7; range = 4-11 Point Observation (1215): ave = 9.6; range =6-12
28/11/2014	Temp: 20.4°C (start); 26.1°C (max) Wind: 1 km/hr NNW Cloud Cover: Clear	T1: 8, 20, 18 (ave = 15.3); T2: 7, 17, 15 (ave = 13) Point Observation (1145): ave = 1.9; range = 0-4 Point Observation (1215): ave = 6.4; range = 4-11
17/12/2014	Temp: 22.1°C (start); 24.3°C (max) Wind: 17 km/hr N Cloud Cover: Clear	T1: 0, 2, 0 (ave = 0.7); T2: 1, 2, 2 (ave = 1.7) Point Observation (1145): ave = 0.1; range = 0-1 Point Observation (1215): ave = 0.3; range = 0-1

While trends in GSM populations are not able to be reliably predicted, observations as part of efforts 1, 2 and 3 are comparable to the highest observation levels of the summer 2009/2010 survey. The 2009/2010 surveys recorded high numbers as part of one effort (25 November 2009), with counts of 25, 19 and 19 GSM. The 2009/2010 survey was undertaken with one central transect; subsequent monitoring was undertaken using two transects in recognition of the size of the Project Area and flying distance (dispersability) of GSM. Observations in November and December 2014 are higher than the same period in 2013.

It is not known to what extent the reduction in grassland as part of the adjacent access road development (EPBC 2010/5548) may have affected the GSM population.

4.0 Recommendations

The following steps are recommended to maintain NTG and GSM values within the Project Area in accordance with the Natural Temperate Grassland Maintenance Plan (Umwelt, 2014):

1. Revise contract weed spraying arrangements by either:

    a. Briefing current contractors on weed management as per the Maintenance Plan, and ensure that non-targeted species are not treated; or

    b. Engagement of a weed contractor with two or more years experience working in areas with Natural Temperate Grassland, and demonstrated weed identification skills and experience.

2. Undertake immediate control of African lovegrass within the Project Area (two individuals were observed in central areas of the Project Area).

3. Due to the reduction of the remnant grassland as per Land Development Agency referral 2010/5548, it is recommended that the Maintenance Plan be amended to exclude areas developed under this referral.

4. Consider installation of permanent markers to identify corners of the NTG monitoring quadrat.

5. Continue with implementation of the Maintenance Plan, to ensure strategic and on-going management of the site occurs order to maintain or improve ecological values and bring awareness to effective management of small sites with conservation value.

5.0 References

ACT Government (1997) *Natural Temperate Grassland: An Endangered Ecological Community*. Action Plan No. 1 (Environment ACT, Canberra).

ACT Government (1998) *Golden Sun Moth (Synemon plana): An Endangered Species*. Action Plan No. 7. Environment ACT, Canberra.

ACT Government (2005) *A Vision Splendid of the Grassy Plains Extended: ACT Lowland Native Grassland Conservation Strategy.* Action Plan No. 28 (Arts, Heritage and Environment, Canberra).

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Rehwinkel, R. (2007) *A Method to Assess Grassy Ecosystem Sites: Using Floristic Information to Assess a Sites' Quality*. Version 2. NSW Department of Environment and Climate Change, Queanbeyan.

Sharp, S., Dorrough, J., Rehwinkel, R., Eddy, D. & Breckwoldt, A. (2005) *Grassy Ecosystems Management Kit: A Guide to Developing Conservation Management Plans*. Environment ACT, Canberra.

Umwelt (2014) *Natural Temperate Grassland Maintenance Plan, Block 33, Section 22, Barton ACT.* Prepared by Umwelt Pty Ltd for the Department of Finance and Deregulation, March 2014.

APPENDIX 1

Plant Species Recorded on Site

	Plant species recorded at Barton GSM site															
	(p = present)															
Species	Common Name	1991-2 WRM	1992 Davis & Hogg	1993 WRM	1994 WRM	1995 WRM	1996 WRM	1999 WRM	2000 WRM	2003 WRM	2006 Rowell	2007 Rowell	2009 Rowell	2011 Rowell	2013 Umwelt	2014 Umwelt
Native grasses																
Aristida ramosa	Wiregrass											p	p			
Rytidosperma auriculata	Lobed Wallaby Grass		p						p			p	p	p	p	**p**
Rytidosperma bipartitum	A Wallaby Grass										p	p	p			
Rytidosperma caespitosum	Ringed Wallaby Grass	p											p	p		**p**
Rytidosperma carphoides	Short Wallaby Grass	p	p							p	p	p	p	p	p	p
Rytidosperma fulvum	A Wallaby Grass												p	p		
Rytidosperma laeve	Smooth Wallaby Grass	p	p								p	p	p	p	p	p
Rytidosperma spp.	Wallaby Grasses			p	p	p	p	p	p	p	p	p		p	p	
Austrostipa bigeniculata	Tall Speargrass	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Austrostipa densiflora	A Speargrass			p												
Austrostipa scabra	Rough Speargrass		p									p		p	p	p
Bothriochloa macra	Redleg Grass	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Chloris truncata	Windmill Grass	p					p					p				
Elymus scaber	Wheatgrass	p	p	p			p	p	p		p	p	p	p	p	p
Eragrostis brownii	A Lovegrass	p														
Eragrostis trachycarpa	A Lovegrass					p	p						p	p		
Microlaena stipoides	Weeping Grass											p		p		
Panicum effusum	Hairy Panic Grass	p	p			p		p	p		p	p	p	p	p	p
Poa labillardieri	Tussock Grass										p	p		p	p	p
Themeda triandra	Kangaroo Grass									p	p	p	p	p	p	p
TOTAL		**9**	**8**	**5**	**3**	**5**	**6**	**5**	**6**	**5**	**10**	**15**	**13**	**15**	**11**	**11**
Native forbs																
Acaena ovina	Sheeps Burr	p	p								p	p		p		p
Asperula conferta	Common Woodruff	p	p	p		p		p			p	p	p	p	p	p
Bulbine bulbosa	Golden Lily	p	p	p			p					p	p	p	p	p
Calocephalus citreus	Lemon Beauty Heads	p	p	p			p			p	p	p	p	p	p	p
Carex sp.	A sedge														p	
Chamaesyce drummondii	Caustic Weed	p														
***Cheilanthes* sp.**						p										
Cheilanthes sieberi	Rock Fern		p								p	p	p	p	p	p
Cheilanthes tenuifolia				p												
Chenopodium pumilio	Small Crumbweed													p		

		1991-2	1992	1993	1994	1995	1996	1999	2000	2003	2006	2007	2009	2011	2013	2014
		WRM	Davis &	WRM	WRM	WRM	WRM	WRM	WRM	WRM	Rowell	Rowell	Rowell	Rowell	Umwelt	Umwelt
Species	Common Name		Hogg													
Chrysocephalum apiculatum	Yellow Buttons	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Convolvulus angustissimus	Australian Bindweed	p	p		p					p	p	p	p	p	p	p
Crassula sieberiana	Australian Stonecrop												p			p
Cymbonotus lawsonianus	Bear's Ears		p													
Drosera peltata	Sundew		p													
Eryngium rostratum	Blue Devil	p	p	p			p	p			p	p	p	p	p	p
Euchiton sp.	A Cudweed					p		p	p							
Euchiton gymnocephalus	A Cudweed											p	p			
Euchiton sphaericus	A Cudweed													p	p	
Glycine tabacina	Vanilla Glycine										p			p		
Gonocarpus tetragynus	Raspwort					p										
Goodenia pinnatifida	Scrambled Eggs	p	p	p	p	p	p			p	p	p	p	p	p	p
Hypericum gramineum	Small St John's Wort		p	p			p							p		
Juncus sp.	A Rush		p													
Lomandra bracteata	A Matrush											p	p	p	p	p
Lomandra filiformis	A Matrush	p	p				p				p					
Lomandra multiflora	A Matrush		p													
***Lomandra* sp.**	A Matrush			p	p	p	p	p	p		p					
Microtis unifolia	Common Onion Orchid		p										p		p	p
Oxalis perennans	Soursob	p	p	p	p	p	p	p	p			p		p	p	p
Pimelea curviflora	Curved Rice-flower		p	p		p					p	p		p	p	p
Plantago varia	Variable Plantain	p	p								p	p	p	p	p	p
Rumex brownii	Swamp Dock	p									p					
Schoenus apogon	Bog-rush		p												p	p
Sebaea ovata			p													
Senecio quadridentatus	Cotton Fireweed													p		
Solenogyne dominii	Smooth Solenogyne	p	p													
Stackhousia monogyna	Creamy Candles		p					p				p			p	p
Tricoryne elatior	Yellow Rush Lily	p	p	p	p		p	p	p	p	p	p	p	p	p	p
Triptilodiscus pygmaeus	Austral Sunray	p	p	p		p	p	p	p			p		p	p	
Vittadinia muelleri	Fuzzweed									p		p		p		
Wahlenbergia sp.	A Bluebell			p	p	p	p	p						p		
Wahlenbergia communis	Tufted Bluebell	p	p								p	p	p	p	p	p
Wahlenbergia luteola	A Bluebell										p	p	p	p	p	p
Wahlenbergia stricta	Tall Bluebell		p													

		1991-2	1992	1993	1994	1995	1996	1999	2000	2003	2006	2007	2009	2011	2013	2014
		WRM	Davis &	WRM	WRM	WRM	WRM	WRM	WRM	WRM	Rowell	Rowell	Rowell	Rowell	Umwelt	Umwelt
Species	**Common Name**		Hogg													
Wurmbea dioica	Early Nancy		p													
Xerochrysum viscosum	Sticky Everlasting													p		
TOTAL		**17**	**28**	**14**	**7**	**11**	**12**	**10**	**6**	**6**	**17**	**20**	**16**	**25**	**21**	**20**
Exotic grasses																
Aira sp.	A Hairgrass	p	p	p		p	p	p	p	p		p	p		p	p
Aira elegantissima	A Hairgrass											p				
Avena sp.	Wild Oats		p	p							p	p	p	p	p	p
Avena barbata	Bearded Oats											p				
Briza maxima	Blowfly Grass	p	p	p		p	p	p	p	p		p	p	p	p	p
Briza minor	Shivery Grass	p	p	p		p	p	p	p	p		p	p	p	p	p
Bromus sp.	A Brome Grass			p	p	p	p	p	p		p					
Bromus catharticus	A Brome Grass		p									p		p		
Bromus diandrus	A Brome Grass		p													
Bromus hordeaceus	A Brome Grass		p									p	p	p	p	p
Bromus mollis	Soft Brome	p														
Cynodon dactylon	Couch			p								p		p		
Dactylis glomerata	Cocksfoot		p		p		p		p		p	p	p	p	p	p
Eleusine tristachya	Goose Grass							p								
Eragrostis curvula	African Lovegrass	p														p
Festuca sp.	A Fine-leaved Fescue		p				p				p				p	
Festuca arundinacea	Tall Fescue								p	p	p	p		p		p
Lolium perenne	Perennial Ryegrass											p			p	
Lolium rigidum	Ryegrass		p	p												
Lophochloa cristata	Annual Cat's Tail											p				
Nassella neesiana	Chilean Needlegrass	p	p						p		p	p	p	p	p	p
Nassella trichotoma	Serrated Tussock							p			p	p			p	
Paspalum dilatatum	Paspalum			p		p	p	p	p	p	p	p	p	p	p	p
Phalaris aquatica	Phalaris	p	p	p		p	p					p		p	p	p
Vulpia sp.	Rat's-tail Fescue		p	p	p	p	p	p	p		p	p	p	p	p	p
TOTAL		**7**	**13**	**10**	**3**	**7**	**9**	**8**	**9**	**5**	**9**	**18**	**9**	**12**	**13**	**12**
Exotic forbs																
Acetosella vulgaris	Sorrel	p														
Anagallis arvensis	Scarlet Pimpernel			p												
Arctotheca calendula	Capeweed											p				

		1991-2	1992	1993	1994	1995	1996	1999	2000	2003	2006	2007	2009	2011	2013	2014
		WRM	Davis &	WRM	WRM	WRM	WRM	WRM	WRM	WRM	Rowell	Rowell	Rowell	Rowell	Umwelt	Umwelt
Species	**Common Name**		Hogg													
Centaurium erythraea	Pink Stars			p		p	p		p		p		p	p	p	p
Cerastium glomeratum	Chickweed		p													
Cirsium vulgare	Spear Thistle			?			?									
Conyza bonariensis	Flax-leaf Fleabane					p	p							p	p	p
Echium plantagineum	Paterson's Curse											p				
Erodium cicutarium	Common Crowfoot			p				p					p			
Galium divaricatum	A Bedstraw					p	p									
Gamochaeta purpurea	A Cudweed						p		p	p	p	p		p	p	p
Gnaphalium sp.	A Cudweed		p	p												
Hirschfeldia incana	Hoary Mustard		p									p		p	p	p
Hypericum perforatum	St John's Wort									p	p	p	p	p	p	p
Hypochaeris glabra	Smooth Catsear	p								p		p			p	p
Hypochaeris radicata	Catsear	p	p	p	p	p		p	p	p	p	p	p	p	p	p
Lactuca serriola	Prickly Lettuce						p	p		p	p	p	p	p	p	p
Lepidium africanum	A Peppercress											p				
Parentucellia latifolia	Common Bartsia		p				p									p
Petrorhagia nanteulii	Proliferous Pink		p							p				p	p	p
Plantago lanceolata	Ribwort Plantain	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Romulea rosea	Onion Grass											p				p
Salvia verbenaca	Wild Sage		p									p				
Silene gallica	French Catchfly						p					p				
Sonchus oleraceus	Common Sow-thistle					p						p				
Tragopogon porrifolius	Salsify										p			p	p	
Trifolium angustifolium	Narrow leaf Clover													p	p	p
Trifolium arvense	Haresfoot Clover		p												p	p
Trifolium campestre	Hop Clover	p	p									p	p	p	p	p
Trifolium dubium			p							p						
Trifolium glomeratum	Clustered Clover		p													p
Trifolium striatum			p													
Trifolium spp.	Clovers			p		p	p	p								
TOTAL		**5**	**13**	**8**	**2**	**7**	**10**	**5**	**4**	**8**	**7**	**15**	**7**	**12**	**14**	**16**
Exotic shrubs and trees																
Cotoneaster sp.	Cotoneaster											p				
Crataegus monogyna	Hawthorn									p						
Ligustrum sinense	Small-leaved Privet															

		1991-2	1992	1993	1994	1995	1996	1999	2000	2003	2006	2007	2009	2011	2013	2014
		WRM	Davis &	WRM	WRM	WRM	WRM	WRM	WRM	WRM	Rowell	Rowell	Rowell	Rowell	Umwelt	Umwelt
Species	**Common Name**		Hogg													
Ligustrum lucidum	Large-leaved Privet															p
Populus nigra var. *italica*	Lombardy Poplar		p													
Prunus sp.	Plum											p	p		p	
Sorbus domestica	Service Tree											p	p	p	p	p
TOTAL		**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**3**	**2**	**1**	**1**	**2**
Indicator 1 (Rehwinkel 2007)																
Indicator 2 (Rehwinkel 2007)																

APPENDIX 2

Cumulative Quadrat Survey Data

TRANSECT 1	2007	2009-10	2011-12	2013-14	2014-14	2007	2009-10	2011-12	2013-14	2014-15
	Hits/100 metres	Hits/100 metres	Hits/100 metres	% veg	% veg	% veg	% veg	% veg	% veg	% veg
	(% frequency)	(% frequency)	(% frequency)	(% frequency)	composition	composition	composition	composition	composition	composition
						(230 veg hits)	(201 veg hits)	(225 veg hits)	(158 hits)	(158 hits)
Date	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**
Easting start (WGS84)	**693810**									
Northing start	**6090258**									
Easting finish	**693877**									
Northing finish	**6090335**									
Bare ground	**20**	**30**	**3**	**0**	**1**	**8.7**	**14.9**	**1.3**	**0.0**	**0.6**
Litter	**30**	**21**	**40**	**19**	**23**	**13.0**	**10.4**	**17.8**	**12.0**	**14.6**
Cryptogam	**14**	**10**	**1**	**0**	**0**	**6.1**	**5.0**	**0.4**	**0.0**	**0.0**
Native grasses										
Austrostipa bigeniculata	58	63	48	48	46	25.2	31.3	21.3	30.4	**29.1**
Bothriochloa macra	27	20	31	15	17	11.7	10.0	13.8	9.5	**10.8**
Rytidosperma spp.	13	4	2	8	4	5.7	2.0	0.9	5.1	**2.5**
Panicum effusum		4	5	1	2		2.0	2.2	0.6	**1.3**
Austrostipa scabra			2	1				0.9	0.6	
Elymus scaber			1	1	1			0.4	0.6	**0.6**
Themeda triandra			1	1	1			0.4	0.6	**0.6**
Total native grasses	**98**	**91**	**90**	**75**	**71**	**42.6**	**45.3**	**40.0**	**47.5**	**44.9**
Native forbs										
Chrysocephalum apiculatum	4	1	4	6	5	1.7	0.5	1.8	3.8	**3.2**
Lomandra bracteata	1	1	1			0.4	0.5	0.4	0.0	
Tricoryne elatior	1		2			0.4		0.9		
Goodenia pinnatifida	1	1	2	2	2	0.4	0.5	0.9	1.3	**1.3**
Triptilodiscus pygmaeus	1					0.4				
Oxalis perennans			1					0.4		
Total native forbs	**8**	**3**	**10**	**8**	**7**	**3.5**	**1.5**	**4.4**	**5.1**	**4.4**
TOTAL NATIVES	**106**	**94**	**100**	**83**	**78**	**46.1**	**46.8**	**44.4**	**52.5**	**49.4**
Exotic grasses										
Dactylis glomerata	13	12	10	10	12	5.7	6.0	4.4	6.3	**7.6**
Paspalum dilatatum	8		11	4	3	3.5		4.9	2.5	**1.9**
Avena barbata	7	9	14	6	10	3.0	4.5	6.2	3.8	**6.3**
Nassella neesiana	5	3	7	7	4	2.2	1.5	3.1	4.4	**2.5**
Aira sp.	2	2				0.9	1.0			
Cynodon dactylon	1					0.4				
Bromus hordeaceus		1					0.5			
Briza maxima					1					**0.6**
Briza minor		2		2			1.0		1.3	
Vulpia sp.		6	1	1	4		3.0	0.4	0.6	**2.5**
Festuca sp.					1					**0.6**
Total exotic grasses	**36**	**35**	**43**	**30**	**35**	**15.7**	**17.4**	**19.1**	**19.0**	**22.2**
Exotic forbs										
Plantago lanceolata	13	7	16	12	14	5.7	3.5	7.1	7.6	**8.9**

TRANSECT 1	2007	2009-10	2011-12	2013-14	2014-14	2007	2009-10	2011-12	2013-14	2014-15
	Hits/100 metres	Hits/100 metres	Hits/100 metres	% veg	% veg	% veg	% veg	% veg	% veg	% veg
	(% frequency)	(% frequency)	(% frequency)	(% frequency)	composition	composition	composition	composition	composition	composition
						(230 veg hits)	(201 veg hits)	(225 veg hits)	(158 hits)	(158 hits)
Date	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**
Hypochoeris radicata	8	1	13	5	3	3.5	0.5	5.8	3.2	1.9
Romulea rosea	2					0.9				
Hypochoeris glabra	1					0.4				
Trifolium campestre		2			1		1.0			0.6
Trifolium angustifolium				1	1				0.6	0.6
Erodium cicutarium		1					0.5			
Tragopogon porrifolius			1					0.4		
Centaurium erythraea			7	3	2			3.1	1.9	1.3
Hypericum perforatum			1	4				0.4	2.5	
Gamochaeta purpurea				1					0.6	
Total exotic forbs	**24**	**11**	**38**	**41623**	**21**	**10.4**	**5.5**	**16.9**	**26343.7**	13.3
TOTAL EXOTICS	**60**	**46**	**81**	**56**	**56**	**26.1**	**22.9**	**36.0**	**35.4**	**35.4**

TRANSECT 2	2007	2009-10	2011-12	2013-14	2014-14	2007	2009-10	2011-12	2013-14	2014-15
	Hits/100 metres	Hits/100 metres	Hits/100 metres	% veg	% veg	% veg	% veg	% veg	% veg	% veg
	(% frequency)	(% frequency)	(% frequency)	composition	composition	composition	composition	composition	composition	composition
						(210 veg hits)	(180 veg hits)	(210 veg hits)	(160 hits)	(165 hits)
Date	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**
Easting start (WGS84)	**693810**									
Northing start	**6090258**									
Easting finish	**693877**									
Northing finish	**6090335**									
Bare ground	**13**	**21**	**6**	**3**	**5**	**6.2**	**11.7**	**2.9**	**1.9**	**3.0**
Litter	**30**	**20**	**30**	**19**	**18**	**14.3**	**11.1**	**14.3**	**11.9**	**10.9**
Cryptogam	**8**	**8**	**2**	**1**	**1**	**3.8**	**4.4**	**1.0**	**0.6**	**0.6**
Native grasses										0.0
Austrostipa bigeniculata	57	56	62	49	53	27.1	31.1	29.5	30.6	32.1
Bothriochloa macra	29	14	38	17	14	13.8	7.8	18.1	10.6	8.5
Rytidosperma spp.	11	6	13	12	11	5.2	3.3	6.2	7.5	6.7
Elymus scaber	1	1		2	3	0.5	0.6		1.3	1.8
Panicum effusum		3	1				1.7	0.5		0.0
Aristida ramosa		2					1.1			0.0
Total native grasses	**98**	**82**	**114**	**80**	**81**	**46.7**	**45.6**	**54.3**	**50.0**	**49.1**
Native forbs										0.0
Chrysocephalum apiculatum	18	15	10	7	6	8.6	8.3	4.8	4.4	3.6
Lomandra bracteata	1	1	1		1	0.5	0.6	0.5		0.6
Tricoryne elatior	3	3		1	1	1.4	1.7		0.6	0.6
Goodenia pinnatifida	3		1	2	3	1.4		0.5	1.3	1.8
Oxalis perennans				1					0.6	0.0
Asperula conferta	1	1				0.5	0.6			0.0
Wahlenbergia luteola	1		1			0.5		0.5		0.0
Calocephalus citreus		3	3	2	5		1.7	1.4	1.3	3.0
Cheilanthes sieberi		1	1				0.6	0.5		0.0
Bulbine bulbosa		1		1			0.6		0.6	0.0
Total native forbs	**27**	**25**	**17**	**14**	**16**	**12.9**	**13.9**	**8.1**	**8.8**	**9.7**
TOTAL NATIVES	**125**	**107**	**131**	**94**	**97**	**59.5**	**59.4**	**62.4**	**58.8**	**58.8**
Exotic grasses										0.0
Dactylis glomerata	3	5	7	12	14	1.4	2.8	3.3	7.5	8.5
Paspalum dilatatum	1	1	6	2	1	0.5	0.6	2.9	1.3	0.6
Avena barbata	11	8	4	4	6	5.2	4.4	1.9	2.5	3.6
Nassella neesiana	7	2	6	1	1	3.3	1.1	2.9	0.6	0.6
Bromus hordeaceus	1	1	1	1	1	0.5	0.6	0.5	0.6	0.6
Aira sp.	1	5		2	4	0.5	2.8		1.3	2.4
Vulpia sp.				1	2				0.6	1.2
Cynodon dactylon	1					0.5				0.0
Briza maxima					2					1.2
Briza minor				1					0.6	0.0
Festuca sp.										0.0
TRANSECT 2	**2007**	**2009-10**	**2011-12**	**2013-14**	**2014-14**	**2007**	**2009-10**	**2011-12**	**2013-14**	**2014-15**

	Hits/100 metres (% frequency)	Hits/100 metres (% frequency)	Hits/100 metres (% frequency)	% veg composition	% veg composition	% veg composition (210 veg hits)	% veg composition (180 veg hits)	% veg composition (210 veg hits)	% veg composition (160 hits)	% veg composition (165 hits)
Date	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**
Total exotic grasses	**25**	**22**	**24**	**24**	**31**	**11.9**	**12.2**	**11.4**	**15.0**	**18.8**
Exotic forbs										0.0
Plantago lanceolata	7	2	6	8	6	3.3	1.1	2.9	5.0	3.6
Hypochoeris radicata	2		6	2	3	1.0		2.9	1.3	1.8
Tragopogon porrifolius				1					0.6	0.0
Lactuca serriola										0.0
Centaurium erythraea			2	2	1			1.0	1.3	0.6
Hirschfeldia incana				1					0.6	0.0
Hypericum perforatum			3	5	3			1.4	3.1	1.8
Total exotic forbs	**9**	**2**	**17**	**19**	**13**	**4.3**	**1.1**	**8.1**	**11.9**	**7.9**
TOTAL EXOTICS	**34**	**24**	**41**	**43**	**44**	**16.2**	**13.3**	**19.5**	**26.9**	**26.7**

APPENDIX 3

Cumulative Step-point Transect Survey Data

Central quadrat data		2006	2007	2009	2011	2013	2014
		Rowell	Rowell	Rowell	Rowell	Umwelt	Umwelt
Cover Abundance Key:	**Date**	**14 Jan 2007**	**9 Nov 2007**	**8 Jan 2010**	**4 Jan 2012**	**19 Nov 2013**	**18 Nov 2014**
r: <5% and solitary (1-3 plants)*	**Easting (WGS 84)**	centre of	693832	693832	693832	693832	693832
+: <5% and few (4-15 plants)*	**Northing**	site	6090303	6090303	6090303	6090303	6090303
1: <5%, common (>15 plants)	**Bare ground (CA)**	2	3	2	1	1	2
2: 5-25%	**Litter (CA)**	2	3	1	2	2	1
3: 25-50%	**Cryptogams (CA)**	1	2	1	+	+	+
4: 50-75%	**Biomass removal**			unmown			
5: 75-100%	**Comments**			Hare			
*combined in 2006 survey				some weed			
				spraying			
	Common Name						
Native grasses							
Austrodanthonia auriculata	Lobed Wallaby Grass		1	1	+	+	+
Austrodanthonia caespitosa	Ringed Wallaby Grass			+			
Austrodanthonia carphoides	Short Wallaby Grass	2	1	1		+	+
Austrodanthonia laevis	Smooth Wallaby Grass	1		1	1	1	1
Austrodanthonia spp.	Wallaby Grasses		+				
Austrostipa bigeniculata	Tall Speargrass	2	3	3	4	3	4
Austrostipa scabra	Rough Speargrass		+				
Bothriochloa macra	Redleg Grass	2	2	2	2	3	3
Elymus scaber	Wheatgrass	r/+	+	+		r	1
Eragrostis trachycarpa	A Lovegrass			1	r		
Panicum effusum	Hairy Panic Grass	r/+	1	1	1	+	+
Themeda triandra	Kangaroo Grass	r/+				r	r
Native forbs							
Bulbine bulbosa	Golden Lily		r	+	r	+	r
Calocephalus citreus	Lemon Beauty Heads	r/+	1	1	1	1	1
Cheilanthes sieberi	Rock Fern		1	+	1	1	1
Chrysocephalum apiculatum	Yellow Buttons	2	2	2	2	1	1
Convolvulus angustissimus	Australian Bindweed		+	r	+	+	1
Crassula sieberiana	Australian Stonecrop			r			+
Eryngium ovinum	Blue Devil	r/+	r	r	r	r	+
Euchiton gymnocephalus	A Cudweed			+			
Euchiton sphaericus	A Cudweed				r		
Goodenia pinnatifida	Scrambled Eggs	r/+	2	1	1	1	1
Hypericum gramineum	Small St John's Wort				r		
Lomandra bracteata	A Matrush		1	1	1	+	+

*combined in 2006 survey				some weed			
				spraying			
		2006	**2007**	**2009**	**2011**	**2013**	**2014**
		Rowell	**Rowell**	**Rowell**	**Rowell**	**Umwelt**	**Umwelt**
		14 Jan 2007	**9 Nov 2007**	**8 Jan 2010**	**4 Jan 2012**	**19 Nov 2013**	**18 Nov 2014**
Lomandra filiformis	A Matrush	r/+					
***Lomandra* sp.**	A Matrush	1	1				
Oxalis perennans	Soursob				+	+	+
Pimelea curviflora	Curved Rice-flower	r/+	1		+	1	+
Schoenus apogon						+	
Senecio quadridentatus	Cotton Fireweed		r		r		
Stackhousia monogyna						1	1
Tricoryne elatior	Yellow Rush Lily	1	1	r	1	r	+
Triptilodiscus pygmaeus	Austral Sunray				r		
Wahlenbergia communis	Tufted Bluebell	1	1	1	+	+	+
Wahlenbergia luteola	A Bluebell	1	+	r	r	r	r
Floristic Value Score (FVS)	Rehwinkel (2007)	**-**	**20**	**16**	**21**	**22**	**22**
Exotic grasses							
Aira sp.	A Hairgrass			1		1	1
Aira elegantissima	A Hairgrass		1				
Avena sp.	Wild Oats		+		+	1	1
Briza maxima	Blowfly Grass		1	r		1	1
Briza minor	Shivery Grass		1		r	1	+
Bromus hordeaceus	A Brome Grass		+	r	r	1	1
Dactylis glomerata	Cocksfoot			r	+	+	1
Nasella neesiana	Chilean Needlegrass					+	
Paspalum dilatatum	Paspalum			r			
Vulpia sp.	Rat's-tail Fescue	r/+	1	1	+	1	1
Exotic forbs							
Centaurium erythraea	Pink Stars			+	1	+	1
Conyza bonariensis	Flax-leaf Fleabane				1		
Echium plantagineum	Paterson's Curse		r				
Gamochaeta purpurea	A Cudweed	r/+	+		1	1	r
Hypericum perforatum	St John's Wort	r/+	r	r	1	1	1
Hypochaeris glabra	Smooth Catsear		1			1	r
Hypochaeris radicata	Catsear	1	2	1	1	1	1

*combined in 2006 survey				some weed			
				spraying			
		2006	**2007**	**2009**	**2011**	**2013**	**2014**
		Rowell	**Rowell**	**Rowell**	**Rowell**	**Umwelt**	**Umwelt**
		14 Jan 2007	**9 Nov 2007**	**8 Jan 2010**	**4 Jan 2012**	**19 Nov 2013**	**18 Nov 2014**
Lactuca serriola	Prickly Lettuce	r/+		r			+
Petrorhagia nanteulii	Proliferous Pink				r	+	
Plantago lanceolata	Ribwort Plantain	1	1	1	1	2	1
Romulea rosea	Onion Grass		+				
Tragopogon porrifolius	Salsify	r/+					
Trifolium campestre	Hop Clover		+	r	r		1
Trifolium arvense	Haresfoot Clover						+
Trifolium glomeratum	Clustered Clover						1
Parentucellia latifolia	Red Bartsia						1
Indicator 1 (Rehwinkel 2007)							
Indicator 2 (Rehwinkel 2007)							

APPENDIX 4

Photographic Record of the Site

Photo 1 (Transect 1, facing south)

Photo 2 (Transect 2, facing south)

Photo 3 (Transect 1, facing north)

Photo 4 (Transect 2, facing north)

Photo 5 (Quadrat)

Other Photos

African lovegrass, central within the Project Area

Area where planted poa tussock has been sprayed, resulting in weed incursion

Canberra

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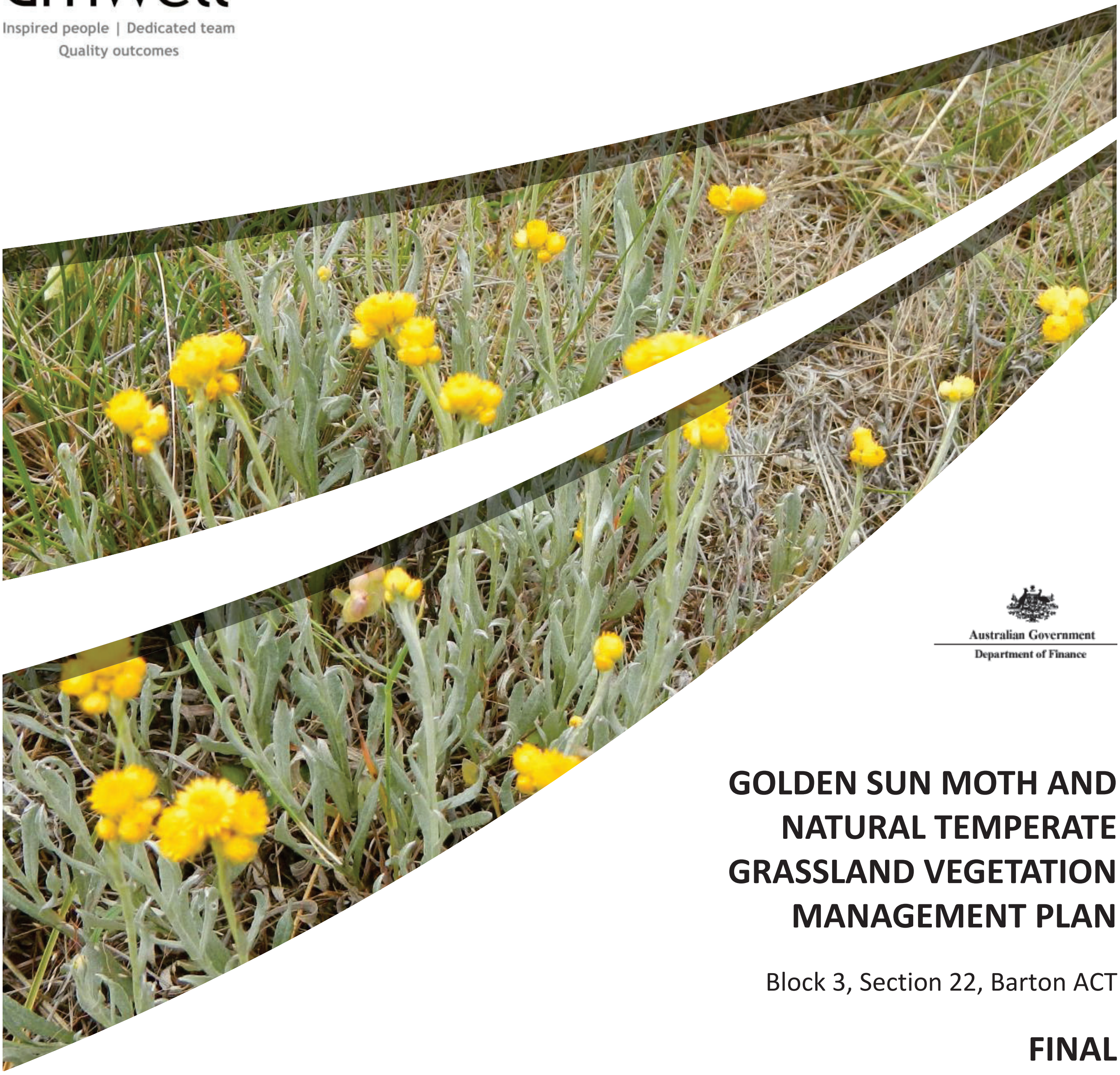
ARCHIVAL RECORD

REFERENCE No. 55

Umwelt 2016
Golden Sun Moth and Natural Temperate Grassland Vegetation Management Plan:
Block 3, Section 22, Barton ACT
Prepared for the Department of Finance
January 2016
Canberra



GOLDEN SUN MOTH AND NATURAL TEMPERATE GRASSLAND VEGETATION MANAGEMENT PLAN

Block 3, Section 22, Barton ACT

FINAL

January 2016

Australian Government
Department of Finance

GOLDEN SUN MOTH AND NATURAL TEMPERATE GRASSLAND VEGETATION MANAGEMENT PLAN

Block 3, Section 22, Barton ACT

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Department of Finance

Project Director:	Peter Cowper
Project Manager:	Rob Armstrong
Report No.	8018C/R01/V1
Date:	January 2016

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This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Executive Summary

Block 3 Section 22 Barton, also known as York Park, contains an area of natural temperate grassland and golden sun moth (*Synemon plana*) habitat. The patch, consisting of approximately 0.32 hectares occurs within a fragmented landscape and is highly susceptible to threats such as weed invasion and genetic isolation. As such, the area requires strategic on-going management in order to maintain or improve ecological values on the site, as well as bring awareness to effective management of small sites with conservation value.

This report presents an update of the maintenance plan completed for the site by Umwelt in 2014 (Umwelt, 2014), and includes contemporary assessment of the status and condition trends associated with the natural temperate grassland area and weed distribution. Additionally, it reports on golden sun moth population numbers, although population trends are not able to be predicted due to the highly ephemeral nature of larval hatchings across seasons.

This report concludes that the natural temperate grassland has changed somewhat since 2007 (based in the condition in 2007 surveys undertaken by Parsons Brinkerhoff (PB, 2008), with a decrease in bare ground and increase in vegetation density due to favourable climatic conditions for grass sward growth. Native flora diversity appears to be stable, although there has been a notable increase in some weed species including St. John's wort (*Hypericum perforatum*), cocksfoot (*Dactylis glomerata*) and ribbed plantain (*Plantago lanceolata*). Wallaby grasses (*Rytidosperma* spp.) important for golden sun moth larval fodder are presently at levels considered low for population maintenance (five per cent of proportional vegetation cover; with a monitoring threshold set at seven per cent). Planted kangaroo grass (*Themeda triandra*) along the eastern boundary has expanded slightly into the natural temperate grassland area.

Key recommendations to maintain the natural temperate grassland and golden sun moth population are as follows:

- undertake weed control as recommended in this report (refer to **Table 3.2**)
- as exotic grass distribution is reduced, reseed areas with native wallaby grasses
- contain kangaroo grass to a two metre strip on the eastern boundary, adjacent to National Circuit
- rake and remove slashed material (additional biomass) in areas where dense swards of native grass and exotic pastures are slashed
- undertake annual monitoring of grassland condition and golden sun moth populations
- if required, undertake additional mowing in wetter years when biomass accumulates
- remove exotic trees from the western boundary, including service tree (*Sorbus domestica*) seedlings.

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Appendices

1.0 Background

1.1 The Project

This Maintenance Plan has been prepared for the Department of Finance (Finance). The intent of this Maintenance Plan is to provide a framework for ongoing best-practice management of the ecological values associated with 'York Park' within part of Block 3 and Block 15 Section 22 Barton (ACT). The location of 'York Park', hereafter referred to as the Project Area, is shown in **Figure 1.1**.

In 2007, Parsons Brinckerhoff (PB) prepared a Master Plan for Block 3, which has been partially developed north-west of an area of Natural Temperate Grassland (NTG). The Master Plan identified an area of Block 3 for ongoing conservation of the NTG and associated golden sun moth (GSM, *Synemon plana*) population, with a Maintenance Plan prepared for this area in 2008 (PB, 2008[1]). The Maintenance Plan integrated with the Master Plan in providing a framework for maintenance of the Project Area. Vegetation on part of Block 15 has been removed for an access road under development approval EPBC 2012/6606 (Australian Government, 2013[2]).

In October 2013, Umwelt (Australia) Pty Limited (Umwelt) was engaged to undertake monitoring for GSM and NTG, and use the results from this survey and knowledge of contemporary monitoring techniques to update the original Maintenance Plan (Umwelt, 2014[3]). This report represented an update of the 2008 plan (refer to **Section 1.2**). Subsequently, Umwelt undertook a GSM and NTG monitoring event in late 2014 (Umwelt, 2015[4]). During these surveys, Umwelt confirmed 0.35 hectares of NTG within the Project Area, as well as a healthy GSM population.

In September 2015, Umwelt was engaged to provide an update to the 2013 Maintenance Plan (Umwelt, 2014) as well as complete a 2015 monitoring event for GSM and NTG.

GSM are listed as Critically Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and Endangered under the ACT *Nature Conservation Act 2014* (NC Act). 'Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory' is listed as an endangered ecological community under the EPBC Act 1999; 'Natural temperate Grassland' is listed as an endangered ecological community under the NC Act 2014. It is these values for which this Maintenance Plan intends to conserve.

[1] PB (2008) Natural Temperate Grassland and Maintenance Plan, Block 3 Section 22 Barton, ACT. Parsons Brinckerhoff, Canberra.

[2] Australian Government (2013) Approval: hotel and carpark development, Block 14 Section 22, Barton, ACT – Stage 1 (EPBC 2012/6066). Approved October 4, 2013. [: http://www.environment .gov.au/epbc/notices/assessments/2012/6606/2012-6606-approval-decision.pdf, URL accessed 16/01/2014]

[3] Umwelt (2014) *Natural Temperate Grassland Maintenance Plan, Block 3, Section 22, Barton ACT.* Prepared by Umwelt Pty Ltd for the Department of Finance and Deregulation, March 2014.

[4] Umwelt (2015) *Natural Temperate Grassland Condition Assessment and Golden Sun Moth Monitoring Events, Block 3, Section 22, Barton ACT.* Prepared by Umwelt Pty Ltd for the Department of Finance, March 2015.

Figure 1.1

Location of Block 3, Section 22 Barton ACT

1.2 Acknowledgements

Umwelt acknowledges Parsons Brinckerhoff, and specifically sub-consultant Alison Rowell, for authorship of the original Maintenance Plan. The Umwelt (2014) Maintenance Plan adopted much of the original Plan and amended, updated and added new sections where appropriate.

The third version of the Maintenance Plan (this report) has been reviewed and updated by representatives from Department of Finance.

1.3 History of the Site

Nearby remnant woodland (Capital Hill, West Block) indicates that the Project Area was near an ecotone between woodland and grassland communities, as mapped in the 'ACT Lowland Native Grassland Conservation Strategy' (ACT Government, 2005[5]).

When the Federal Capital Territory was created in 1911, the area around the Project Area appears to have been open grazing land with few trees. In the 1920s, the Provisional Parliament House and some of the associated roads were built. A 1933 map shows that the Project Area was then part of a larger undeveloped area bounded by National Circuit, State Circle, Kings Avenue and Canberra Avenue (Marshall 2007[6]) (for an aerial photo taken circa 1940's refer to http://www.flickr.com/photos/archivesact/11074074125/sizes/l/in/photo stream/). At this time, the nearest building was the Methodist Church diagonally opposite. The Project Area would have maintained some connectivity to other grassland or native pasture until fairly recently, with surrounding blocks and roads being developed from the 1970s onwards.

The north-western part of Block 3 appears to have received fill during the construction of surrounding buildings, and is now dominated by exotic species.

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[5] ACT Government (2005) A Vision Splendid of the Grassy Plains Extended: ACT Lowland Native Grassland Conservation Strategy. Action Plan No. 28 (Arts, Heritage and Environment, Canberra).

[6] Marshall, D., Boden, R., Mann, A., Rowell, A. & Fogarty, P. (2007) Heritage Management Plan for the York Park North Oak Plantation, Barton ACT. Prepared for the National Capital Authority, Canberra.

2.0 Environmental Values of the Site

2.1 Natural Temperate Grassland

The NTG endangered ecological community is typically found between 560 and 1200 metres above sea level in valleys and broad plains. The dominant cover is native tussock grasses, with forbs such as daisies, lilies and native legumes in the inter-tussock spaces. It is estimated that approximately 5 per cent of the original area of the community in the ACT survives in moderate to good condition (ESSS, 2000[7]), a figure which has most likely reduced further in recent years.

2.1.1 Site Values

The grassland on the Project Area has been given a Botanical Significance Rating of 4 (Low), and a Conservation Rating of 2 (Complementary Conservation Site). Botanical Significance Ratings are shown in **Table 2.1**. The Conservation Rating reflects that the Project Area has only a low to moderate Botanical Significance, but contains a population of a threatened species that is considered to be viable in the medium term (ACT Government, 2005).

Table 2.1 Botanical Significance Rating for Natural Temperate Grassland

Degree of Disturbance	Ground Layer Species	Examples of Characteristic Species	Typical Flora of the Ground Layer	BSR Rating
very low	disturbance sensitive species	*Diuris* spp., *Caladenia* spp., and *Thelymitra* spp.	Native species including orchids, lilies, and other highly sensitive species as well as more tolerant species.	1
low	moderately disturbance tolerant species	*Dichopogon* spp., *Bulbine bulbosa*, *Craspedia variabilis*, *Cryptandra amara*, *Themeda triandra*, *Pimelea* spp., and *Wurmbea dioica*.	Species present include those moderately tolerant of disturbance, as well as more tolerant species.	2
moderate	disturbance tolerant species	*Chrysocephalum apiculatum*, *Plantago varia*, *Convolvulus angustissimus*, *Asperula conferta*, *Glycine* spp., and *Hibbertia obtusifolia*.	Native species include those commonly found in a range of sites that have been subject to moderate disturbance; sensitive plants are rarely present.	3, 4

[7] ESSS (2000) Commonwealth Listing Advice on Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory. Advice to the Minister for the Environment and Heritage from the Endangered Species Scientific Subcommittee (ESSS) on a proposal to add an ecological community to Schedule 2 of the *Endangered Species Protection Act 1992*.

Degree of Disturbance	Ground Layer Species	Examples of Characteristic Species	Typical Flora of the Ground Layer	BSR Rating
high	disturbance tolerant native grasses	*Poa* spp., *Rytidosperma* spp., *Austrostipa* spp., *Bothriochloa macra*, and *Microlaena stipoides*.	Sites may contain a variety of native grass species but have few or no native forbs present.	5*
very high	exotic species	Perennial and annual weeds, introduced or adventitious species.	Either dominated by perennial exotic species or a low cover and diversity of native species, of which most are grasses.	E*

* Not considered natural temperate grassland.

Since 1992, the NTG on the Project Area has been part of a long-term grassland monitoring program being undertaken by the ACT Government and surveys commissioned by the Department of Finance, and the vegetation quality in the Project Area has been previously been assessed and mapped (Davis & Hogg, 1992[8]; ERM, 2005[9]; Rowell, 2007[10]; Rowell, 2012[11]; Umwelt, 2014; Umwelt, 2015; and numerous unpublished datasets from ACT Government). **Appendix 1** contains a summary of plant species recorded on the Project Area across numerous surveys between 1991 and 2015, with **Appendix 2** and **Appendix 3** showing cumulative quadrat and step-point transect survey data respectively. These data are not strictly comparable from year to year, having been collected by a variety of methods. However, the list shows trends such as the apparent loss of some native species and the recent arrival and persistence of some undesirable exotic species, most notably St John's wort (*Hypericum perforatum*).

The NTG area is dominated by tall speargrass (*Austrostipa bigeniculata*), red-leg grass (*Bothriochloa macra*), various wallaby grasses (*Rytidosperma* spp.) and forbs including *Chrysocephalum apiculatum*, *Goodenia pinnatifida*, *Calocephalus citreus* and *Tricoryne elatior*. This species assemblage is consistent with the plant community 'r5: *Rytidosperma* spp. – *Austrostipa bigeniculata* – *Chrysocephalum apiculatum* tussock grassland of the South Eastern Highlands bioregion' as described by Armstrong et al. (2013[12]). This grassland type is broadly distributed across the northern ACT, with other main occurrences from around Bungendore to north of Goulburn. Across its range, this community has been extensively cleared and remnants are subject to weed invasion, small-scale clearing, grazing pressures and nutrient run-on from adjacent management activities (Armstrong et al., 2013).

[8] Davis, M. S. & Hogg, D. McC. (1992) York Park, Barton. Botanical Survey. Report to the National Capital Planning Authority by David Hogg Pty. Ltd.

[9] ERM (2005) Strategic advice on the development potential of Block 3, Section 22: York Park, Barton. Report prepared for Department of Finance and Administration by Environmental Resources and Management, Australia.

[10] Rowell, A. M. (2007) Survey and impact assessment at Golden Sun Moth *Synemon plana* site, Blocks 3 and 7, Section 22 Barton (York Park). Report prepared for Parsons Brinckerhoff and Department of Finance.

[11] Rowell, A. (2012) Block 3, Section 22 Barton ACT: Five-year monitoring event for Golden Sun moth and condition Assessment of Natural Temperate Grassland. Report to Department of Finance and Deregulation by Alison Rowell, May 2012.

[12] Armstrong, R.C., Turner, K.D., McDougall, K.L., Rehwinkel, R. and Crooks, J.I. (2013) Plant communities of the upper Murrumbidgee catchment in New South Wales and the Australian Capital Territory. *Cunninghamia* **13**(1): 125-266.

2.2 Golden Sun Moth (*Synemon plana*)

2.2.1 Distribution

Prior to European settlement GSM were widespread in native grasslands in south-eastern Australia, from near Bathurst in New South Wales through the Australian Capital Territory and Victoria to Bordertown in South Australia (Edwards, 1993[13]; 1994[14]). This distribution was correlated with grasslands dominated by low-growing wallaby grasses (*Rytidosperma* spp.), and has contracted substantially over time (O'Dwyer & Attiwill, 1999[15]). GSM are now only found in a few relatively small breeding areas due to habitat loss, fragmentation and degradation. Possibly less than one percent of the original habitat now remains, much of it degraded by weed invasion (Clarke & O'Dwyer, 1997[16], O'Dwyer & Attiwill, 1999, ACT Government, 2005).

2.2.2 Description and Life History

GSM is a medium sized day-flying moth in the family Castniidae. The male has a wingspan of about 34 millimetres, the female slightly less. The upper forewings of both are grey/brown with paler patterns. The male has dark brown upper hindwings, and in the female these are bright yellow/orange edged with black spots (ACT Government, 1998[17]).

GSM larvae feed on the subterranean parts of wallaby grasses (Edwards, 1993; O'Dwyer & Attiwill 1999), and may sometimes feed on other native and introduced C3 grasses (Braby & Dunford, 2006[18]; Richter et al*.,* 2010[19]). Larval development time is unknown and may vary between one and three years.

The adults live for only one to four days after emerging during late spring to early summer, and do not feed as they have no functional mouth parts. In the middle of the day when conditions are sunny and warm, males patrol the grassland in search of the females, which have reduced hind-wings and are poor fliers. The starting date and duration of the flight season vary from year to year, probably depending on spring weather conditions, with the season starting earlier in a warm dry spring (Cook & Edwards, 1993[20]). The limited flight ability of the female moths adds to the species' vulnerability to extinction on small sites, and makes natural re-colonisation from other sites unlikely.

2.2.3 Site Values

Although small, the Project Area is rated as having a Moderate Conservation Value rating, because of the previous scientific work undertaken (ACT Government, 1998). Clarke & O'Dwyer (1998[21]) also

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13 Edwards, E. D. (1993) The Golden Sun Moth *Synemon plana* – an endangered species. ANIC News No. 2: 7-8.
14 Edwards, E. D. (1994) Survey of lowland grassland sites in ACT for the Golden Sun Moth *Synemon plana*. CSIRO Report to the Wildlife Research Unit, ACT Parks and Conservation Service, Canberra.
15 O'Dwyer, C. & Attiwill, P. M. (1999) A comparative study of habitats of the Golden Sun Moth *Synemon plana* Walker (Lepidoptera: Castniidae): implications for restoration*. Biol. Cons.* **89**: 131-141.
16 Clarke, G.M. and O'Dwyer, C. (1997) A survey of native grassland sites in south-eastern New South Wales for the endangered Golden Sun Moth, *Synemon plana*. A report prepared for the Threatened Species Unit, NSW National Parks and Wildlife Service, southern zone.
17 ACT Government (1998) Golden Sun Moth (*Synemon plana*): An endangered species. Action Plan No. 7. Environment ACT, Canberra.
18 Braby, M. F. & Dunford, M. (2006) Field observations on the ecology of the Golden Sun Moth, *Synemon plana* Walker (Lepidoptera: Castniidae). *Australian Entomologist* **33**, 103-110.
19 Richter A, Osborne W & Traugott M (2010) Dietary specialisation in the Golden Sun Moth *Synemon plana* – the key to understanding habitat requirements and site rehabilitation for this critically endangered species. Final report to Biodiversity and Programs Branch, Department of Sustainability and Environment (Victoria).
20 Cook, L. & Edwards, E. D. (1993) Population Monitoring of Endangered Moth *Synemon plana* 1992-93, York Park, Barton. CSIRO Australia. Report to the National Capital Planning Authority.
21 Clarke, G. M. & O'Dwyer, C. (1998) Genetic analysis of populations of the endangered Golden Sun Moth, *Synemon plana*. Report for Threatened Species Unit, NSW National Parks and Wildlife Service, Southern Zone, and the Wildlife Research and Monitoring Unit, Environment ACT. CSIRO Division of Entomology, Canberra.

considered that the Project Area warranted special attention due to its 'high profile and considerable research focus in past years'.

The previous studies include six mark-release-recapture surveys, producing estimates of population size (Cook & Edwards, 1993; Cook & Edwards, 1994; Edwards, 1994[22]; Harwood et al., 1995[23]; Rowell 2007; and Rowell, 2012), and genetic analysis of the population (Clarke & O'Dwyer, 1998). Provisional management recommendations were prepared for the Project Area (Frawley, 1995[24]; Edwards, 1995[25]), including rehabilitation of the vegetation by translocation of soil and grassland plants from a nearby area which was being developed (Davis & Hogg, 1992; Harwood et al., 1995). **Appendix 4** contains a summary of the GSM population studies to date.

2.2.4 Other Important Species

Active burrows of the uncommon Canberra raspy cricket (*Cooraboorama canberrae*) were observed in scattered locations across the site in 2007 (PB, 2008). Additionally, Anett Richter (formerly of University of Canberra) and Emma Cook (ACT Environment and Planning Directorate) observed this species during surveys in 2006 and 2007. No observations of active burrows have been made since; it is not known whether this species is absent or whether this is a function of increased biomass in post-drought conditions. This is a large wingless cricket, known only from relatively undisturbed grasslands in the lower parts of the Majura, Jerrabomberra and Molonglo valleys, and a small number of other locations in the ACT and nearby NSW (Queanbeyan-Bungendore). Much of its known habitat has been lost to housing in the ACT, and it is vulnerable to habitat fragmentation because it is flightless. It makes distinctive vertical burrows with a round cross-section, a clay and silk cap and a circle of bare soil around the entrance. Information about this cricket could be included in interpretative signage on the Project Area.

The grassland earless dragon (*Tympanocryptis pinguicolla*) is known to generally use the abandoned burrows of this species as shelter sites. This species is endangered under the EPBC Act 1999 and NC Act 2014. This species has not been recorded on site.

22 Cook, L. & Edwards, E. D. (1994) Population Monitoring of Endangered Moth *Synemon plana* 1993-94, York Park, Barton. CSIRO report to the National Capital Planning Authority.
23 Harwood, T., Narain, S. & Edwards, E. D. (1995) Population Monitoring of Endangered Moth *Synemon plana* 1994-95, York Park, Barton. CSIRO Australia. Report to the National Capital Planning Authority.
24 Frawley, K. (1995) Planning for urban native grassland conservation: York Park, Barton, ACT. *In* Management of relict lowland grasslands. Proceedings of a workshop and public seminar. September 24 and 25, 1993.
25 Edwards, E. D. (1995) Provisional Management Recommendations for York Park Moth Site. Report to the National Capital Planning Authority. CSIRO Division of Entomology, Canberra.

3.0 Maintenance Requirements

3.1 Weed Management

Weeds are recognised as one of the most significant threats to biodiversity in the ACT. They displace native species, reduce habitat quality, modify vegetation structure and alter ecological functions (TaMS, 2007[26]).

Figure 3.1 shows a vegetation map of the site, delineated into vegetation associations based on fine-scale on-site classification. Associations were determined based on dominant species, with areas considered to be exotic if they contain ≥50 per cent of exotic species cover/composition. The NTG corresponds with the best GSM habitat, and chemical weed control in this area should be undertaken with caution and sparingly, as the effect of herbicides on GSM are unknown. Areas containing Chilean needlegrass (*Nassella neesiana*) on the road verge may also contain GSM.

Several weeds of concern on the Project Area are perennial grasses. These include exotic grasses and forbs, as well as two native species which have been planted on the Project Area. These species, kangaroo grass (*Themeda triandra*) and poa tussock (*Poa labillardierei*), are not considered a useful food source for GSM larvae, and they should be prevented from spreading beyond the original areas of planting (refer to **Figure 3.1**). Despite this, it is worth noting that these species provide a useful service in their current location: the kangaroo grass reduces opportunities for weeds to establish from seeds washing off the path, and similarly, the poa tussock protects a low-lying patch which may also be susceptible to seed invasion.

The weedy area at the southern end of the Project Area results from attempted translocation of soil and native grasses from an area which was developed nearby. Historically, other weed patches have developed where trees have been removed from the Project Area, and where trees around the boundary shade the native grassland (PB, 2008), a pattern which continues to this day.

If weed management is to be undertaking during the GSM flying period, generally late October to late December, this should be completed preferably in the morning hours through careful spot-spraying. It is highly undesirable that any management practices be undertaken after 11:00 hours in order to reduce the risk of disturbing egg-laying females.

[26] TaMS (2007) Draft ACT Weeds Strategy, 2007-2017. July 2007. Department of Territory and Municipal Services, Canberra.

Figure 3.1

Current Vegetation Associations

3.1.1 Objectives

The objectives of weed management of individual species are summarised in **Table 3.1**. They include:

- Eradication: no plants of the target species remain on the Project Area.
- Suppression: reduce density of target species within the infested area and prevent infestation from spreading.
- Containment: define the boundary of the existing infestation of target species and prevent spread beyond that line.

3.1.2 Procedures

Table 3.2 summarises control methods and timing for weed species of concern. This table is indicative only, and timing can be varied to suit seasonal conditions or based on local experience of site managers. Triggers for weed management are discussed in **Section 4.1.1.1**.

The Project Area should be visited to treat weeds and assess the effectiveness of previous control in spring, summer and autumn. Attention should be paid to the plants listed **Table 3.1**.

- A record should be kept of methods, area/numbers and species of weeds treated.

3.1.2.1 Herbicide Use (spot-spray)

The following are key directions relating to the use of non-residual herbicides:

- operators/contractors should have significant prior experience (minimum of two years) in selective weed management in NTG, and demonstrated expertise in the identification and successful treatment of the key weed species
- the appropriate herbicide registered for use on particular species, the methods and rates of application, licensing requirements and other relevant aspects should be checked annually with ACT Territory and Municipal Services
- residual herbicides should not be used
- treatments should be timed to maximise results i.e. prior to seeds forming and during active growth phases
- risks to non-target species should be minimised by avoiding the spread of herbicides on footwear and equipment, using spray hoods and shields, spraying under appropriate weather (low wind) conditions etc
- woody weeds should be treated by the cut-and-paint method, and regrowth should be spot-sprayed. Roots should not be dug out in order to avoid unnecessary soil disturbance
- the effectiveness of all herbicide spraying should be monitored the following month, and follow-up spraying carried out if required.

3.1.2.2 Other Methods

Hand-pulling (the Bradley Method)

Small infestations of some weeds can be removed by hand-pulling after rain when the soil is soft, ensuring that all parts of the plant are removed. This method, also known as 'the Bradley method' (Bradley, 2002[27]) is suitable for smaller St John's wort (*Hypericum perforatum*) and Paterson's curse (*Echium plantagineum*) plants (i.e. not larger/mature ones) and can be carried out during site inspections or monitoring visits. Uprooted material should be bagged on site and removed to be disposed of appropriately.

Targeted Slashing

Wild oats (*Avena* spp.), cocksfoot (*Dactylis glomeratum*), tall fescue (*Festuca* spp.) and phalaris (*Phalaris aquatica*) can be slashed before the seed heads form. The plants often grow earlier and taller than surrounding native species, in response to soil moisture. In particular, the infestation of wild oats on the slight slope at the south end of the Project Area should be treated by high slashing (e.g. with a brush cutter/line trimmer) as required, and the slashed material removed. In particular, wild oats can have multiple flowering events per season is conditions are favourable, so this should be monitored in wetter spring periods.

If some Paterson's curse (*Echium plantagineum*) plants have begun to flower when spraying of rosettes is taking place, these flower stems also can be slashed and removed from the Project Area.

Removal of Mulch

The deciduous trees around the boundary cause dead leaf deposits to build up on parts of the Project Area at times. This is particularly prominent along the southern boundary. This mulch is likely to alter soil moisture, pH and nutrients in ways that will favour the growth of weeds, as well as smother or prevent recruitment of native grasses and forbs. The problem is most noticeable near the oak trees on National Circuit. The leaves should be removed annually, at the end of autumn, by careful raking.

Table 3.1 Main Plant Species Posing Threat to the Natural Temperate Grassland and/or Golden Sun Moth Habitat and Management Aims

Common Name	Species	WoNS[28]	Declared Pest Plant (ACT)[29]	Aim of Management
Exotic Grass Species				
wild oats	*Avena* spp.			suppression
cocksfoot	*Dactylis glomerata*			suppression
African lovegrass	*Eragrostis curvula*[1]		yes	eradicate
tall fescue	*Festuca* spp.			suppression

[27] Bradley, J. (2002) Bringing back the bush: the Bradley method of bush regeneration. Reed New Holland, Sydney.

[28] Weeds of National Significance. [http://www.weeds.org.au/WoNS/, URL Accessed 27/12/2013].

[29] Pest Plants and Animals (Pest Plants) Declaration 2009 (No 1) Disallowable instrument DI2009-67 made under the Pest Plants and Animals Act 2005, s7 (Declaration of pest plants) . [http://www.legislation.act.gov.au/di/2009-67/current/pdf/2009-67.pdf, URL Accessed 27/12/2013].

Common Name	Species	WoNS[28]	Declared Pest Plant (ACT)[29]	Aim of Management
Chilean needlegrass	*Nassella neesiana*[1]	yes	yes	eradication
serrated tussock	*Nassella trichotoma*	yes	yes	not present, requires vigilance
paspalum	*Paspalum dilatatum*			suppression
phalaris	*Phalaris aquatica*			eradication
Exotic Forb Species				
Paterson's curse	*Echium plantagineum*		yes	not present, requires vigilance
St. John's wort	*Hypericum perforatum*		yes	eradication
flatweed, cat's ear	*Hypochaeris radicata*			suppression
ribbed plantain	*Plantago lanceolata*[2]			suppression
Exotic Tree Species				
service tree	*Sorbus domestica*		yes	eradication
Native Species				
poa tussock	*Poa labillardierei*			containment
kangaroo grass	*Themeda triandra*			containment

[1] present in roadside verge on National Cct
[2] not to be confused with the native variable plantain (*Plantago varia*)

Table 3.2 Summary of Weed Control Methods and Timing

<table>
<tr><th rowspan="2">Species</th><th colspan="12">Month</th></tr>
<tr><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>wild oats</td><td colspan="8"></td><td colspan="3">slash and remove stems</td><td></td></tr>
<tr><td rowspan="2">cocksfoot</td><td colspan="8" rowspan="2"></td><td colspan="2">slash and remove stems</td><td colspan="2" rowspan="2"></td></tr>
<tr><td colspan="2">spot-spray n/s or g/s</td></tr>
<tr><td>Paterson's curse</td><td>hand cut and remove seedling stems</td><td colspan="3"></td><td colspan="2">spot-spray rosettes</td><td colspan="4"></td><td colspan="2">hand cut and remove seeding stems</td></tr>
<tr><td>African lovegrass</td><td colspan="2">spot-spray</td><td colspan="6"></td><td colspan="4">spot-spray</td></tr>
<tr><td rowspan="2">tall fescue</td><td colspan="8" rowspan="2"></td><td colspan="2">slash and remove stems</td><td colspan="2"></td></tr>
<tr><td colspan="4">spot-spray</td></tr>
<tr><td rowspan="2">St. John's wort</td><td colspan="3">hand-pull small plants after rain</td><td colspan="5" rowspan="2"></td><td colspan="4">hand-pull small plants after rain</td></tr>
<tr><td colspan="3"></td><td colspan="2">spot-spray bl/s or n/s</td><td colspan="2"></td></tr>
<tr><td>Chilean needlegrass</td><td colspan="6">spot-spray</td><td></td><td colspan="5">spot-spray</td></tr>
<tr><td>serrated tussock</td><td colspan="2">spot-spray</td><td colspan="6"></td><td colspan="4">spot-spray</td></tr>
<tr><td>paspalum</td><td colspan="8"></td><td colspan="4">spot-spray</td></tr>
<tr><td>phalaris</td><td colspan="8"></td><td colspan="2">slash and remove stems</td><td colspan="2"></td></tr>
<tr><td>ribbed plantain</td><td colspan="4">spot-spray</td><td colspan="3"></td><td colspan="4">spot-spray</td><td></td></tr>
<tr><td>flatweed, cat's ear</td><td colspan="4">spot-spray</td><td colspan="3"></td><td colspan="4">spot-spray</td><td></td></tr>
<tr><td>service tree</td><td colspan="12">hand-pull small plants after rain (at this stage they are only seedlings)</td></tr>
</table>

n/s = non-selective non-residual herbicides; g/s = grass-selective non-residual herbicide; bl/s = broadleaf-selective non-residual herbicide

3.2 Biomass Management

Biomass removal (defoliation) at appropriate levels and times is beneficial to many grasslands. Generally, higher levels of biodiversity are to be found at intermediate levels of disturbance and at intermediate time spans following the disturbance. It maintains an open structure, which enables native plants to flower and set seed, and allows their seedlings to become established. In natural and pastoral systems, biomass removal generally occurs through grazing or burning; at this site slashing is the only realistic option. In the Project Area, there is the additional requirement of maintaining a moderate proportion of wallaby grasses in the sward as food plants for GSM, and retaining open spaces between tussocks for basking and mating.

The Project Area has been managed by slashing for many years. The population estimate for GSM in 2006 suggested that this regime has favoured GSM, and the 2007 baseline vegetation composition data from the 20 metre x 20 metre quadrat can be used as a guide to appropriate proportions of bare ground and grasses (PB, 2008; refer to **Appendix 2**). This will vary from year to year with variations in temperature and rainfall (refer to **Section 4.0**).

Slashing on the Project Area should observe the following guidelines:

- Sward to be cut using a flail mower to mulch and spread litter and reduce windrows. Any patches of mulched material should be removed from the Project Area. The blade set height of the flail mower should be 12 centimetres; ensuring sward is not cut lower than 10 centimetres in height.

- Machinery not to be used when the ground is wet in order to avoid soil compaction and damage to the cryptogams (soil crust).

- Machinery to be washed down before entering the Project Area to remove soil and seeds. The least weedy part of the Project Area should be mown first, then the margins planted with native grasses, and the weedier areas last to avoid spreading weed seeds.

- Slashing to be carried out annually in August-September, before the emergence of adult GSM. This will help maintain the low open grassland favoured by GSM. In parts of the Project Area dominated by tall weeds (e.g. wild oats), the slashed material should be removed (by raking or use of a grass-catcher) rather than left in windrows.

- Slashing to be repeated in February if necessary (if the average vegetation height exceeds 15 centimetres. Note: average vegetation height is determined as the bulk of the grass tussock, not the seed head).

3.3 Other Management Prescriptions

3.3.1 Record Keeping

A diary of management actions and other relevant occurrences should be kept. This can be in the form of notes in the work program and management checklist (refer to **Table 3.3**).

Table 3.3 Work Program and Management Record (activities are to be undertaken annually unless otherwise indicated)

Activity	Spring	Summer	Autumn	Winter	Reporting
weed management	• Slash and remove early flowering stems of wild oats, cocksfoot, fescue and phalaris • cut-and-paint woody weeds • hand-pull smaller exotic St John's wort after rain • follow-up treatments.	• follow-up treatments • remove aerial parts of Paterson's curse (if present) • spot spray exotic perennial grasses, plantain • hand-pull smaller exotic St John's wort after rain.	• spot-spray plantain and Chilean needlegrass • cut-and-paint woody weeds.	• Spot-spray plantain and Paterson's curse (if present).	Annually: Provide weed management record to the Department of the Environment, Department of Finance, National Capital Authority and ACT Government.
weed monitoring		Assess success of management.			Annually: Provide results of monitoring to the Department of the Environment, Department of Finance, National Capital Authority and ACT Government.
biomass management	Slash to no shorter than 8 centimetres (Aug-Sept).	Slash again in February if average height >15 cm in native grassland area.			
NTG monitoring	Photographs from reference points, transects and quadrat.				Annually: provide results of monitoring to the Department of the Environment, Department of Finance, National Capital Authority and ACT Government.
GSM monitoring	• point counts and transects • every 5 years: capture-release survey for population estimation (next late 2016). ****Aim for middle of GSM flight season, assuming appropriate climatic conditions (a broader spread is preferable for capture-release****				
site inspection	Note condition, damage.	Note condition, damage.	Note condition, damage.	Note condition, damage.	
plan review	Every five years (**next review due at end of 2020**)				

3.3.2 Memorandum of Understanding

There are several key stakeholders that must be represented in the Memoranda of Understanding. These are:

- Lessor (Commonwealth)
  - interest in ongoing use of Block 3 Section 22.
- Lessee (owner)
  - role as the land manager.
- National Capital Authority
  - consent authority for development.
- ACT Government (Territory and Municipal Services)
  - management of road network and verges that adjoin Block 3, Section 22.
- ACT Government (ACT Planning and Land Authority)
  - consent Authority for development on the adjoining Block 15.
- ACT Government (Conservation, Planning and Research)
  - role in reviewing the ongoing maintenance of the conservation area.

The Memoranda should include agreement about activities such as construction, maintenance, landscaping, shading, irrigation and drainage which may affect Block 3 Section 22, and specifically the conservation area. Any proposal to extend or increase the height of the buildings in the neighbouring area (Territory land) should consider the potential impact on NTG and GSM.

3.3.3 Construction Phase

The Project Area should be protected from damage during the construction phase. It should be securely fenced, with signs on all fences stating that it is an environmentally sensitive site. There should be no activities associated with construction on the Project Area, including (but not limited to):

- vehicle or pedestrian access through the Project Area
- dumping of debris
- parking of vehicles
- storage of machinery or materials
- trenching for pipes or cables, or other earthworks.

These restrictions should be noted in the works program.

3.3.4 Rehabilitation

No soil should be brought onto the Project Area. Areas bared through control of large areas of weeds, or inadvertently damaged, should be rehabilitated using native weed-free seed or thatch collected from the Project Area (note: do not collect more than 10 per cent of a population in order to allow the majority to set seed naturally). Grasses sourced for thatch should <u>not</u> include kangaroo grass or poa tussock.

3.3.5 Adjacent Vegetation

Deciduous trees on the boundary of the Project Area have degraded the adjacent grassland, as well as providing perches and nest sites for birds that feed on GSM. The size and location of any trees or landscape features on the western portion of Block 3 should be such that the shadow they cast does not extend beyond the shadow of the buildings, as proposed in the Master Plan.

Landscaping should be designed to have low to nil impact on the grassland. Specifically, it should have low irrigation and fertiliser needs, and not be a significant source of mulch or seeds. Adjacent landscaping should not include non-local native grassland species or exotic grass species.

The use of pesticides on adjacent vegetation is undesirable, given the presence of rare/endangered insect species on the Project Area. In the event of this being required, a works plan should be developed with consideration of the Maintenance Plan, and reviewed by an appropriately qualified ecologist or entomologist familiar with the biology of GSM and Canberra raspy cricket.

3.3.6 Drainage

Development on the western portion of Block 3 should avoid increase in drainage onto the Project Area. Similarly, repair or replacement of the footpaths on National Circuit and Sydney Avenue should avoid an increase in drainage discharge onto the Project Area.

3.3.7 Fencing, Signs and Paths

Interpretive signs have been placed on the boundary of the Project Area. Additional fencing and signs should avoid a significant shadow and the creation of perches for birds. There should be no paths, landscaping, seating or other structures within the conservation area. Pedestrian access from the western boundary or opportunities to be used as a thoroughfare should also be prevented. If a new fence is constructed, associated materials and vehicles should be kept off-site as far as practicable during construction.

Spot cleaning of the fencing and signage should be undertaken as necessary with products that pose no risk of impacting on the NTG and the GSM.

3.3.8 Site Access and Induction Guidelines

Access to the subject area should be restricted to tasks essential for the ongoing maintenance tasks, as detailed in this Maintenance Plan. All personnel accessing the area must be appropriately inducted.

Induction Information

It is anticipated that there will be varying levels of induction, dependent on the role of the personnel to the conservation area. These groups of personnel include:

- construction and development workers during the construction phases

- require a direct induction

- facility management and associated site contractor personnel for the ongoing management of completed development
  - require a direct induction
- all building occupants
  - awareness information should be made available to this personnel group.

The intent of this information is to identify with the inductees the strategic importance of this conservation area, and ensure a level of awareness for those working on Block 3 (during construction and for the ongoing management). This information can be specifically tailored for the different levels of induction, and includes:

- the Project Area contains a population of the critically endangered GSM, whose survival relies on the protection of its NTG habitat
- although the GSM is only noticeable when the adults fly in a few weeks in late spring to early summer, it is present as eggs, larvae and pupae in the soil throughout the year
- access to the Project Area should only be for activities related to its study or maintenance, and should take place according to the restrictions prescribed the Maintenance Plan.

Conservation and Education-related Visits

As the Project Area is sensitive, very small and can be viewed from all sides, educational visits by school and university classes should be restricted to viewing of GSM and their habitat from the edge of the Project Area.

The potential need for referral and approval under the EPBC Act should be considered for any conservation activities that are not specifically nominated in this Maintenance Plan, and that the planning of such activities should first involve consultation with ACT Conservation Planning and Research (within Environment and Planning Directorate).

A licence under the *Nature Conservation Act 2014* (formerly known as a ‘ Permit to Take’) should also be sought for all actions which interfere with the GSM, including physical handling, trapping or activities that have the potential to directly interact with adult or larval individuals. This includes the mark/recapture survey as detailed in this Maintenance Plan.

Activities should be planned to minimise foot traffic and site disturbance, and should especially avoid disturbing egg-laying females. This can be achieved by minimising activities on the Project Area after 11:00 hours during the flying period, which may take between late October and late December.

Monitoring

Monitoring should be carried out by appropriately qualified personnel, with supervisors having at least five years’ experience in the assessment and management of NTG and GSM populations.

4.0 Monitoring

4.1 Methodology

4.1.1 Natural Temperate Grassland

The condition of the grassland should be monitored annually in spring.

Monitoring was previously recommended to be undertaken biennially however the benefits of increased sampling would include a reduction in the impact of data anomalies borne from infrequent observations. From a data analysis perspective, when a monitoring event in a biennial sampling regime is undertaken in conditions which are not typical of other years, it is more difficult to rationalise the variation if there is no monitoring event in a previous or following year. **Appendices 1**, **2** and **3** contain the floristic results of grassland monitoring from 2007, 2009, 2011 and 2013, 2015 and 2015.

4.1.1.1 Mapping of Vegetation Associations

Vegetation associations were previously mapped by PB (2008), Rowell (2012), Umwelt (2014) and Umwelt (2015). Annually, vegetation associations are to be mapped to determine any changes in extent as per the categories in **Table 4.1**.

Table 4.1 Vegetation Associations Present

Vegetation Association	Included Species
High quality native-dominated grassland: >75% of vegetation cover is native, dominated by tall speargrass (*Austrostipa bigeniculata*) and wallaby grasses (*Rytidosperma* spp.), with a diversity of native forbs.	Species less tolerant of disturbance such as: • rock fern (*Cheilanthes sieberi* subsp. *sieberi*) • common onion orchid (*Microtis unifolia*) • bulbine lily (*Bulbine bulbosa*) • early nancy (*Wurmbea dioica* subsp. *dioica*) • curved rice-flower (*Pimelea curviflora*) • creamy candles (*Stackhousia monogyna*) • blue devil (*Eryngium ovinum*) • lemon beauty heads (*Calocephalus citreus*).
Lower quality native-dominated grassland: >50% of vegetation cover is native, dominated by red-leg grass (*Bothriochloa macra*) and wallaby grasses, with fewer native forbs.	Disturbance-tolerant species such as: • swamp dock (*Rumex brownii*) • Australian bindweed (*Convolvulus angustissimus*) • tufted bluebell (*Wahlenbergia communis*) • fuzz-weed (*Vittadinia* spp.) • yellow buttons (*Chrysocephalum apiculatum*).

Vegetation Association	Included Species
Exotic-dominated grassland: >50% of vegetation cover is exotic.	Species of particular concern are listed in **Table 3.1**.

Annual checking of the vegetation association boundaries in spring will provide information on the effectiveness of weed control. An aim of the Maintenance Plan is to contain or reduce the exotic-dominated areas, and to maintain or enlarge the high quality native-dominated areas.

Refer to **Figure 3.1** for an updated extent of the vegetation associations in 2015.

4.1.1.2 Species List

Annually in spring, all plant species noted on the Project Area during management and monitoring activities are recorded on a cumulative annual species list (**Appendix 1**). This list records the arrival of species of weeds, or their eradication and the loss of native species. In combination with the assessments below, it will measure changes in species richness and site condition over time. A major aim of management of the Project Area is to retain native species and eliminate or contain exotic species. Any observations of fauna of interest (e.g. Canberra raspy cricket) should be recorded at the same time.

4.1.1.3 Quadrat Assessment

A 20 x 20 metre quadrat in the middle of the Project Area has been assessed in Spring 2007, 2009, 2011, 2013, 2014 and 2015 (**Appendix 2**). This sector was chosen as it had a high number of GSM captures in 2006 and even in 2015, remains the highest quality grassland area on site. An aim of the Maintenance Plan is to maintain the native plant diversity in this area.

Within the quadrat area, each species is recorded with an associated scaled cover/abundance rating as per Braun-Blanquet (1932[30]). This information is then entered into the 'Grassy Site Quality Assessment Tool' spreadsheet developed by Rehwinkel (2007[31]) to provide a 'Floristic Value Score' (FVS). Using this scoring system, each species is assigned a value ranging from one to five based on their relative rarity as determined by regional grassland assessment data. Species are categorised as follows:

- Common or increaser species, which do not add much to the value of a site
- 'Indicator species, level 1', which indicated that a site has value
- 'Indicator species, level 2', which are highly significant species; these are the rarest of grassy ecosystem species and have the highest significance scores.

The sum of values for each species within a quadrat provides a FVS. This is considered more valuable than conventional species richness scores as it provides each quadrat with a relative value score based on the presence of rare or regionally significant species that are often not present in sites of lesser quality. Additionally, it does not reward common or increaser native species which often thrive in highly disturbed sites. This scoring system is generally used to characterise grassland condition, and has been used by ACT

[30] Braun-Blanquet, J. (1932) Plant sociology. McGraw Hill, New York.

[31] Rehwinkel, R. (2007) A method to assess grassy ecosystem sites: using floristic information to assess a sites' quality. Version 2. NSW Department of Environment and Climate Change, Queanbeyan.

government to monitor the effects of macropod grazing in grassy ecosystems (Armstrong, 2013[32]; ongoing monitoring undertaken by ACT Government, no reference available).

4.1.1.4 Step-point Transects

This method assesses the relative abundance of plant species, and gives an indication of the dominant species, degree of weed invasion and amount of bare ground (see Sharp et al. 2005[33]). Two transects are surveyed along the long axis of the Project Area, starting and finishing 10 metres from the external boundary to avoid edge effects (refer to **Figure 4.1**). At each step, a long vertical wire is place ahead of the observer, and a record is made of which species touch the wire (a 'hit'). 'Hits' on rock, bare ground, cryptogams and litter are also recorded. Results of the 2007, 2009, 2011 and 2013 transects are in **Appendix 3**. The number of 'hits' may vary depending on observer stride length, and should be converted to a percentage value for each variable.

An aim of the Maintenance Plan is to maintain a balance between bare ground and vegetation, and to keep the cover of presumed GSM food plants at current or increased levels. For the life of the current Maintenance Plan, the aim is for bare ground to be kept at 5-25 per cent, the main native grasses at about 60 per cent of the vegetation cover (proportional to native forbs and exotic species) and 8-20 centimetres height, with wallaby grasses contributing 7 per cent or more of the proportional vegetation cover.

Note that these percentage figures relate to vegetation cover only, rather than total cover which includes litter, bare ground and cryptogams. While these values are important and should still be collected and analysed, they are excluded from proportional vegetation cover calculations as they can vary significantly due to slashing management, moisture conditions and other variation in prevailing weather conditions.

4.1.1.5 Photographic Record

A photographic record is to be made each spring, from the points indicated in **Figure 4.1**. The photographs from 2013 are in **Appendix 5**. They give a general indication of vegetation structure on various parts of the Project Area. In following years, photographs should be captured in accordance with **Figure 4.1** and **Appendix 5**.

Figure 4.1 shows the location of the step-point survey transects, quadrat and photographic record locations.

4.1.1.6 Weeds

Biennially, every second summer, the need for weed control should be compared with the previous year's activity, and assessed against the objectives in **Table 3.1**. This should be undertaken for individual species, and compared to previous years' activities to determine successes and failures. Successful weed management will result in eradication of some target species, suppression or containment of others, and the identification and treatment of new weed infestations. Areas where treatment has been less effective should be noted, and future treatments adjusted accordingly.

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[32] Armstrong, R. (2013) Interim analysis of relationships between vegetation condition and kangaroo density in grassy ecosystems of the northern ACT: data collected in Spring-Summer 2009/2012. A report prepared for ACT government, Environment and Sustainable Development Directorate, Canberra. February 2013.

[33] Sharp, S., Dorrough, J., Rehwinkel, R., Eddy, D. & Breckwoldt, A. (2005) Grassy Ecosystems Management Kit: A Guide to Developing Conservation Management Plans. Environment ACT, Canberra.

Figure 4.1

Location of the Step-point Survey Transects, Quadrat and Photographic Record Points

Any increase in the area of vegetation dominated by exotic species measured in the mapping exercise described above should be a trigger for an increase in weed control effort, as should repeated or continuing infestations of weeds listed for eradication, or the spread of species required to be contained (including native grass species previously planted in the Project Area).

4.1.2 Golden Sun Moth

4.1.2.1 Annual Monitoring

The Project Area is too small for standard transect surveys (e.g. Clarke & Dunford, 1999[34]) to be strictly comparable with larger sites. However, its size provides an opportunity for ongoing comparisons of observational data collection methods. Due to the small area to be surveyed and the potential for double counting, observational surveys will not give absolute numbers for a site, but provide an indication of density and activity of flying males (refer to Appendix B of Hogg, 2010[35]). Repetition of counts allows averaging to reduce the variability that can arise from changes in wind speed or sunshine intensity between short counts on the same day.

Review of the original Maintenance Plan indicates that the survey guidelines for GSM (EPBC Act Policy Statement 3.12: DEWHA, 2009[36]) are not consistent with that of the Plan. This is understandable considering the original Maintenance Plan was developed prior to the release of the GSM survey guidelines. Under the EPBC survey guidelines, survey is required to be undertaken over four (4) non-consecutive days, with optimal conditions targeted based on seasonal conditions rather than rigid timeframes outlined in the existing Plan. For instance, throughout the ACT, the flying season can vary between early November to mid-December and late November to early January. The following survey parameters should be used for selecting appropriate days to undertake monitoring:

- a warm to hot day (above 20 °C by 10:00 am)
- the warmest part the day (i.e. between 10:00 am and 2:00 pm)
- clear or mostly cloudless sky
- still or relatively still wind conditions during the survey period
- ≥ 2 days since rain
- staggered to increase the likelihood of detection given the short adult life span (1-4 days between surveys).

As per the original Maintenance Plan, the following methods are to be used to undertake GSM survey on site:

- Transect surveys: on each visit at 11:30, 12:00 and 12:30 hours, observer to walk steadily on a 100 metre transect along the long axis of the Project Area, starting and finishing 10 metres from the external boundary to avoid edge effects. All GSM seen flying ahead and on each side of the observer on

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[34] Clarke, G.M. & Dunford, M. (1999) Survey of the Belconnen Naval Transmitting Station for the Endangered Golden Sun Moth, *Synemon plana*. A report prepared for Wildlife Research and Monitoring, Environment ACT.
[35] Hogg, D. (2010) A strategic approach to the conservation and environmental assessment of Golden Sun Moth sites in the Canberra area. Interim revised report. Prepared on behalf of the ACT Land Development Agency.
[36] DEWHA (2009) EPBC Act Policy Statement 3.12 - Significant Impact Guidelines for the Critically Endangered Golden Sun Moth (*Synemon plana*) Department of the Environment. [http://www.environment.gov.au/epbc/publications/pubs/golden-sun-moth.pdf, URL Accessed 27/09/2013]

each pass should be recorded on a hand- counter. Double counting of individuals to be avoided as far as possible. Results to be recorded as number of GSM per 100 metre transect.

- Point observations: to be undertaken twice on each visit in sets of ten, between the transect survey sessions. Observer to stand in centre of Project Area (in the high condition grassland area), and rotate slowly (360º in 30 seconds). All GSM seen in a radius of 25 metres during rotation to be recorded, including double counting of individuals that change track and recross the observer's visual path. Results from ten rotations to be recorded in each of the two sessions, with the range and average calculated for each session (number of GSM per 30 second rotation).

- GSM seen will be mostly flying males; any females should be recorded separately.

4.1.2.2 Five Yearly Monitoring

Population Estimate

Previous population estimation surveys have involved daily capture of males (and females in some years) throughout the flying period. The impact of this on survival and breeding of GSM is not known, although numbers were not reduced when the procedure was carried out over three consecutive seasons in the 1990s. However, it is a very intrusive procedure, and could be damaging to the population in years when numbers are already low for other reasons.

An alternative method using a nested sampling structure is outlined below (designed by Anett Richter, University of Canberra; cited in PB, 2008; Rowell, 2012). It allows population estimation with less interference, while also recording the ratio of males to females captured (recommended for larger populations only; in 2006, females were not captured to reduce interference to egg-laying). Capture, marking and release methods should be as described in Rowell (2012), although capture of females should be avoided as per the 2006 survey due to the intrusive nature of the method (A. Rowell, personal communication).

Note: mark-recapture surveys involve repeated handling of animals, and require the prior issue of a 'Permit to Take' by the Commonwealth Department of the Environment. The personnel involved in the survey should be appropriately qualified and experienced in such work, and the application for the permit should be lodged three months prior to commencement of the proposed survey.

The Robust Design

This mark-recapture method allows population estimation without daily captures. It features a nested sampling structure, timed to take account of the short life-span of adult GSM (one to four days). The first level consists of primary sampling sessions. The population experiences mortality (and potentially immigration) between primary sessions, allowing application of open population models. The secondary level of sampling involves a short mark-recapture study within each primary session. Closed population models are used at this stage to estimate the animal abundance at each primary session.

The design of the mark-recapture study (primary and secondary sampling sessions) depends on the biology of the study species. Due to the short life span of GSM (average two days), secondary sampling sessions should take place within two days. It is suggested to have at least four secondary sessions within one primary session to obtain an appropriate number of captured and recaptured individuals. To verify a closed population (no immigration, emigration, birth and deaths) four secondary sessions need to take place within two days (see design in **Figure 4.2**).

The first primary session should begin as soon as flying males are detected, and should be repeated every eight days until there are no new captures. Observational surveys of the Project Area should be undertaken weekly from late October to determine the beginning of the flying period. Analysis is to be carried out using the software package 'MARK'. The package includes the estimation of total population size of closed and open populations based on the Robust Design. It also provides estimates of daily survival rates and recapture probabilities.

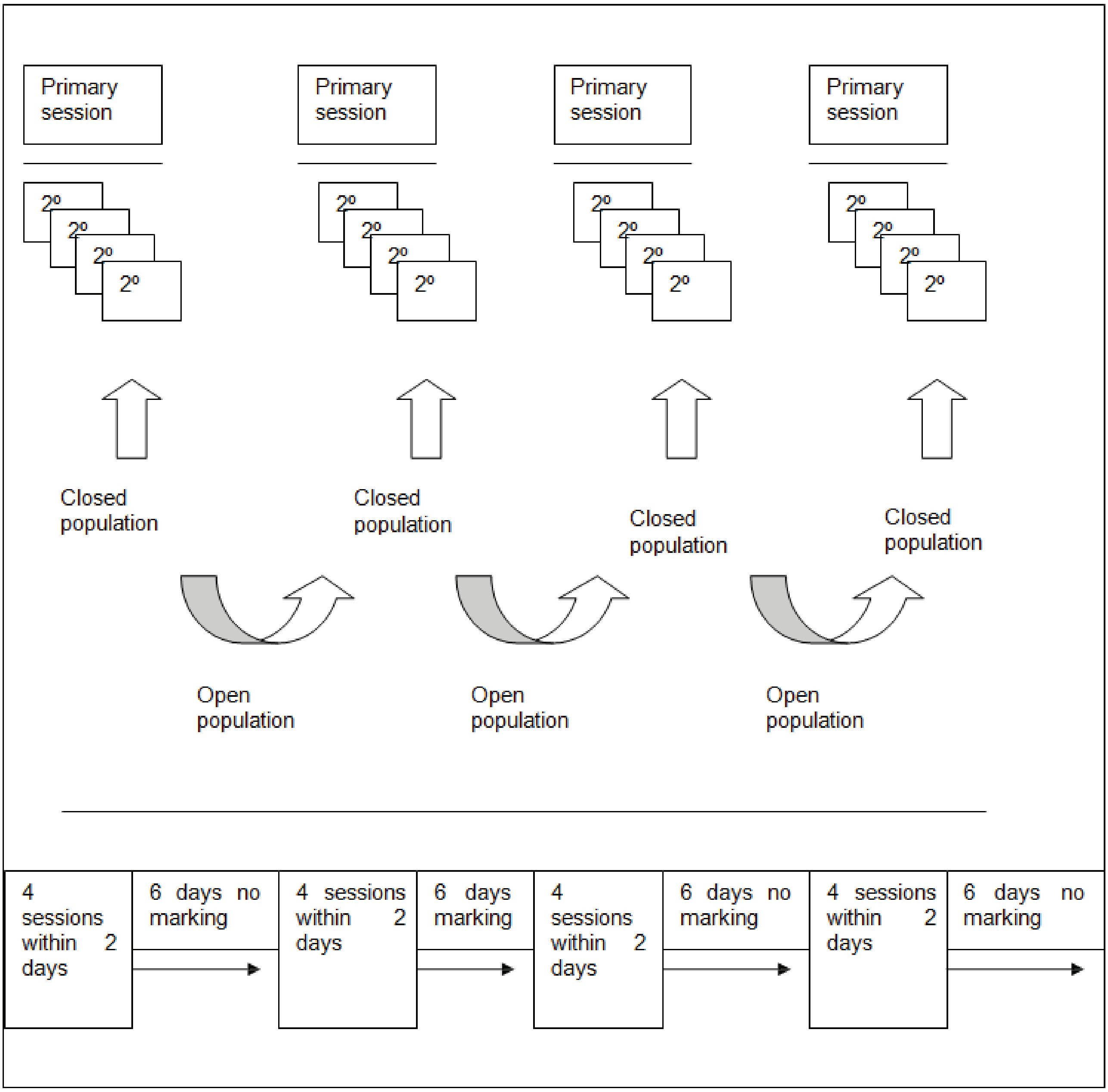


Figure 4.2

Experimental Design for Golden Sun Moth Population Estimation

Source: Anett Richter, University of Canberra, 2006 (cited in PB 2008, Rowell 2012)

4.1.3 Recording and Reporting

4.1.3.1 Management Checklist

The annotated work program and data from periodic monitoring will provide a record of management actions and outcomes that can be submitted to the lessee (National Capital Authority), the Commonwealth Department of the Environment and the ACT Government biennially or as required.

A report should be prepared in the final year of the five year Maintenance Plan, detailing the results of management and monitoring, with recommendations for variations in the reviewed Maintenance Plan.

4.2 Results and Discussion (2007-2015 Data)

4.2.1 Vegetation

4.2.1.1 Vegetation Mapping and Weed Distribution

Vegetation mapping undertaken by Umwelt (2015) was validated as part of the updated Maintenance Plan. Since this time, extent of NTG being 0.32 hectares (a reduction of 0.03 hectares since spring 2014). While changes between 2013 and 2014 were minor, it is apparent that the site has degraded in the past 12 months due to adjacent construction and general weed transfer.

Established weeds include perennial exotic grasses such as phalaris (*Phalaris aquatica*), paspalum (*Paspalum dilatatum*), tall fescue (*Festuca* sp.), Chilean needlegrass (*Nassella neesiana*) and cocksfoot (*Dactylis glomerata*). These were particularly prominent in the wetter southern third of the site, although cocksfoot and Chilean needlegrass in particular are distributed in lower abundance through native grassland areas, with Chilean needlegrass occurring outside the reject Area on the road verge along with African lovegrass (*Eragrostis curvula*).

On the bank adjacent to Sydney Avenue where disturbance from road widening and possibly replanting is evident, annual and perennial grasses were dominant. Along the western boundary, perennial exotic grasses and ribwort plantain (*Plantago lanceolata*) were abundant particularly beneath exotic deciduous trees. St John's wort (*Hypericum perforatum*) is scattered across the site.

Refer to **Figure 3.1** for updated vegetation mapping for the site.

4.2.1.2 Species List

The number of native and exotic grasses and forbs recorded since 2006 has remained relatively stable, with infrequently recorded species accounting for mild fluctuations in species richness. Prior to 2006, full-site species lists were not recorded. Notes on changes in abundance of species of interest are found in **Section 4.2.1.3**.

The species list across years since 1991 is found in **Appendix 1**.

4.2.1.3 Condition Trend Analysis

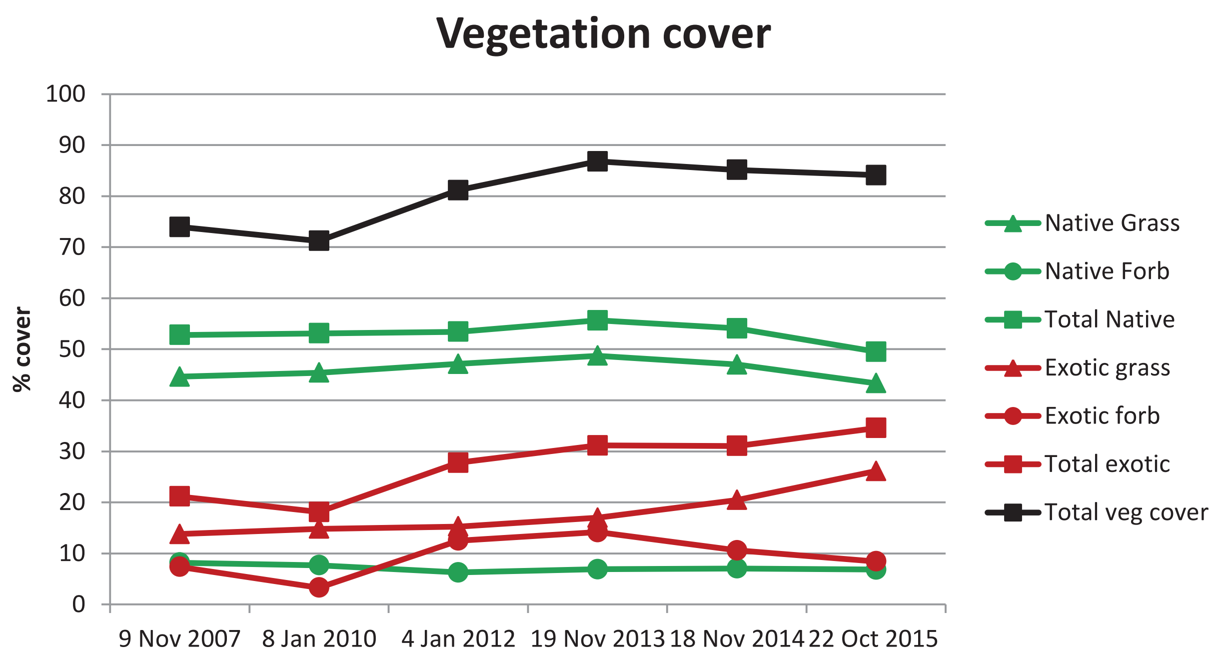
Analysis was undertaken on floristic data collected from four periods between 2007 and 2013: 9 November 2007 (late spring); 8 January 2010 (mid summer); 4 January 2012 (mid summer); 19 November 2013 (late spring); 18 November 2014 (late spring); and 22 October 2015 (mid spring).

Analysis of Step-point Transect Survey Data

A graph presented in **Graph 4.1** demonstrating changes in vegetation cover over time are based on data generated from the two step-point vegetation transects running north-south across the site (**Figure 4.1**). While step-point data is a useful means of quantifying changes in grassland composition over time, it is worth noting that even with the same observer, the exact same observation points are not sampled across years. As such, minor fluctuations in observations may not be significant; rather it is a useful way of exploring trends over time. Floristic value scores were generated from the 20 x 20 metre quadrat (location of quadrat shown in **Figure 4.1**).

As shown in **Graph 4.1**, step-point data indicates that native vegetation cover appears to be declining, with total native vegetation cover across the site currently at 50 per cent, down from 54 per cent in November 2014 and a peak of 56 per cent in November 2013.

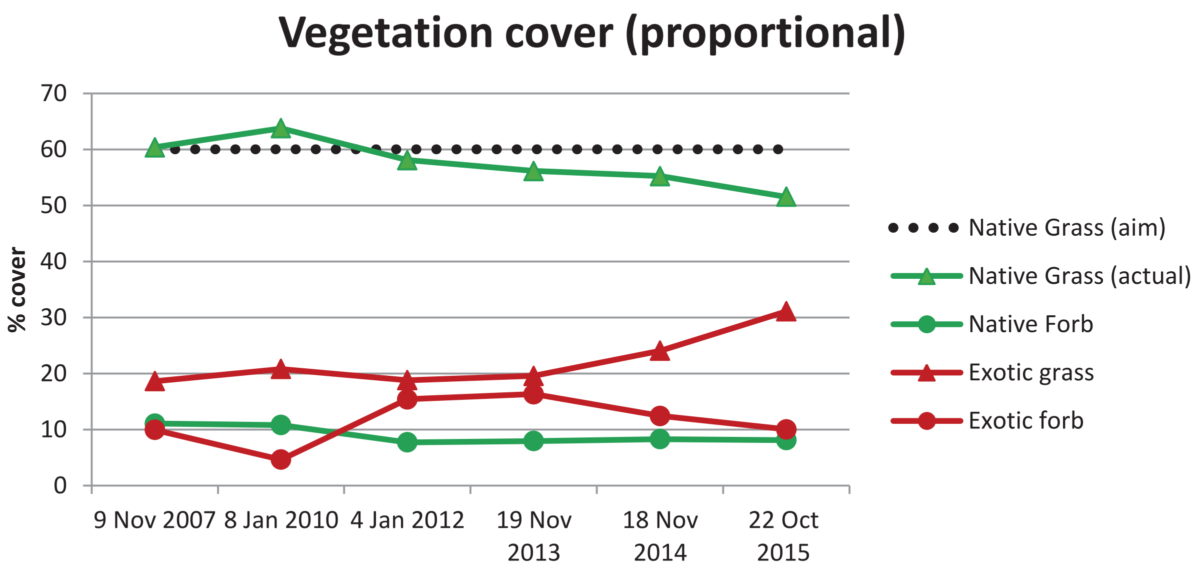
Total exotic vegetation cover has risen from 18 per cent on January 2010 to 36 per cent in October 2015, due to an increased cover of exotic grasses. During this time, exotic forb cover has decreased. This may be due to favourable rainfall conditions for exotic grass growth in the past few years, and potentially, success in control of exotic forbs through herbicide application. Each of the two step-point transect surveys cover high quality grassland areas dominated by native grasses and forbs, as well as areas dominated by exotic grasses. Without stratifying transects by vegetation condition, it is difficult to report on relative cover in native and exotic condition grasslands. However, as a guide it is estimated that native grassland areas are generally comprised of 80-90 per cent native species; similarly, areas dominated by exotic pastures are generally 80-90 per cent exotic species.



Graph 4.1

Changes in Native and Exotic Vegetation Cover over Time

A stated aim in managing the site is to retain native grasses at ≥60 per cent vegetation cover proportional to other vegetation (necessary to remove variation related to site management activities such as slashing – refer to **Section 4.1.1**). When vegetation cover is analysed independent of non-vascular cover such as litter, bare ground and cryptograms, the proportional native grass cover relative to other vegetation cover has been below this since 2012, with a cover of 52 per cent in October 2015, as shown in **Graph 4.2**. While vegetation cover on site has not reduced significantly (**Graph 4.1**), exotic grass abundance has increased and should be controlled in order to maintain grassland health and a proportional cover of ≥60% of native grasses relative to other vegetation. For further information on the increase of exotic grasses and forbs, refer to **Section 4.2.1.4** below.

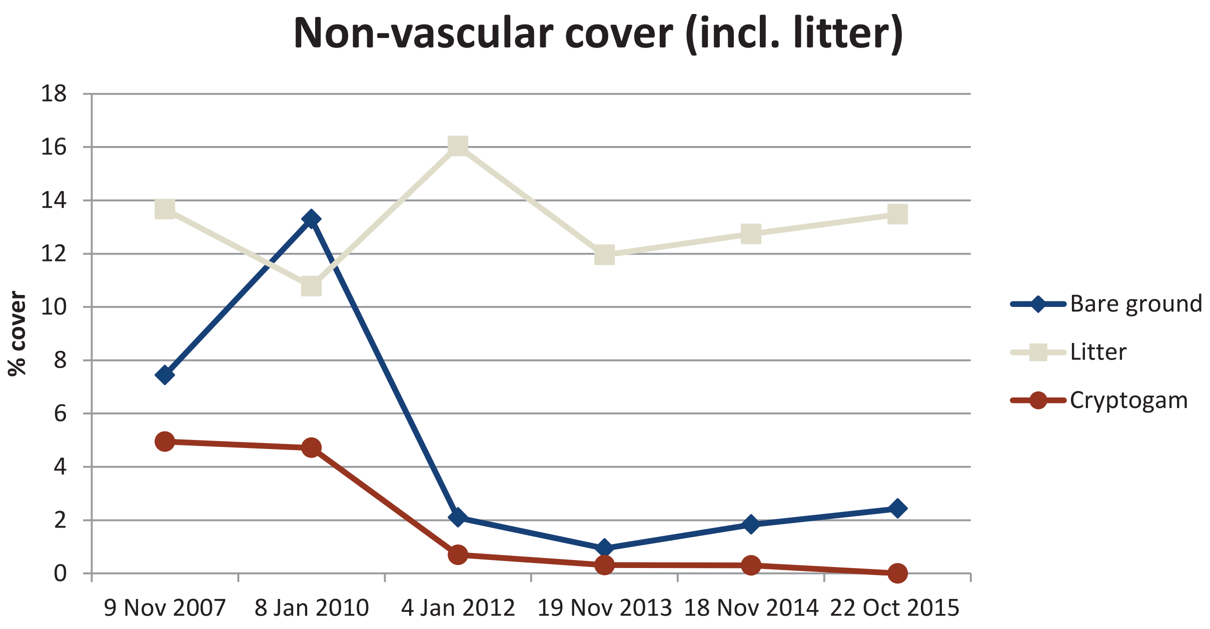


Graph 4.2

Proportional Vegetation Cover (Non-vascular Cover Excluded)

Kangaroo grass (*Themeda triandra*) that has been planted on the eastern footpath edge is gradually spreading across the site. This should be closely monitored and spot-sprayed if necessary. Kangaroo grass should be maintained along the edge of the path however, as it has formed an effective barrier to weed seed dispersal adjacent to the footpath.

Graph 4.3 demonstrates that litter cover across the site has been fluctuating between 11 per cent and 16 per cent since 2007. Significant reductions in bare ground and litter since January 2010 are likely to be as a result of spread of exotic grasses and forbs into inter-tussock spaces during favourable seasons for weed establishment.

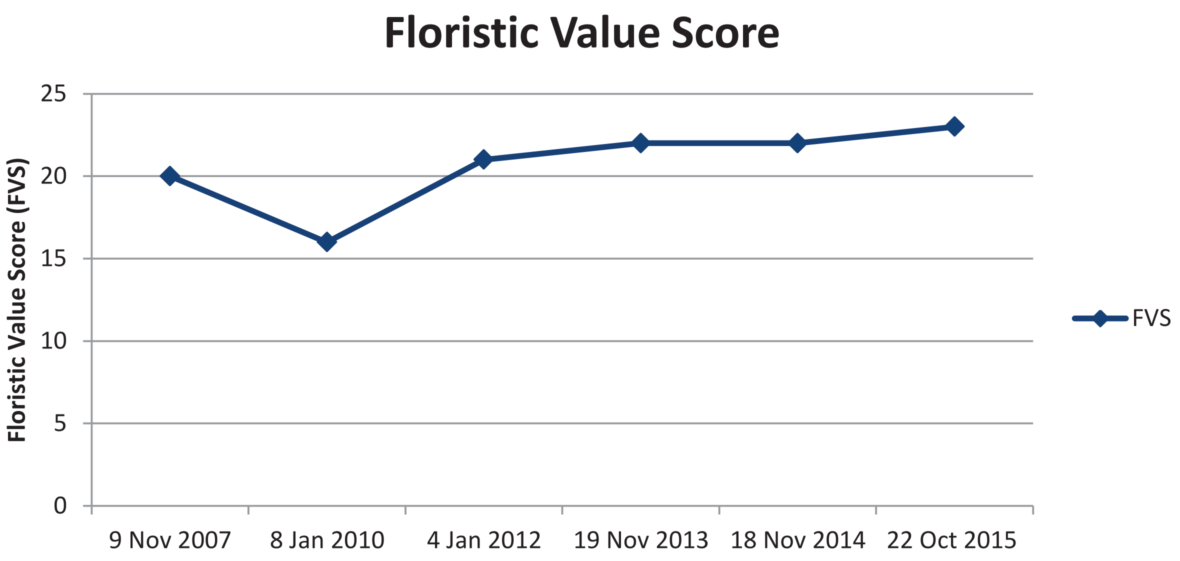


Graph 4.3

Changes in Non-vascular Cover over Time

Analysis of Quadrat Data

Within the 20 x 20 metre quadrat area, floristic values as defined by Rehwinkel (2007) have remained relatively stable over time, with a lowest value of '16' in January 2010 and a highest value of '23' in October 2015 (**Graph 4.4**). Low to moderate levels of variance using this scoring system are not considered noteworthy, as while based on the presence of 'significant' or 'indicator' species it is unlikely that floristic this information was unable to be collected in the exact same plot area as the plot corners were not permanently marked. In any case, if a 'significant' or 'important' species occurs just outside the plot it does not contribute to the floristic value score, but contributes to the overall floristic integrity of the site, which is of greater importance. However, the presence of exotic species is not factored in using this floristic value score method. Should exotic species need to be factored into the analysis in the future, data collected to-date can be used for retrospective analyses.



Graph 4.4

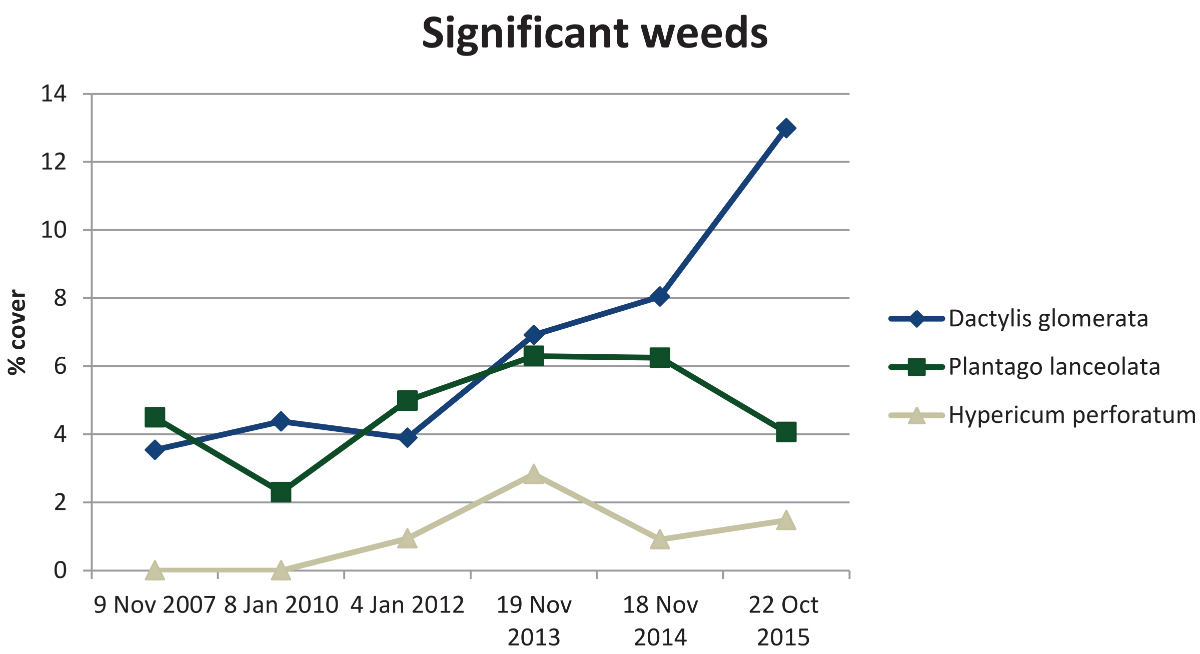
Changes in Floristic Values over Time

4.2.1.4 Changes in Weed Cover

Graph 4.5 shows the weeds of concern which have increased significantly since 2007. Generally, step-point vegetation transects record species which are of higher abundance across a site; recent observations indicate that these highly invasive weeds has increased considerably across the site in recent years.

While St. John's wort (*Hypericum perforatum*) has been known to be present on the site since 2003, it was not recorded as part of the step-point vegetation transects until January 2012. In the November 2013 survey it was observed to be scattered across the majority of the site; tis was less so in the October 2015 survey but it was still precent. Similarly, cocksfoot (*Dactylis glomerata*) and ribbed plantain (*Plantago lanceolata*) appear to be coming far more common, perhaps due to favourable growth conditions in the past few years. These species should be monitored closely in subsequent years.

Other significant weeds listed in **Table 3.1** are not shown in **Graph 4.5** as they are either considered stable, or are in a low enough abundance to not be recorded using the step-point transect survey method. Chilean needlegrass (*Nassella neesiana*), wild oats (*Avena* species), flatweed (*Hypochaeris radicata*) and tall fescue (*Festuca* sp.) appear relatively stable within the Project Area (noting that Chilean needlegrass is becoming more prevalent on the road verge), but should be controlled as they may increase after a disturbance event.



Graph 4.5

Changes in Significant Weed Cover over Time

4.2.2 Golden Sun Moth

Quantification of GSM populations at a given site is problematic due to variance in suitable flying weather and the potential for 'double-counting'. As such, low interference 'mark-capture-release' methods such as that developed by Dr Anett Richter (formerly of University of Canberra) and adopted as part of five-yearly monitoring in this Maintenance Plan by Rowell (2012) are preferable in determining long term population trends.

A sustained annual monitoring effort has only recently begun at the site, with survey undertaken broadly in line with annual monitoring protocols completed in the November 2009 to January 2010 period, and again from November 2013. Exploratory analysis of this data (shown in **Table 4.2**) is not presented; assuming annual monitoring events are maintained it may be more appropriate to analyse population trends when the Maintenance Plan is up for review in 2020. In any case, analysis should be undertaken with consideration of general population trends across the ACT and Southern Tablelands to partially account for variation in larval survival based on seasonal and annual climatic variation (noting differences in this site compared with those of part of larger non-isolated remnants). Future monitoring efforts should follow guidelines as per DEWHA (2009) (refer to **Section 4.1.2.1**).

In 2015, surveys commenced during the known flight season, based on Umwelt's prior reconnaissance and observations of GSM at nearby sites, as well as advice on observations from other ecologists.

Table 4.2 Monitoring Data for Golden Sun Moth, 2009-10 and 2013–2015

Survey Date and Time	Weather Conditions*	Observations
November 2009 to January 2010		
09/11/2009; middle of day	Temp: Max 32-35°C Rainfall: Unknown Wind: Unknown	Nil. Two male GSM observed on Sydney Ave. Median strip
25/11/2009; 1320-1350		T1 – 25; T2 – 19; T3 – 19. (ave = 21). Point observation (north) – ave = 5.5; range = 2 to 7 Point observation (south) – ave = 3.6; range = 2 to 5
08/12/2009; 1150-1220		T1 – 1; T2 – 9; T3 – 0. (ave = 3.3). Point observation (north) – ave = 0.8; range = 0 to 3 Point observation (south) – ave = 1.3; range = 0 to 4
08/01/2010; middle of day		Nil.
November to December 2013		
19/11/2013; 1130, 1200, 1230.	Temp: Max 28°C Rainfall: 0 mm Wind: Low, SSW	T1 – 4, 4, 5 (ave = 4.67); T2 – 1, 4, 1 (ave = 2). Point observation (1145) – ave = 0.7; range = 0 to 3 Point observation (1215) – ave = 0.5; range = 0 to 2
27/11/2013; 1130, 1200, 1230.	Temp: Max 29°C Rainfall: 0 mm Wind: 13km/hr, WNW	T1 – 3, 10, 5 (ave = 6); T2 – 2, 12, 9 (ave = 7.7). Point observation (1145) – ave = 0.3; range = 0 to 1 Point observation (1215) – ave = n/a; range = 0 to 0
12/12/2013; 1130, 1200, 1230.	Temp: Max 26.4°C Rainfall: 0 mm Wind: 19km/hr, WNW	T1 – 1, 0, 2 (ave = 1); T2 – 1, 5, 9 (ave = 5). Point observation (1145) – ave = 0.2; range = 0 to 1 Point observation (1215) – ave = 3.6; range = 0 to 6
November to December 2014		
18/11/2014; 1130, 1200, 1230.	Temp: 19.6°C (start); 24.3°C (max). Wind: 6km/hr WNW. Cloud cover: clear.	T1 – 0, 11, 13 (ave = 8); T2 – 1, 15, 17 (ave = 11). Point observation (1145) – ave = 0.9; range = 0 to 12. Point observation (1215) – ave = 6.2; range = 3 to 11.
18/11/2014; 1130, 1200, 1230.	Temp: 19.6°C (start); 24.3°C (max). Wind: 6km/hr WNW. Cloud cover: clear.	T1 – 0, 11, 13 (ave = 8); T2 – 1, 15, 17 (ave = 11). Point observation (1145) – ave = 0.9; range = 0 to 12. Point observation (1215) – ave = 6.2; range = 3 to 11.

Survey Date and Time	Weather Conditions*	Observations
22/11/2014; 1130, 1200, 1230.	Temp: 26.4°C (start); 31.0°C (max). Wind: 8km/hr NE. Cloud cover: clear.	T1 – 9, 17, 19 (ave = 15); T2 – 6, 12, 16 (ave = 11.3). Point observation (1145) – ave = 7; range = 4 to 11. Point observation (1215) – ave = 9.6; range = 6 to 12.
28/11/2014; 1130, 1200, 1230.	Temp: 20.4°C (start); 26.1°C (max). Wind: 1km/hr NNW. Cloud cover: clear.	T1 – 8, 20, 18 (ave = 15.3); T2 – 7, 17, 15 (ave = 13). Point observation (1145) – ave = 1.9; range = 0 to 4. Point observation (1215) – ave = 6.4; range = 4 to 11.
17/12/2014; 1130, 1200, 1230.	Temp: 22.1°C (start); 24.3°C (max). Wind: 17km/hr N. Cloud cover: clear.	T1 – 0, 2, 0 (ave = 0.7); T2 – 1, 2, 2 (ave = 1.7). Point observation (1145) – ave = 0.1; range = 0 to 1. Point observation (1215) – ave = 0.3; range = 0 to 1.
November to December 2015		
23/11/2015; 1130, 1200, 1230.	Temp: 22.5°C (start); 23.2°C (max). Rainfall: 0 mm. Wind: 19km/hr, NW. Cloud cover: clear.	T1 – 12, 20, 18 (ave = 16.67); T2 – 11, 30, 23 (ave = 21.33). Point observation (1145) – ave = 6.7; range = 3 to 12. Point observation (1215) – ave = 5.9; range = 3 to 9.
4/12/2015; 1130, 1200, 1230.	Temp: 21.5°C (start); 24.4°C (max). Rainfall: 0 mm. Wind: 9km/hr, N. Cloud cover: clear.	T1 – 2, 2, 3 (ave = 2.33); T2 – 6, 12, 6 (ave = 8.0). Point observation (1145) – ave = 2.0; range = 0 to 4 Point observation (1215) – ave = 1.1; range = 0 to 3
10/12/2015; 1130, 1200, 1230.	Temp: 19.7°C (start); 22.0°C (max). Rainfall: 0 mm. Wind: 15km/hr, NW. Cloud cover: clear.	T1 – 0, 9, 6 (ave = 5.0); T2 – 3, 5, 12 (ave = 6.67). Point observation (1145) – ave = 1.1; range = 0 to 4 Point observation (1215) – ave = 3; range = 1 to 5
24/12/2015; 1130, 1200, 1230.	Temp: 22.0°C (start); 23.2°C (max). Rainfall: 0.8 mm previous morning. Wind: 19km/hr, ENE. Cloud cover: clear.	Nil. No GSM observed throughout the transect or point observation surveys.

*In 2009-10 weather conditions were reported as a range, with all days being favourable.

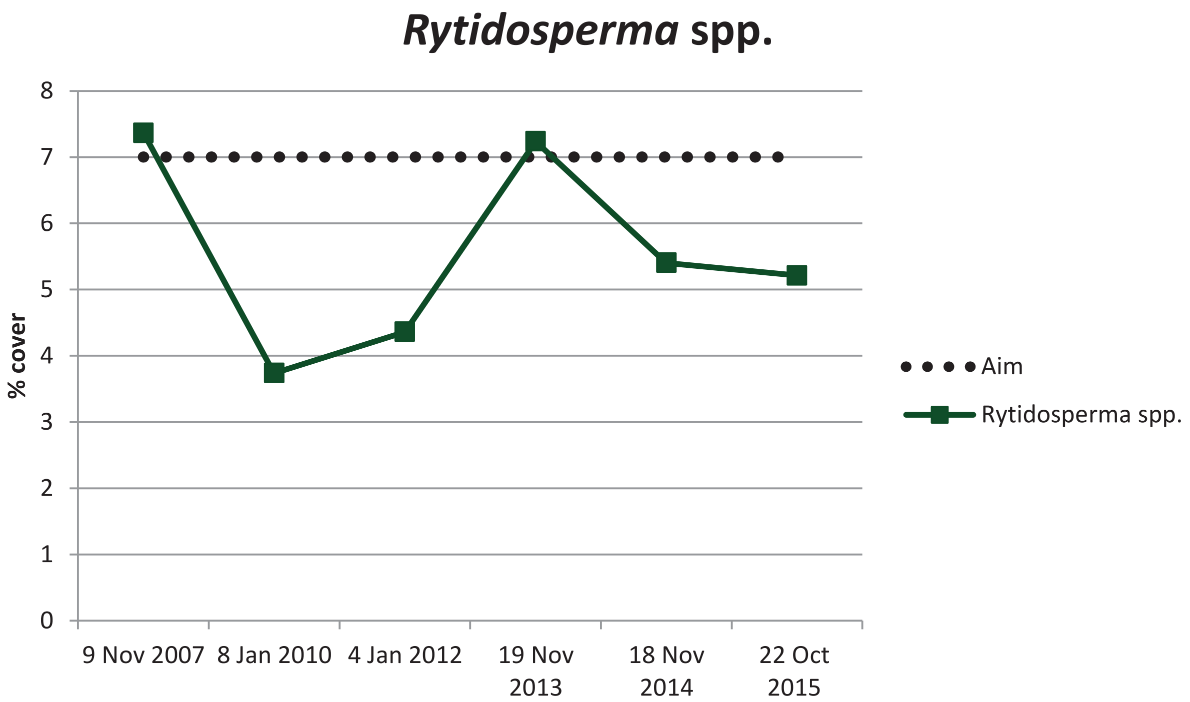
The five-year monitoring event was undertaken by Alison Rowell in December 2011 (Rowell, 2012). Across three primary capture sessions totals of 50, 32 and 12 month were achieved. Based on analysis undertaken by Dr Anett Richter, the GSM population at this time were estimated to be as shown in **Table 4.3** (from Rowell, 2012).

Table 4.3 Primary Session Golden sun Moth Population Estimates (Mark-recapture), December 2011

Primary Session	Dates	Position in Flying Season	Estimated Population Size During Session	95% Confidence Interval
1	9-10/12/2011	Mid	66	57-85
2	23-24/12/2011	Mid to late	49	39-75
3	31/12/2011-1/1/2012	Late	12*	-

*Minimum number alive, population estimate not possible due to a lack of recaptures.

At the Project Area the presence of wallaby grasses (*Rytidosperma* spp.) is important for the survival of GSM. Additionally, other C3 grasses such as tall speargrass (*Austrostipa bigeniculata*) and the exotic Chilean needlegrass (*Nassella neesiana*) provide fodder value for GSM (Richter et al. 2010). A stated aim of the Maintenance Plan is to maintain wallaby grasses at 7 per cent or more vegetation cover (proportional to vegetation only). Analysis of step-point transect survey data indicate that wallaby grasses are presently at 7.2 per cent, having ranged from 3.7 per cent to 7.4 per cent (±1.9) since November 2007 (**Graph 4.6**). As a perennial native grass in a site that is likely to be rarely subjected to macropod grazing, it is unlikely that wallaby grass cover has varied this amount since 2007. Rather, it may be a function of variance of the step-point transect survey method (noting there is probably no better way to quantify across the site), or time since slashing (which can temporarily reduce the surface area of grass tussocks).



Graph 4.6

Changes in Wallaby Grass (Rytidosperma spp.) Cover over Time

Kangaroo grass (*Themeda triandra*) has been planted on the eastern footpath edge, and it is gradually spreading across the site. Additionally, exotic pasture species such as cocksfoot (*Dactylis glomerata*) are present in all but the highest quality areas, and these species may displace C3 grasses that provide food for GSM larvae (refer to Richter et al., 2010). Rowell (2012) noted that in late 2011, grasses were longer and denser than desirable for GSM habitat, perhaps as they hadn't been mown twice in wetter years (the Plan recommends once a year with follow-up mowing in wetter years to reduce biomass). At the time of the October 2015 surveys the structure (height) was considered reasonable, perhaps due to a relatively dry spring-summer period. While inter-tussock spaces have reduced, this is more likely to vary based on climatic conditions rather than management actions such as slashing.

5.0 Review and Implementation

5.1 Review of the Maintenance Plan

The Maintenance Plan should be reviewed again at the end of five years (i.e. 2020). A new draft Plan should be prepared by an appropriately qualified person, and be presented for review and approval by the National Recovery Teams for GSM and NTG, or a committee of specialists from bodies such as ACT Government, NSW Office of Environment and Heritage, the Commonwealth Department of the Environment, University of Canberra, Australian National University, CSIRO Department of Entomology etc.

This report represents the first review of the Maintenance Plan. Review of the updated plan was undertaken by local biologist and author of the original Plan Alison Rowell, and representatives from Territory and Commonwealth Government Departments. Refer to **Section 1.2** (Acknowledgements) for further information.

5.2 Implementation of the Maintenance Plan

The leaseholder of the site will be responsible for the implementation and ongoing management of the Maintenance Plan and all associated costs.

All aspects of the Maintenance Plan should be carried out by:

- suitably qualified operators/contractors with demonstrated experience in NTG management, to be engage directly by the leaseholder of the site; or
- a recognised authority (e.g. the ACT Government), subject to an agreement, arrangement or Memorandums of Understanding with the recognised authority, with all expenses to be funded by the leaseholder.

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APPENDIX 1

Plant Species Recorded on Site

	Plant species recorded at York Park																
	(p = present)																
		1991-2	**1992**	**1993**	**1994**	**1995**	**1996**	**1999**	**2000**	**2003**	**2006**	**2007**	**2009**	**2011**	**2013**	**2014**	**2015**
		WRM	**Davis & Hogg**	**WRM**	**WRM**	**WRM**	**WRM**	**WRM**	**WRM**	**WRM**	**Rowell**	**Rowell**	**Rowell**	**Rowell**	**Umwelt**	**Umwelt**	**Umwelt**
Species	**Common Name**																
Native grasses																	
Aristida ramosa	Wiregrass											p	p				
Rytidosperma auriculata	Lobed Wallaby Grass		p						p			p	p	p	p	**p**	**p**
Rytidosperma bipartitum	A Wallaby Grass										p	p	p				
Rytidosperma caespitosum	Ringed Wallaby Grass	p											p	p		**p**	
Rytidosperma carphoides	Short Wallaby Grass	p	p							p	p	p	p	p	p	p	p
Rytidosperma fulvum	A Wallaby Grass												p	p			
Rytidosperma laeve	Smooth Wallaby Grass	p	p								p	p	p	p	p	p	p
Rytidosperma spp.	Wallaby Grasses			p	p	p	p	p	p	p	p	p		p	p		p
Austrostipa bigeniculata	Tall Speargrass	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Austrostipa densiflora	A Speargrass			p													
Austrostipa scabra	Rough Speargrass		p									p		p	p	p	p
Bothriochloa macra	Redleg Grass	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Chloris truncata	Windmill Grass	p					p					p					
Elymus scaber	Wheatgrass	p	p	p			p	p	p		p	p	p	p	p	p	p
Eragrostis brownii	A Lovegrass	p															
Eragrostis trachycarpa	A Lovegrass					p	p						p	p			
Microlaena stipoides	Weeping Grass											p		p			
Panicum effusum	Hairy Panic Grass	p	p			p		p	p		p	p	p	p	p	p	p
Poa labillardieri	Tussock Grass										p	p		p	p	p	p
Themeda triandra	Kangaroo Grass									p	p	p	p	p	p	p	p
TOTAL		**9**	**8**	**5**	**3**	**5**	**6**	**5**	**6**	**5**	**10**	**15**	**13**	**15**	**11**	**11**	**11**
Native forbs																	
Acaena ovina	Sheeps Burr	p	p								p	p		p		p	p
Asperula conferta	Common Woodruff	p	p	p		p		p			p	p	p	p	p	p	p
Bulbine bulbosa	Golden Lily	p	p	p			p					p	p	p	p	p	p
Calocephalus citreus	Lemon Beauty Heads	p	p	p			p			p	p	p	p	p	p	p	p
Carex sp.	A sedge														p		
Chamaesyce drummondii	Caustic Weed	p															
***Cheilanthes* sp.**						p											
Cheilanthes sieberi	Rock Fern		p								p	p	p	p	p	p	p
Cheilanthes tenuifolia				p													
Chenopodium pumilio	Small Crumbweed													p			
Chrysocephalum apiculatum	Yellow Buttons	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Convolvulus angustissimus	Australian Bindweed	p	p		p					p	p	p	p	p	p	p	p
Crassula sieberiana	Australian Stonecrop												p			p	p
Cymbonotus lawsonianus	Bear's Ears		p														
Drosera peltata	Sundew		p														
Eryngium rostratum	Blue Devil	p	p	p			p	p			p	p	p	p	p	p	p
Euchiton sp.	A Cudweed					p		p	p								
Euchiton gymnocephalus	A Cudweed											p	p				
Euchiton sphaericus	A Cudweed													p	p		
Glycine tabacina	Vanilla Glycine										p			p			p
Gonocarpus tetragynus	Raspwort					p											
Goodenia pinnatifida	Scrambled Eggs	p	p	p	p	p	p			p	p	p	p	p	p	p	p
Hypericum gramineum	Small St John's Wort		p	p			p							p			
Juncus sp.	A Rush		p														
Lomandra bracteata	A Matrush											p	p	p	p	p	p
Lomandra filiformis	A Matrush	p	p				p				p						
Lomandra multiflora	A Matrush		p														
***Lomandra* sp.**	A Matrush			p	p	p	p	p	p		p						
Microtis unifolia	Common Onion Orchid		p										p		p	p	p
Oxalis perennans	Soursob	p	p	p	p	p	p	p	p			p		p	p	p	p
Pimelea curviflora	Curved Rice-flower		p	p		p					p	p		p	p	p	p
Plantago varia	Variable Plantain	p	p								p	p	p	p	p	p	p
Rumex brownii	Swamp Dock	p									p						

Species	Common Name	1991-2 WRM	1992 Davis & Hogg	1993 WRM	1994 WRM	1995 WRM	1996 WRM	1999 WRM	2000 WRM	2003 WRM	2006 Rowell	2007 Rowell	2009 Rowell	2011 Rowell	2013 Umwelt	2014 Umwelt	2015 Umwelt
Schoenus apogon	Bog-rush		p												p	p	p
Sebaea ovata			p														
Senecio quadridentatus	Cotton Fireweed													p			
Solenogyne dominii	Smooth Solenogyne	p	p														
Stackhousia monogyna	Creamy Candles		p					p				p			p	p	
Tricoryne elatior	Yellow Rush Lily	p	p	p	p		p	p	p	p	p	p	p	p	p	p	p
Triptilodiscus pygmaeus	Austral Sunray	p	p	p		p	p	p	p			p		p	p		p
Vittadinia muelleri	Fuzzweed									p		p		p			
Wahlenbergia sp.	A Bluebell			p	p	p	p	p						p			
Wahlenbergia communis	Tufted Bluebell	p	p								p	p	p	p	p	p	p
Wahlenbergia luteola	A Bluebell										p	p	p	p	p	p	p
Wahlenbergia multicaulis	Tadgell's Bluebell																p
Wahlenbergia stricta	A Bluebell		p														
Wurmbea dioica	Early Nancy		p														
Xerochrysum viscosum	Sticky Everlasting													p			
TOTAL		**17**	**28**	**14**	**7**	**11**	**12**	**10**	**6**	**6**	**17**	**20**	**16**	**25**	**21**	**20**	**20**
Exotic grasses																	
Aira sp.	A Hairgrass	p	p	p		p	p	p	p	p		p	p		p	p	
Aira elegantissima	A Hairgrass											p					p
Avena sp.	Wild Oats		p	p							p	p	p	p	p	p	
Avena barbata	Bearded Oats											p					p
Briza maxima	Blowfly Grass	p	p	p		p	p	p	p	p		p	p	p	p	p	
Briza minor	Shivery Grass	p	p	p		p	p	p	p	p		p	p	p	p	p	p
Bromus sp.	A Brome Grass			p	p	p	p	p	p		p						p
Bromus catharticus	A Brome Grass		p									p		p			
Bromus diandrus	A Brome Grass		p														
Bromus hordeaceus	A Brome Grass		p									p	p	p	p	p	p
Bromus mollis	Soft Brome	p															p
Cynodon dactylon	Couch			p								p		p			
Dactylis glomerata	Cocksfoot		p		p		p		p		p	p	p	p	p	p	p
Eleusine tristachya	Goose Grass							p									p
Eragrostis curvula	African Lovegrass	p														p	
Festuca sp.	A Fine-leaved Fescue		p				p				p				p		p
Festuca arundinacea	Tall Fescue								p	p	p	p		p		p	
Lolium perenne	Perennial Ryegrass											p			p		p
Lolium rigidum	Ryegrass		p	p													
Lophochloa cristata	Annual Cat's Tail											p					
Nassella neesiana	Chilean Needlegrass	p	p						p		p	p	p	p	p	p	
Nassella trichotoma	Serrated Tussock							p			p	p			p		p
Paspalum dilatatum	Paspalum			p		p	p	p	p	p	p	p	p	p	p	p	p
Phalaris aquatica	Phalaris	p	p	p		p	p					p		p	p	p	p
Vulpia sp.	Rat's-tail Fescue		p	p	p	p	p	p	p		p	p	p	p	p	p	p
TOTAL		**7**	**13**	**10**	**3**	**7**	**9**	**8**	**9**	**5**	**9**	**18**	**9**	**12**	**13**	**12**	**14**
Exotic forbs	Sorrel																
Acetosella vulgaris	Scarlet Pimpernel	p															
Anagallis arvensis	Capeweed			p													
Arctotheca calendula	Pink Stars											p					
Centaurium erythraea	Chickweed			p		p	p		p		p		p	p	p	p	p
Cerastium glomeratum	Spear Thistle		p														
Cirsium vulgare	Flax-leaf Fleabane			?			?										
Conyza bonariensis	Paterson's Curse					p	p							p	p	p	p
Echium plantagineum	Common Crowfoot											p					
Erodium cicutarium	A Bedstraw			p				p					p				
Galium divaricatum	A Cudweed					p	p										p
Gamochaeta purpurea	A Cudweed						p		p	p	p	p		p	p	p	p
Gnaphalium sp.	Hoary Mustard		p	p													
Hirschfeldia incana	St John's Wort		p									p		p	p	p	p
Hypericum perforatum	Smooth Catsear									p	p	p	p	p	p	p	p
Hypochaeris glabra	Catsear	p								p		p			p	p	p

		1991-2	1992	1993	1994	1995	1996	1999	2000	2003	2006	2007	2009	2011	2013	2014	2015
		WRM	**Davis & Hogg**	**WRM**	**WRM**	**WRM**	**WRM**	**WRM**	**WRM**	**WRM**	**Rowell**	**Rowell**	**Rowell**	**Rowell**	**Umwelt**	**Umwelt**	**Umwelt**
Species	**Common Name**																
Hypochaeris radicata	Prickly Lettuce	p	p	p	p	p		p	p	p	p	p	p	p	p	p	p
Lactuca serriola	A Peppercress						p	p		p	p	p	p	p	p	p	p
Lepidium africanum	Common Bartsia											p					
Parentucellia latifolia	Proliferous Pink		p				p									p	p
Petrorhagia nanteulii	Ribwort Plantain		p							p				p	p	p	p
Plantago lanceolata	Onion Grass	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Romulea rosea	Wild Sage											p				p	
Salvia verbenaca	French Catchfly		p									p					
Silene gallica	Common Sow-thistle						p					p					
Sonchus oleraceus	Salsify					p						p					
Tragopogon porrifolius	Narrow leaf Clover										p			p	p		
Trifolium angustifolium	Haresfoot Clover													p	p	p	p
Trifolium arvense	Hop Clover		p												p	p	p
Trifolium campestre		p	p									p	p	p	p	p	p
Trifolium dubium	Clustered Clover		p							p							p
Trifolium glomeratum			p													p	p
Trifolium striatum	Clovers		p														
Trifolium spp.				p		p	p	p									
TOTAL		**5**	**13**	**8**	**2**	**7**	**10**	**5**	**4**	**8**	**7**	**15**	**7**	**12**	**14**	**16**	**16**
Exotic shrubs and trees	Cotoneaster																
Cotoneaster sp.	Hawthorn											p					
Crataegus monogyna	Small-leaved Privet									p							
Ligustrum sinense	Large-leaved Privet																
Ligustrum lucidum	Lombardy Poplar															p	p
Populus nigra var. *italica*	Plum		p														
Prunus sp.	Service Tree											p	p		p		p
Sorbus domestica												p	p	p	p	p	p
TOTAL		**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**3**	**2**	**1**	**1**	**2**	**2**
Indicator 1 (Rehwinkel 2007)																	
Indicator 2 (Rehwinkel 2007)																	

APPENDIX 2

Cumulative Step-point Transect Survey Data

TRANSECT 1	2007	2009-10	2011-12	2013-14	2014-15	2015-16	2007	2009-10	2011-12	2013-14	2014-15	2015-16
	Hits/100 metres	Hits/100 metres	Hits/100 metres	% veg	% veg	% veg	% veg	% veg	% veg	% veg	% veg	% veg
	(% frequency)	(% frequency)	(% frequency)	(% frequency)	composition	composition	composition	composition	composition	composition	composition	composition
							(230 veg hits)	(201 veg hits)	(225 veg hits)	(158 hits)	(158 hits)	(156 hits)
Date	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**	**22-Oct-15**	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**	**22-Oct-15**
Easting start (WGS84)	**693810**											
Northing start	**6090258**											
Easting finish	**693877**											
Northing finish	**6090335**											
Bare ground	**20**	**30**	**3**		**1**	**3**	**8.7**	**14.9**	**1.3**		**0.6**	**1.9**
Litter	**30**	**21**	**40**	**19**	**23**	**20**	**13.0**	**10.4**	**17.8**	**12.0**	**14.6**	**12.8**
Cryptogam	**14**	**10**	**1**				**6.1**	**5.0**	**0.4**			
Native grasses												
Austrostipa bigeniculata	58	63	48	48	46	43	25.2	31.3	21.3	30.4	29.1	27.6
Bothriochloa macra	27	20	31	15	17	15	11.7	10.0	13.8	9.5	10.8	9.6
Rytidosperma spp.	13	4	2	8	4	6	5.7	2.0	0.9	5.1	2.5	3.8
Panicum effusum		4	5	1	2	1		2.0	2.2	0.6	1.3	0.6
Austrostipa scabra			2	1					0.9	0.6		
Elymus scaber			1	1	1	1			0.4	0.6	0.6	0.6
Themeda triandra			1	1	1				0.4	0.6	0.6	
Total native grasses	**98**	**91**	**90**	**75**	**71**	**66**	**42.6**	**45.3**	**40.0**	**47.5**	**44.9**	**42.3**
Native forbs												
Chrysocephalum apiculatum	4	1	4	6	5	6	1.7	0.5	1.8	3.8	3.2	3.8
Lomandra bracteata	1	1	1				0.4	0.5	0.4	0.0		
Tricoryne elatior	1		2				0.4		0.9			
Goodenia pinnatifida	1	1	2	2	2	2	0.4	0.5	0.9	1.3	1.3	1.3
Caocephalus citreus						4						2.6
Triptilodiscus pygmaeus	1						0.4					
Oxalis perennans			1						0.4			
Total native forbs	**8**	**3**	**10**	**8**	**7**	**12**	**3.5**	**1.5**	**4.4**	**5.1**	4.4	7.7
TOTAL NATIVES	**106**	**94**	**100**	**83**	**78**	**78**	**46.1**	**46.8**	**44.4**	**52.5**	**49.4**	**50.0**
Exotic grasses												
Dactylis glomerata	13	12	10	10	12	14	5.7	6.0	4.4	6.3	7.6	9.0
Paspalum dilatatum	8		11	4	3	5	3.5		4.9	2.5	1.9	3.2
Avena barbata	7	9	14	6	10	4	3.0	4.5	6.2	3.8	6.3	2.6
Nassella neesiana	5	3	7	7	4	3	2.2	1.5	3.1	4.4	2.5	1.9
Aira sp.	2	2					0.9	1.0				
Cynodon dactylon	1						0.4					
Bromus hordeaceus		1						0.5				
Briza maxima					1						0.6	
Briza minor		2		2		2		1.0		1.3		1.3
Vulpia sp.		6	1	1	4			3.0	0.4	0.6	2.5	
Festuca sp.					1	5					0.6	3.2
Total exotic grasses	**36**	**35**	**43**	**30**	**35**	**33**	**15.7**	**17.4**	**19.1**	**19.0**	**22.2**	**21.2**
Exotic forbs												
Plantago lanceolata	13	7	16	12	14	13	5.7	3.5	7.1	7.6	8.9	8.3
Hypochoeris radicata	8	1	13	5	3	4	3.5	0.5	5.8	3.2	1.9	2.6
Romulea rosea	2						0.9					
Hypochoeris glabra	1						0.4					
Trifolium campestre		2			1	2		1.0			0.6	1.3
Trifolium angustifolium				1	1					0.6	0.6	
Erodium cicutarium		1						0.5				
Tragopogon porrifolius			1						0.4			
Centaurium erythraea			7	3	2	1			3.1	1.9	1.3	0.6
Hypericum perforatum			1	4		2			0.4	2.5		1.3
Gamochaeta purpurea				1						0.6		
Total exotic forbs	**24**	**11**	**38**	**14**	**21**	**22**	**10.4**	**5.5**	**16.9**	**8.9**	13.3	14.1
TOTAL EXOTICS	**60**	**46**	**81**	**56**	**56**	**55**	**26.1**	**22.9**	**36.0**	**35.4**	**35.4**	**35.3**

TRANSECT 2	2007	2009-10	2011-12	2013-14	2014-15	2015-16	2007	2009-10	2011-12	2013-14	2014-15	2015-16
	Hits/100 metres	Hits/100 metres	Hits/100 metres	% veg	% veg	% veg	% veg	% veg	% veg	% veg	% veg	% veg
	(% frequency)	(% frequency)	(% frequency)	composition	composition	composition	composition	composition	composition	composition	composition	composition
							(210 veg hits)	(180 veg hits)	(210 veg hits)	(160 hits)	(165 hits)	(169 hits)
Date	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**	**23-Oct-15**	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**	**22-Oct-15**
Easting start (WGS84)	**693810**											
Northing start	**6090258**											
Easting finish	**693877**											
Northing finish	**6090335**											
Bare ground	**13**	**21**	**6**	**3**	**5**	**4**	**6.2**	**11.7**	**2.9**	**1.9**	**3.0**	**2.4**
Litter	**30**	**20**	**30**	**19**	**18**	**21**	**14.3**	**11.1**	**14.3**	**11.9**	**10.9**	**12.4**
Cryptogam	**8**	**8**	**2**	**1**	**1**		**3.8**	**4.4**	**1.0**	**0.6**	**0.6**	
Native grasses												
Austrostipa bigeniculata	57	56	62	49	53	40	27.1	31.1	29.5	30.6	32.1	23.7
Bothriochloa macra	29	14	38	17	14	12	13.8	7.8	18.1	10.6	8.5	7.1
Rytidosperma spp.	11	6	13	12	11	7	5.2	3.3	6.2	7.5	6.7	4.1
Elymus scaber	1	1		2	3	6	0.5	0.6		1.3	1.8	3.6
Panicum effusum		3	1					1.7	0.5			
Aristida ramosa		2						1.1				
Total native grasses	**98**	**82**	**114**	**80**	**81**	**65**	**46.7**	**45.6**	**54.3**	**50.0**	**49.1**	**38.5**
Native forbs												
Chrysocephalum apiculatum	18	15	10	7	6	4	8.6	8.3	4.8	4.4	3.6	2.4
Lomandra bracteata	1	1	1		1		0.5	0.6	0.5		0.6	0.0
Tricoryne elatior	3	3		1	1	4	1.4	1.7		0.6	0.6	2.4
Goodenia pinnatifida	3		1	2	3	1	1.4		0.5	1.3	1.8	0.6
Triptilodiscus pygmeus				1		2				0.6		1.2
Asperula conferta	1	1					0.5	0.6				
Wahlenbergia luteola	1		1				0.5		0.5			
Calocephalus citreus		3	3	2	5	3		1.7	1.4	1.3	3.0	1.8
Cheilanthes sieberi		1	1					0.6	0.5			
Bulbine bulbosa		1		1				0.6		0.6		
Total native forbs	**27**	**25**	**17**	**14**	**16**	**14**	**12.9**	**13.9**	**8.1**	**8.8**	**9.7**	8.3
TOTAL NATIVES	**125**	**107**	**131**	**94**	**97**	**79**	**59.5**	**59.4**	**62.4**	**58.8**	**58.8**	**46.7**
Exotic grasses												
Dactylis glomerata	3	5	7	12	14	22	1.4	2.8	3.3	7.5	8.5	13.0
Paspalum dilatatum	1	1	6	2	1	6	0.5	0.6	2.9	1.3	0.6	3.6
Avena barbata	11	8	4	4	6	6	5.2	4.4	1.9	2.5	3.6	3.6
Nassella neesiana	7	2	6	1	1	3	3.3	1.1	2.9	0.6	0.6	1.8
Bromus hordeaceus	1	1	1	1	1	1	0.5	0.6	0.5	0.6	0.6	0.6
Aira sp.	1	5		2	4	2	0.5	2.8		1.3	2.4	1.2
Vulpia sp.				1	2	1				0.6	1.2	0.6
Cynodon dactylon	1						0.5					
Briza maxima					2	2					1.2	1.2
Briza minor				1						0.6		
Festuca sp.						1						0.6
Total exotic grasses	**25**	**22**	**24**	**24**	**31**	**44**	**11.9**	**12.2**	**11.4**	**15.0**	**18.8**	**26.0**
Exotic forbs												
Plantago lanceolata	7	2	6	8	6	4	3.3	1.1	2.9	5.0	3.6	2.4
Hypochoeris radicata	2		6	2	3	4	1.0		2.9	1.3	1.8	2.4
Tragopogon porrifolius				1						0.6		
Lactuca serriola												
Centaurium erythraea			2	2	1				1.0	1.3	0.6	
Hirschfeldia incana				1						0.6		
Hypericum perforatum			3	5	3	2			1.4	3.1	1.8	1.2
Total exotic forbs	**9**	**2**	**17**	**19**	**13**	**10**	**4.3**	**1.1**	**8.1**	**11.9**	**7.9**	**5.9**
TOTAL EXOTICS	**34**	**24**	**41**	**43**	**44**	**54**	**16.2**	**13.3**	**19.5**	**26.9**	**26.7**	**32.0**

APPENDIX 3

Cumulative Central Quadrat Data

Central quadrat data		2006	2007	2009	2011	2013	2014	2015
		Rowell	Rowell	Rowell	Rowell	Umwelt	Umwelt	Umwelt
Cover Abundance Key:	**Date**	**14 Jan 2007**	**9 Nov 2007**	**8 Jan 2010**	**4 Jan 2012**	**19 Nov 2013**	**18 Nov 2014**	**22 Oct 2015**
r: <5% and solitary (1-3 plants)*	**Easting (WGS 84)**	centre of	693832	693832	693832	693832	693832	693832
+: <5% and few (4-15 plants)*	**Northing**	site	6090303	6090303	6090303	6090303	6090303	6090303
1: <5%, common (>15 plants)	**Bare ground (CA)**	2	3	2	1	1	2	2
2: 5-25%	**Litter (CA)**	2	3	1	2	2	1	1
3: 25-50%	**Cryptogams (CA)**	1	2	1	+	+	+	
4: 50-75%	**Biomass removal**			unmown				
5: 75-100%								
*combined in 2006 survey								
Native grasses								
Anthosachne scabra	Wheatgrass	r/+	+	+		r	1	1
Austrostipa bigeniculata	Tall Speargrass	2	3	3	4	3	4	4
Austrostipa scabra	Rough Speargrass		+					
Bothriochloa macra	Redleg Grass	2	2	2	2	3	3	3
Eragrostis trachycarpa	A Lovegrass			1	r			
Panicum effusum	Hairy Panic Grass	r/+	1	1	1	+	+	
Rytidosperma auriculatum	Lobed Wallaby Grass		1	1	+	+	+	
Rytidosperma caespitosum	Ringed Wallaby Grass			+				
Rytidosperma carphoides	Short Wallaby Grass	2	1	1		+	+	2
Rytidosperma laeve	Smooth Wallaby Grass	1		1	1	1	1	
Rytidosperma spp.	Wallaby Grasses		+					2
Themeda triandra	Kangaroo Grass	r/+				r	r	2
Native forbs								
Bulbine bulbosa	Golden Lily		r	+	r	+	r	1
Convolvulus angustissimus	Australian Bindweed		+	r	+	+	1	1
Wahlenbergia communis	Tufted Bluebell	1	1	1	+	+	+	1
Calocephalus citreus	Lemon Beauty Heads	r/+	1	1	1	1	1	2
Cheilanthes sieberi	Rock Fern		1	+	1	1	1	2
Chrysocephalum apiculatum	Yellow Buttons	2	2	2	2	1	1	2
Goodenia pinnatifida	Scrambled Eggs	r/+	2	1	1	1	1	2
Lomandra bracteata	A Matrush		1	1	1	+	+	2
Pimelea curviflora	Curved Rice-flower	r/+	1		+	1	+	2
Tricoryne elatior	Yellow Rush Lily	1	1	r	1	r	+	2
Triptilodiscus pygmaeus	Austral Sunray				r			2
Wahlenbergia luteola	A Bluebell	1	+	r	r	r	r	2
Crassula sieberiana	Australian Stonecrop			r			+	
Eryngium ovinum	Blue Devil	r/+	r	r	r	r	+	
Euchiton gymnocephalus	A Cudweed			+				
Euchiton sphaericus	A Cudweed				r			
Hypericum gramineum	Small St John's Wort				r			
Lomandra filiformis	A Matrush	r/+						
***Lomandra* sp.**	A Matrush	1	1					
Oxalis perennans	Soursob				+	+	+	
Schoenus apogon						+		
Senecio quadridentatus	Cotton Fireweed		r		r			
Stackhousia monogyna						1	1	
Floristic Value Score (FVS)	Rehwinkel (2007)	**-**	**20**	**16**	**21**	**22**	**22**	
Exotic grasses								
Aira elegantissima	A Hairgrass		1					
Aira sp.	A Hairgrass			1		1	1	2
Avena sp.	Wild Oats		+		+	1	1	
Briza maxima	Blowfly Grass		1	r		1	1	2
Briza minor	Shivery Grass		1		r	1	+	1
Bromus hordeaceus	A Brome Grass		+	r	r	1	1	
Dactylis glomerata	Cocksfoot			r	+	+	1	2
Holcus lanatus	Yorkshire Fog							1
Nassella neesiana	Chilean Needlegrass					+		
Paspalum dilatatum	Paspalum			r				
Vulpia sp.	Rat's-tail Fescue	r/+	1	1	+	1	1	2
Exotic forbs								
Centaurium erythraea	Pink Stars			+	1	+	1	2
Conyza bonariensis	Flax-leaf Fleabane				1			
Echium plantagineum	Paterson's Curse		r					
Gamochaeta purpurea	A Cudweed	r/+	+		1	1	r	
Hypericum perforatum	St John's Wort	r/+	r	r	1	1	1	2
Hypochaeris glabra	Smooth Catsear		1			1	r	
Hypochaeris radicata	Catsear	1	2	1	1	1	1	2
Lactuca serriola	Prickly Lettuce	r/+		r			+	
Parentucellia latifolia	Red Bartsia						1	2
Petrorhagia nanteulii	Proliferous Pink				r	+		2
Plantago lanceolata	Ribwort Plantain	1	1	1	1	2	1	2
Romulea rosea	Onion Grass		+					
Tragopogon porrifolius	Salsify	r/+						
Triflium dubium	Yellow Suckling Clover							1
Trifolium arvense	Haresfoot Clover						+	
Trifolium campestre	Hop Clover		+	r	r		1	
Trifolium glomeratum	Clustered Clover						1	
Indicator 1 (Rehwinkel 2007)								
Indicator 2 (Rehwinkel 2007)								

APPENDIX 4

Summary of Mark-Release-Recapture Results for Male Golden Sun Moths for all Surveys

Year (period of captures)		**1992** (69 days)	**1993** (48 days)	**1994** (45 days)	**2006** (27 days)	**2011** (6 days)
Number of individuals captured		317	321	375	398	94
Total captures		354	389	419	423	35
Recaptures after	1 day	25	54	30	21	After 1 session: 23 After 2 sessions: 15
	2 days	8	8	10	4	After 3 sessions: 5
	3 days	2	2	2	0	
	4 days	1	1	1	0	
	5 days	1	0	0	0	
Estimated total male population during period of captures: Fisher-Ford method MARK method JOLLY method		**524**	**456**	**736**	**440** **1230**	**Daily population est.:** 1^{st} primary session: **66** (57-85) 2^{nd} primary session: **49** (39-75) 3^{rd} primary session: **12*** (* minimum number alive)

(Source: Rowell, 2012)

APPENDIX 5

Photographic Record of Site

Photo 1 (Transect 1, facing south)

Photo 2 (Transect 2, facing south)

Photo 3 (Transect 1, facing north)

Photo 4 (Transect 2, facing north)

Photo 5 (Quadrat)

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Golden Sun Moth Ecological Surveys
Prepared for the Department of Finance
April 2018
Canberra

umwelt

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Quality outcomes

Australian Government
Department of Finance

GOLDEN SUN MOTH ECOLOGICAL SURVEYS

Blocks 3 and 15, Section 22, Barton ACT
Rural Block 48, Hall ACT
Lot 1, Wallaroo Road, NSW

FINAL

April 2018

Australian Government
Department of Finance

GOLDEN SUN MOTH ECOLOGICAL SURVEYS

Blocks 3 and 15, Section 22, Barton ACT
Rural Block 48, Hall ACT
Lot 1, Wallaroo Road, NSW

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
The Department of Finance

Project Director:	Naomi Buchhorn
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Report No.	8144/R01/V3
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Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	**Date**	**Name**	**Date**
Final	Naomi Buchhorn	6/04/2018	Naomi Buchhorn	6/04/2018

Executive Summary

The Commonwealth Department of Finance (Finance) is proposing to divest of Blocks 3 and 15, Section 22, Barton, Australian Capital Territory (ACT) 2600. Prior to sale, the land will be cleared resulting in a full impact to all environmental values currently present.

This action is currently subject to a referral submitted to the Commonwealth Department of the Environment and Energy (DoEE) under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act), referral reference EPBC 2017/8028.

Umwelt (Australia) Pty Ltd (Umwelt) has been engaged by Finance to undertake surveys of golden sun moth (*Synemon plana*) and an impact assessment for the proposed action, which will support the EPBC Referral as part of the Preliminary Documentation. This report supports the original impact assessment submitted with the Referral (Umwelt, 2017).

Known environmental values protected by the EPBC Act that are present within the Project Area include:

- Natural Temperate Grassland of the South Eastern Highlands (NTG), a critically endangered ecological community;
- golden sun moth (*Synemon plana*) (GSM), a critically endangered invertebrate species; and
- striped legless lizard (*Delma impar*) (SLL), a vulnerable reptile species.

Scope of Assessment

As part of the EPBC Referral process, DoEE has requested that Finance provide additional information on the surveys undertaken for GSM since 2007 to confirm the extent of GSM habitat that will be impacted by the proposed action.

This report provides the results of a desktop assessment and surveys targeting GSM which were undertaken in November and December 2017. Surveys were undertaken at the following locations:

- Barton study area: Blocks 3 and 15, Section 22, Barton, ACT; and the two (2) most south-eastern median strips of Sydney Avenue.
- Block 48 study area: Registered Rural Block 48, Hall, ACT.
- Lot 1 study area: Lot 1 in DP 1144979, Wallaroo Road, New South Wales.

Specifically, these surveys were undertaken in the following stages:

1. Desktop Review to identify the GSM surveys undertaken since 2007.
2. Targeted GSM surveys at the Project Area using transect counts of flying males methodology in accordance with GSM survey guidelines (DEWHA, 2009).
3. Surveys targeting female moths at Blocks 3 and 15, Section 22, Barton.

4. Habitat Assessment using a combination of 50 metre step-point transects and meandering survey methodology.

5. Assess the significance of the likely impacts of the proposed action with consideration of the following guidelines:

    a. EPBC Significant Impact Guidelines 1.1 (DSEWPaC, 2013); and

    b. GSM Significant Impact Guidelines (DEWHA, 2009).

Survey Results

GSM was confirmed to be present at all three study areas. The locations of GSM records at the Block 48 and Lot 1 study area were generally consistent with previous records. At the Barton study area, GSM were found to occupy a larger area than previously recorded within Block 3, and were confirmed to occur on Block 15 and within the Sydney Avenue median strips.

GSM habitat was identified based on consideration of the presence of feed species (ie. 'C3' grasses); previous GSM habitat mapping and/or flying records; and new GSM records. The following table summarises the extent of habitat

Habitat Quality	Barton Study Area (ha)	Block 48 Study Area (ha)	Lot 1 Study Area (ha)
Low	0.40	0	0
Moderate (Disturbed)	0.74	0	0
Moderate	0	0.45	0.64
High	0.32	4.35	0
Total	**1.46**	**4.8**	**0.64**

No female moths were identified during searches of the Barton study area.

Impact Assessment

The impact assessment completed for the original Referral (Umwelt, 2017) determined that impacts to 0.72 hectares of GSM habitat at the Barton study area would be significant, and therefore would require offsetting.

This survey determined that there is 1.46 hectares of GSM habitat present within the Barton study area; all of which would be impacted by the proposed action.

As this is a greater impact than originally included in the Referral, it is still regarded a significant impact. The Offset Strategy which will be prepared for the proposed action must compensate for the loss of 1.46 hectares of GSM habitat.

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Figures

Tables

1.0 Introduction

Umwelt Australia Pty Ltd (Umwelt) was commissioned by the Commonwealth Department of Finance (Finance) to undertake ecological surveys at properties with known ecological values. Previous ecological investigations of these properties have identified the following matters of national environmental significance (MNES), protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act):

- Natural Temperate Grassland of the South Eastern Highlands (NTG), a critically endangered ecological community;
- golden sun moth (*Synemon plana*) (GSM), a critically endangered invertebrate species; and
- striped legless lizard (*Delma impar*) (SLL), a vulnerable reptile species.

The results of these surveys will support a referral (EPBC 2017/8028) submitted by Finance seeking approval from the Commonwealth Department of the Environment and Energy (DoEE) for the proposed divestment of Block 3, Section 22, Barton, Australian Capital Territory (ACT).

1.1 Project Area

The Project Area consists of the following three (3) discrete study areas:

- 'Barton'(**Figure 1.1**): totalling 1.65 hectares, including the following areas:
    - Block 3, Section 22, Barton ACT 2600 (referred to as Block 3 herein), which is 1.15 hectares in size;
    - Block 15, Section 22, Barton ACT 2600 (referred to as Block 15 herein), 0.10 hectares; and
    - the two (2) most south-eastern median strips of Sydney Avenue, which are approximately 0.4 hectares in total.

  The Barton study area includes the York Park Conservation Area (0.51 hectares), which extends across the southern portion of Block 3 and Block 15.
- 'Block 48': Registered Rural Block 48, Wallaroo Road, Hall, ACT 2618 (**Figure 1.2**) (referred to as Block 48 herein). Block 48 is 57.95 hectares in size.
- 'Lot 1': Lot 1 in DP 1144979, Wallaroo Road, NSW 2618 (**Figure 1.2**) (referred to as Lot 1 herein). Lot 1 is approximately 108 hectares in size.

Barton is currently vacant land, located on the corner of Sydney Avenue and National Circuit within the highly developed suburb of Barton in Canberra, ACT. Surrounding land uses include accommodation (hotels), office space, residential (apartments), and major roads. Block 15 and the south-eastern portion of Block 3 are managed as an area called 'York Park Conservation Area', with the aim of maintaining the MNES values onsite. The York Park Conservation Area has been managed as a single vegetation unit, separately from the remainder of the Barton study area for some years.

The Sydney Avenue median strips have been included in the Barton study area as the referral process determined that it was likely that these areas support GSM and GSM habitat, and would be indirectly impacted by the proposed action (Umwelt, 2017).

Block 48 and Lot 1 are both Commonwealth land currently leased as rural holdings used primarily for cattle grazing. At the time of assessment, both sites had existing contractual clauses requiring the lessees to manage and maintain the existing MNES values present at both study areas. These properties have been included in surveys as potential offset sites for the Project.

1.2 Project Background

Finance proposes to divest Block 3 in a single, open market sale to a private purchaser for the purpose of development. The divestment may also include the adjacent Block 15, which is currently Territory land managed by the ACT Government. The proposal includes the clearing of both blocks prior to sale. Clearing will occur between exchange and completion of contracts for sale, prior to transfer.

Both Blocks 3 and 15 are 'designated land' under the *National Capital Plan 1990* (as amended), being land having 'special characteristics of the National Capital' (s. 1.2, *National Capital Plan 1990*). Block 3 is also National Land managed by Finance and therefore is not subject to Territory planning legislation.

Any development of Block 3 and 15 following divestment will be subject to the *National Capital Plan 1990* and approval from the National Capital Authority (NCA). In order to facilitate development of Block 3 and 15, the Proponent submitted a proposed amendment to the *National Capital Plan 1990*. This amendment, which allows for development of the land as a mixed use precinct, was supported by the Acting Minister for Local Government and Territories, Hon. Darren Chester on 5 December 2017; and was gazetted on 8 February 2018. The intended development is still subject to approval of the referral (EPBC 2017/8028) by DoEE.

Umwelt, on behalf of Finance, prepared and submitted a referral (EPBC 2017/8028) for the proposed action to DoEE on 25 August 2017. The proposed action was determined to be a controlled action under the EPBC Act on 11 October 2017, due to the likelihood of significant impacts to threatened species and communities, and as a Commonwealth action. As such, it would be assessed on preliminary documentation.

Following the referral determination, Finance received advice from DoEE on the requirements for the preliminary documentation. This advice identified five key information areas that required clarification in order for a complete assessment to be made. These were:

- **GSM**: additional information on the surveys undertaken for GSM since 2007 to substantiate the statement in the referral that GSM habitat in the impact area is equivalent to the area of NTG (ie. 0.32 hectares).

- **SLL**: confirm that SLL has been recorded at the site, and if so, provide an assessment of the importance of the population in accordance with relevant Commonwealth guidelines.

- **Scientific Heritage**: document any consultations held with the scientific community to date relating to the site's scientific heritage values. If required, conduct further consultation so that the specific scientific heritage values can be quantified and assessed against the Significant Impact Guidelines 1.2 (DSEWPaC, 2013); and mitigated.

- **Offset Strategy**: provide information on the proposed offset strategy; including an assessment of the strategy against the EPBC Act Environmental Offsets Policy (DoE, 2012).

- **Economic and Social Matters**: provide information on the relevant economic and social impacts of the proposed action, including consideration of costs and benefits across multiple scales as appropriate.

This document has been prepared to address the request for information regarding GSM. All other matters raised by DoEE will be addressed separately. In addition to providing clarification on the quantum of impact to GSM, this document will also provide a conclusion regarding the likelihood of a significant impact to GSM, and may inform any offset strategy and associated calculations if required.

The referral determination confirmed the outcome of the impact assessment submitted with the referral (Umwelt, 2017) that the impact to GSM is significant and will require offsetting under the EPBC Offset Policy (DoE, 2012). DoEE, as part of its preliminary documentation requirements, sought further clarification on the full extent of GSM habitat present at the impact site, including the surrounding Sydney Avenue median strips (i.e. Barton study area).

Additional surveys were also performed at Block 48 and Lot 1, to reconfirm the extent of GSM habitat present in these areas. This allows survey results for all three study areas to be compared and assessed for offset purposes in the future.

Legend

- Study Area
- York Park

FIGURE 1.1

Barton Study Area Locality Plan

Image Source: Environment and Planning Directorate, ACT Government (2016) and Google Earth (2015)

Legend

Study Area

State/Territory Boundary

FIGURE 1.2

Lot 1 and Block 48 Study Areas Locality Plan

File Name (A4): R01/8144_002.dgn
20180216 13.59

2.0 Method

2.1 Literature Review

A literature review was undertaken to determine the previous extent and quality of GSM habitat present in the Project Area. The results of the literature review allowed the GSM surveys and habitat assessments to be targeted to locations most likely to still provide habitat for GSM.

2.2 Golden Sun Moth Survey

GSM is an EPBC Act critically endangered species that is known to occur throughout the Project Area (see **Section 3.1**). It is a medium sized, day-flying moth that spends much of its lifecycle in the soil, feeding on the roots of 'C3' grasses (almost exclusively on wallaby grass (*Rytidosperma* spp.), spear grass (*Austrostipa* spp.), and Chilean needle grass (*Nassella neesiana*)) (DEWHA, 2009). GSM emerge in moth form, typically during mid-November to mid-December, with an individual living for up to four (4) days post emergence.

The start of the flying season for 2017 was identified in consultation with other ecologists and specialists working in the region. Surveys were not commenced until after the flying season had been confirmed across many similar sites nearby.

GSM surveys were undertaken in accordance with the Commonwealth survey guidelines for the species (DEWHA, 2009). These guidelines target times of highest male moth flying activity, so that the species is most easily detected. Surveys are required to be undertaken over a period of four (4) non-consecutive days during suitable climatic conditions.

The Commonwealth survey guidelines for GSM identify the following optimum survey conditions recommended for the species:

- a warm to hot day (above 20°C by 10.00);
- the warmest part the day (i.e. between 10.00 and 14.00);
- clear or mostly cloudless sky;
- still, or relatively still wind conditions during the survey period; and
- greater than two days since rain.

Transect surveys were undertaken at the Barton and Block 48 study areas on four (4) separate occasions during appropriate survey conditions. Two (2) separate transect surveys were undertaken during appropriate survey conditions at the Lot 1 study area.

Given the short window available for surveying, not all survey days met all recommended Commonwealth survey conditions (DEWHA, 2009). However, it unlikely that survey conditions affected the identification of GSM within the Project Area, as explained further in with the results in **Section 3.2**.

Transects were located in areas with known GSM populations as identified in literature review and referral survey events were staggered to increase the likelihood of detection given the short adult life span of GSM (1-4 days). **Figures 2.1 to 2.3** show the location of transects; which were spaced to avoid double counting of flying males and did not fall within 10 metres of the external property boundary to avoid edge effects.

Image Source: Environment and Planning Directorate, ACT Government (2016)
Data Source: Barton Habitat Umwelt (2016a)

0 25 50 100m
1:2 000

Legend

- Study Area
- York Park
- GSM Transects
- Known GSM Habitat Pre 2017 Surveys

FIGURE 2.1

GSM Survey Transects at Barton Study Area

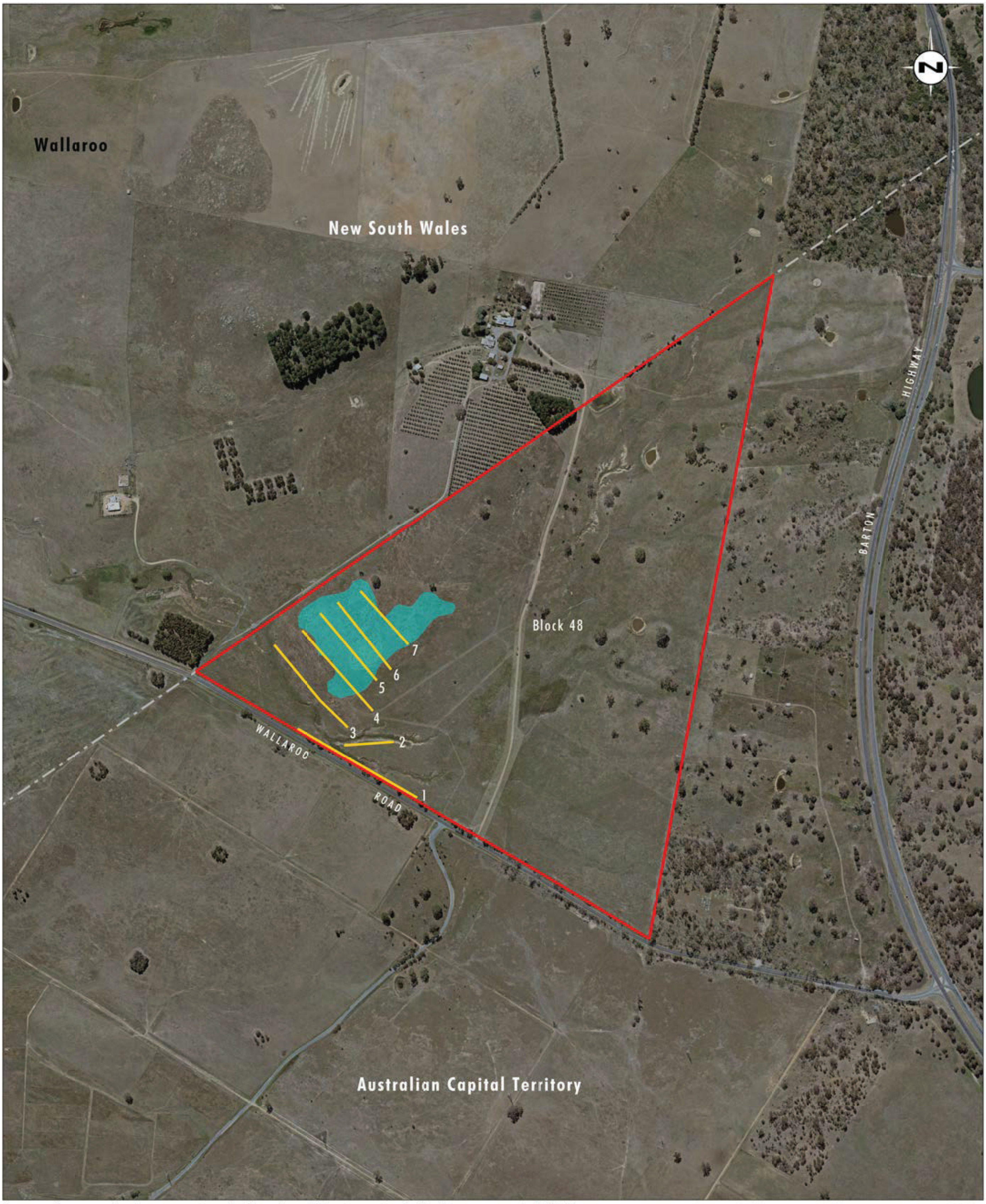

Image Source: Environment and Planning Directorate, ACT Government (2016)
Data Source: Block 48 Habitat Umwelt (2016b)

0 100 250 500m
1:10 000

Legend

- Study Area
- State/Territory Boundary
- GSM Transects
- Known GSM Habitat Pre 2017 Surveys

FIGURE 2.2

GSM Survey Transects at Block 48 Study Area

Image Source: Environment and Planning Directorate, ACT Government (2016)
Data Source: Lot 1 Habitat Umwelt (2016c and 2016f)

0 100 250 500m
1:10 000

Legend

- Study Area
- State/Territory Boundary
- GSM Transects
- Known GSM Habitat Pre 2017 Surveys

FIGURE 2.3

GSM Survey Transects at Lot 1 Study Area

2.3 Habitat Survey and Assessment

GSM habitat is primarily native temperate grasslands; however, GSM will also occur in grassy woodlands that contain feed species and exotic grasslands dominated by Chilean needle grass. For the purposes of this ecological assessment, GSM habitat was mapped according to dominant vegetation type and the presence of feed species (i.e. 'C3' grasses; namely wallaby grass, spear grass, and Chilean needle grass).
A combination of meandering surveys and step-point transects were used to determine the extent and quality of GSM habitat present across the Project Area.

The meandering survey consisted of walking the perimeter of each habitat type and recording the route taken in a GPS. Habitat type was determined by a visual assessment of each study area by a qualified ecologist. The results of the meandering survey were validated by step-point transects.

The step-point transect method assesses the relative abundance of plant species, and gives an indication of the dominant species, degree of weed invasion, and cover of bare ground (see Sharp *et al.* 2005). At every one (1) metre mark the observer notes any plant species, rock, bare ground, cryptogram, or litter that occurs at that point across all strata. Tussock size and the presence of thatch are also recorded as relevant. For plant species of note (e.g. GSM feed species or noxious weeds) these are specifically noted. All other plant species are noted to type (e.g. native forb). The location of step-point transects are shown in **Figures 2.4** to **2.6**.

In addition to validating broad habitat types defined by the meandering survey, the step-point transect results were used to quantify habitat quality. The following definitions (adapted from Rowell, 2013) were used to determine the habitat quality present within the Project Area:

- Low quality habitat:
  - exotic grasslands with a moderate amount of GSM feed species (including Chilean needle grass);
  - native grasslands dominated by kangaroo grass (*Themeda triandra*), with a moderate component of native GSM feed species on shallow, eroded soils; or
  - moderately dense mixed grassland, with a moderate component of GSM feed species.
- Moderate (Disturbed) quality habitat: exotic grassland dominated by Chilean needle grass.
- Moderate quality habitat: native grassland with low to moderate weed cover and a moderate cover of native GSM feed species.
- High quality habitat: dominated by native grasses, including a moderate component of wallaby grasses, moderate diversity of native forbs, and moderate bare ground (excluding rocky outcrops with shallow soil).

Sites dominated by Chilean needle grass have been shown to support high numbers of GSM, initially indicating high quality habitat for the species. However, due to the potential for fluctuations in biomass and the overall negative environmental impact of Chilean needle grass, such areas only constitute moderate quality habitat at best (Rowell, 2013).

Image Source: Environment and Planning Directorate, ACT Government (2016)

0 25 50 100m
1:2 000

Legend

- Study Area
- York Park
- GSM Habitat Transects

FIGURE 2.4

Barton Study Area GSM Habitat Transect Locations

File Name (A4): R01/8144_009.dgn
20180216 14.46

Image Source: Environment and Planning Directorate, ACT Government (2016)

0 100 250 500m
1:10 000

Legend
Study Area
State/Territory Boundary
GSM Habitat Transects

FIGURE 2.5

Block 48 Study Area
GSM Habitat Transect Locations

umwelt

Image Source: Environment and Planning Directorate, ACT Government (2016)

0 100 250 500m
1:10 000

Legend

- Study Area
- State/Territory Boundary
- GSM Habitat Transects

FIGURE 2.6

Lot 1 Study Area
GSM Habitat Transect Locations

3.0 Results

3.1 Literature Review

A large number of ecological surveys have been conducted across the Project Area. Many of these targeted GSM and NTG, and included ongoing monitoring, vegetation management plans, and population studies.

A GSM Maintenance Plan was prepared by Parsons Brinckerhoff (2008) to provide a framework for ongoing best-practice management of the ecological values associated with the use of Blocks 3 and 15 (then Blocks 3 and 7, Section 22). The Maintenance Plan (Parsons Brinckerhoff, 2008) noted that approximately 0.5 hectares of GSM habitat occurred within the York Park Conservation Area. This was based on ACT Government data from the late 1990s and 2005. The GSM Maintenance Plan also established ongoing monitoring methodology for GSM and NTG which formed the basis of many of the surveys described below.

Barton Study Area:

- AHE (2005) 'ACT Action Plan 28'. The York Park Conservation Area is specifically identified in the ACT native lowland grassland action plan as containing NTG and GSM habitat. It is not clear where this data comes from or its age.

- Rowell (2007) 'Survey and Impact Assessment at Golden Sun Moth *Synemon plana* site, Blocks 3 and 7, Section 22 Barton (York Park)'. This survey was completed to support an understanding of the environmental factors for Block 3 and included capture-mark-release techniques to estimate the population size.

- Richter *et al* (2009) 'Community Monitoring of Golden Sun Moths in the Australian Capital Territory Region, 2008-2009'. This project was a pilot GSM monitoring program that surveyed a number of sites across the ACT and the surrounding region, including the York Park Conservation Area and Sydney Avenue median strips. Surveys were undertaken by community members supervised and trained by ecologists.

- Rowell (2012) 'Five (5)-year Monitoring Event for Golden Sun Moth'. The GSM Maintenance Plan for the York Park Conservation Area included five (5)-yearly population monitoring that utilised a capture-mark-release method (Parsons Brinckerhoff, 2008). This report provides the results of the 2011 surveys.

- Umwelt (2014) 'Natural Temperate Grassland Maintenance Plan Block 3 Section 22 Barton ACT'. An update to the Parsons Brinkerhoff (2008) Maintenance Plan for York Park Conservation Area only. Provided management recommendations to maintain the NTG and associated GSM values at the site.

- Umwelt (2015) 'Natural Temperate Grassland Condition Assessment and Golden Sun Moth Monitoring Event'. Provides the results of the 2014 monitoring event as recommended by Umwelt (2014). The monitoring targets GSM and NTG within York Park Conservation Area (as amended following the approval of the proposed development of Little National Hotel on the adjacent block (EPBC Referral 2012/6606)).

- SMEC (2016) 'Golden Sun Moth Monitoring 2015 York Park' and SMEC (2017) 'Golden Sun Moth Monitoring 2016 York Park Conservation Area'. GSM monitoring report for York Park Conservation Area only, prepared as a condition of approval under EBPC Referral 2012/6606. Monitoring includes a count of flying moths, pupae case survey, vegetation survey, and soil temperature monitoring.

- Umwelt (2016a) 'Golden Sun Moth and Natural Temperate Grassland Vegetation Management Plan Block 3, Section 22, Barton ACT'. Provides the results of the 2015 monitoring event as recommended by Umwelt (2014). The monitoring targeted GSM and NTG within the York Park Conservation Area.

Block 48 and Lot 1 Study Areas:

- Robert Jessop (2014a) 'Block 48 Wallaroo Road Golden Sun Moth Survey 2013' and Robert Jessop (2014b) 'Lots 1 and 2 Wallaroo Road Golden Sun Moth Survey 2013'. GSM surveys used to inform the relevant Kellogg Brown & Root reports (2014a; 2014b). Results were provided in terms of GSM numbers observed rather than habitat area.

- Umwelt (2016b) 'Vegetation Management Plan Block 48 Wallaroo Road' and Umwelt (2016c) 'Vegetation Management Plan Lot 1 Wallaroo Road'. Both reports prepared and updated as part of Finance's due diligence as a Commonwealth Department that manages land with MNES values present. These reports updated Kellogg Brown & Root (2014a; 2014b) Vegetation Management Plan respectively. MNES identified at both blocks include GSM and NTG. Block 48 has white box – yellow box – Blakely's red gum grassy woodland and derived native grassland (an EPBC critically endangered ecological community) recorded. Lot 1 has the EPBC migratory species rainbow bee-eater (*Merops ornatus*) and the NSW listed White Box Yellow Box Blakely's Red Gum Woodland endangered ecological community.

- Vegetation monitoring has occurred on three occasions at both sites and were used to inform the relevant updates to the vegetation management plans (see below):

  - Kellogg Brown & Root (2013) 'Block 48 Vegetation Condition Assessment Report' and Kellogg Brown & Root (2014c) 'Lots 1 and 2 Wallaroo Road Vegetation Condition Assessment Report'.

  - Biosis (2015a) 'Block 48, Hall ACT – Year 1 Vegetation Condition Monitoring Report' and Biosis (2015b) 'Lots 1 & 2, Wallaroo Road – Year 1 Vegetation Condition Monitoring Report'. This provided baseline monitoring of vegetation at Block 48 and Lot 1 respectively.

  - Umwelt (2016d) 'Year 2/Baseline Vegetation Condition Monitoring Block 48 Wallaroo Road, Hall ACT' and Umwelt (2016e) 'Year 2/Baseline Vegetation Condition Monitoring Report Lot 1 Wallaroo Road, Hall NSW'. These reports provide the results of the Year 2 monitoring event for Block 48 and Lot 1 respectively and were used to inform the update to the relevant vegetation management plans (Umwelt 2016b; 2016c).

Past surveys demonstrate a decrease in availability of GSM habitat within York Park Conservation Area since 2013 (see **Table 3.1**). The primary reasons for this decrease in habitat are described as follows:

- EPBC approved impact, associated with EPBC Referral 2012/6606. This referral was for the construction of the Little National Hotel, which included a driveway off National Circuit. The driveway directly impacted upon approximately 0.21 hectares of NTG in the north of York Park Conservation Area.

- Weed incursion has also been recorded (Umwelt, 2014; 2015; 2016a), primarily through the southern portion of Block 3. This weed incursion has been exotic perennial grass species: cocksfoot (*Dactylis glomerata*), and phalaris (*Phalaris aquatica*). Due to small width of the weed incursion, male moths were observed flying over this area, however, neither of these species are C3 grasses, therefore do not form habitat for GSM (Umwelt, 2016a).

- Upgrades to the footpath adjacent to National Circuit disturbed the grassland of York Park Conservation Area. This area was re-planted with native kangaroo grass, which is not a GSM feed species, therefore these works also reduced the area of GSM habitat present within York Park Conservation Area (Umwelt, 2016a).

During the preparation of the referral in 2017, an Umwelt ecologist re-visited York Park Conservation Area, and confirmed the extent of GSM habitat was 0.32 hectares as previously reported (Referral 2017/8028). It was also noted at this time, that the ACT Government (2015) had mapped the two south-eastern median strips of Sydney Avenue as being GSM habitat. These areas had not been surveyed since 2006, when they were confirmed as habitat (Rowell, 2009).

The referral (2017/8028) assessed the impact to GSM based on the following habitat areas:

- 0.32 hectares within the York Park Conservation Area, consisting of high quality habitat within NTG; and

- 0.4 hectares across the entirety of both median strips, of unknown quality.

Table 3.1 GSM Habitat within Each Study Area Identified in Literature Review

Study Area	Prior to 2005^	2006	2008	2011	2013	2014	2015	2016
Barton - York Park Conservation Area	0.4ha (AHE, 2005)	0.56ha (Rowell, 2007)	0.56ha (Parsons Brinckerhoff, 2008)	0.56ha (Rowell, 2012)	0.56ha (Umwelt, 2014)	0.34ha (Umwelt, 2015)	0.32ha (Umwelt, 2016a)	0.32ha (Umwelt, 2017)
Barton - Remaining Area*	No data	Not considered to be GSM habitat (Rowell, 2007)	No data	No data	No data	No data	No data	No data
Barton - Median Strips	No data	Potential habitat if rehabilitated (Rowell, 2007)	GSM recorded (Richter *et al*, 2009)	No data	No data	No data	No data	0.4ha assumed habitat (Umwelt, 2017)
Block 48	No data	No data	No data	No data	7.08ha (Robert Jessop, 2014a)	Similar to 2013 extent mapped by Robert Jessop (2014a) (Rowell, 2015)	3.06ha (Umwelt, 2016b)	No data
Lot 1	No data	No data	No data	15.7ha (Parsons Brinckerhoff, 2010)	4.47ha (Robert Jessop, 2014b)	Similar to 2013 extent mapped by Robert Jessop (2014b) (Rowell, 2015)	0.65ha (Umwelt, 2016c)	No data

*Remaining Area = Block 3 that is not part of York Park Conservation Area.
^Note: actual date of survey data unknown.

3.2 Golden Sun Moth Survey Results

All surveys of the Project Area were undertaken between November and December 2017 at the locations shown in **Figures 2.1** to **2.3**. The specific days and times of the surveys are provided in the tables in the following sections.

Consultation with other ACT specialists (including ACT and NSW Government ecologists and consultants) was undertaken to ensure that the local GSM flying season had begun, prior to the surveys being undertaken. Preliminary advice from these discussions show an early November 2017 start to the flying season; with the end around 23 December 2017 at most sites. Low numbers of flying males were recorded into mid-January 2018, however these observations are considered to occur outside of the peak (i.e. optimal) survey time.

It is a limitation of these surveys that the exact EPBC survey conditions were not optimally met for each survey day. Conditions at the start of November and again in December were cooler than average, with most days not meeting the 20 degrees Celsius by 10am requirement. Notwithstanding the prevailing weather conditions, GSM were known to be flying at other sites in the Canberra area.

The flying season was also marked by regular showers, with significant rainfall during the first week of December (Weather Zone, 2018). On days when optimal conditions could not be met, days that were sunny with light winds were favoured over warmer temperatures and higher winds. It is not considered likely that the survey conditions affected the identification of GSM within the Barton or Block 48 study areas given they were recorded in areas where they were previously unidentified (see **Section 3.2.1**).

In late November 2017, Lot 1 was added to the Project Area. Accordingly it was not possible to complete the minimum survey effort (four times) before GSM stopped flying for the season. Information from previous years' was used to substantiate any conclusions regarding this study area.

3.2.1 Barton Study Area

The GSM survey results for the Barton study area, including the climatic conditions at the time of the survey, are provided in **Table 3.2**.

Of note, GSM were confirmed to be flying at both Sydney Avenue median strips and throughout the north-western portion of Block 3. The number of moths recorded in and their extent throughout these areas indicate that it is likely that the moths observed emerged from these areas, rather than flying over from the York Park Conservation Area.

The number of male GSM observed within the York Park Conservation Area was slightly higher than in previous years (Umwelt, 2016a), yet was generally consistent with expected results. Given the higher number of sightings within the York Park Conservation Area, this area still appears to support the core population for the Barton study area.

Temporal differentiation between the exotic dominated Block 3 (i.e. the portion outside of the York Park Conservation Area) and median strips was also observed, with moths seeming to emerge later in the season (see results from 13 December 2017) in these areas, when the numbers at the York Park Conservation Area were starting to decrease. In addition, moths recorded at York Park Conservation Area during this time were primarily flushed, whilst those in other areas were still free flying.

While undertaking GSM surveys along the median strips, males were observed to be flying over the next median strip west along Sydney Avenue.

Table 3.2 GSM Survey Conditions and Results – Barton Study Area

Survey Date and Time	Weather Conditions	Sightings of Males		
		York Park	Medians	Block 3
21 November 2017 12.10-12.56	10.00 Temperature: 18.4˚C. Days since rain: 2. Temperature: 22.5˚C – 23.5˚C; partly cloudy (3/8); low wind (7-24km/hr) east to east-nor-east. Meet recommended criteria? No.	72	6	7
24 November 2017 10.04-10.13	10.00 Temperature: 21.1˚C. Days since rain: 5. Temperature: 21˚C; cloudy (5/8); low wind (6-11km/hr) north-easterly. Meet recommended criteria? Yes.	0	0	13
28 November 2017 13.07-14.01	10.00 Temperature: 19.6˚C. Days since rain: 0. Temperature: 24˚C – 26˚C; partly cloudy (1/8 to 4/8); low wind (5-20km/hr) southerly to easterly. Meet recommended criteria? No.	47	7	7
13 December 2017 10.58-11.30	10.00 Temperature: 21.8˚C. Days since rain: 4. Temperature: 27.4˚C – 28.4˚C; sunny (0/8); low wind but gusty towards the end (9-26km/hr), northerly to north-nor-westerly. Meet recommended criteria? Yes.	10	11	37
Total Sightings		**129**	**24**	**64**

The recommended survey conditions were met on two (2) of the four (4) survey efforts for the Barton study area (see **Table 3.2**). As the temperature was not above 20 degrees Celsius at 10.00 on 21 and 28 November 2017, these survey efforts did not meet the recommended survey conditions. However, as conditions during the actual survey periods were met and moths were recorded throughout the Barton study area, this discrepancy is not considered to impact the survey results on this day. Rain was also recorded within the Canberra region on 27 November 2017, meaning that the survey conducted on 28 November 2017 did not occur more than two (2) days after rainfall. Very little of this rainfall occurred at the Barton study area and the soil was dry during the surveys; the localised rainfall event is not considered to have affected the survey results on this day.

A search for females was also undertaken at the Barton study area on 28 November 2017, between 14.27 and 15.15. No females were recorded. Records of female moths are used to confirm the presence of GSM habitat (opposed to grassland which males happen to be flying over); however, given the number of male moths recorded during this survey, the lack of female records is not considered to preclude the Sydney Avenue median strips or areas of Block 3 outside of the York Park Conservation Area being identified as GSM habitat.

3.2.2 Block 48 Study Area

The GSM survey results for the Block 48 study area, including the climatic conditions at the time of the survey, are shown in **Table 3.3**.

GSM was not recorded in any new areas, with activity primarily occurring within the NTG and derived box gum woodland in the south-west. Low numbers of moths were recorded within the NTG patches along the drainage lines. These results are primarily consistent with previous survey results (Umwelt, 2016b).

Table 3.3 GSM Survey Conditions and Results – Block 48 Study Area

Survey Date and Time	Weather Conditions	Sightings of Males
22 November 2017 11.23-11.55	10.00 Temperature: 17.1˚C. Days since rain: 3. Temperature: 21˚C-22˚C; partial cloud (1/8); light wind (7-17km/hr) northerly. Meet recommended criteria? No.	126
23 November 2017 13.17-14.09	10.00 Temperature: 21.1˚C. Days since rain: 4. Temperature: 25.5˚C; light cloud (1/8); moderate wind (20-26km/hr) north-westerly. Meet recommended criteria? No.	37
29 November 2017 13.35-13.59	10.00 Temperature: 21.8˚C. Days since rain: 1. Temperature: 27˚C; partly cloudy (2/8); light wind (8-15km/hr) east-sou-easterly. Meet recommended criteria? No.	8
13 December 2017 12.12-13.11	10.00 Temperature: 21.8 ˚C. Days since rain: 4. Temperature: 29.7˚C – 30.4˚C; sunny (0/8); moderate to high wind (24-39km/hr), north-westerly. Meet recommended criteria? No.	20
Total Sightings		**191**

Given its ridgetop location, Block 48 typically experiences greater wind speeds than surrounding areas, yet GSM have been known to fly during these conditions at this site. While wind speeds on 23 November 2017 and 13 December 2017 exceeded the recommended 'calm' conditions for survey; they are not considered abnormal for the study area. To compensate for any impacts the wind speed may have had on detection, transects were walked at a slower pace. It is therefore considered that the survey conditions were appropriate for GSM survey on these dates.

As the temperature was not above 20 degrees Celsius at 10:00 on 22 November 2017, this survey effort did not meet the recommended survey conditions. However, as conditions during the actual survey periods were met and the highest number of moths was recorded, it would appear that this discrepancy has not impacted the survey results on this day. Rain was also recorded within the Canberra region on 27 November 2017, meaning that the survey conducted on 29 November 2017 did not occur more than two days after rainfall. Very little of this rainfall occurred at the Block 48 study area and the soil was dry once surveys were undertaken; this discrepancy is also not considered to affect the survey results on this day.

3.2.3 Lot 1 Study Area

Lot 1 was added as a study area later in the Project, based on the preliminary results from the Barton study area. As such, Lot 1 was only surveyed on two (2) occasions, rather than the preferred four (4) efforts. This is a limitation of this survey, as such, should be considered in conjunction with recent survey results from previous years. The GSM survey results for the Lot 1 study area, including the climatic conditions at the time of the survey, are shown in **Table 3.4**.

Table 3.4 GSM Survey Conditions and Results – Lot 1 Study Area

Survey Date and Time	Weather Conditions	Sightings of Males
22 November 2017 13.02-13.04	10.00 Temperature: 17.1˚C. Days since rain: 3. Temperature: 23.5˚C; light cloud (1/8); light wind (11-24km/hr) northerly. Meet recommended criteria? No.	7
14 December 2017 10.10-13.25	10.00 Temperature: 27.4˚C. Days since rain: 5. Temperature: 26.7˚C – 30.7˚C; clearing cloud (6/8 – 1/8); moderate to high wind (22-39km/hr) north-westerly. Meet recommended criteria? No.	0
	Total Sighting	**7**

As the temperature was not above 20 degrees Celsius at 10:00 on 22 November 2017, this survey effort did not meet the recommended survey conditions. However, as conditions during the actual survey periods were met and the highest number of moths was recorded, this discrepancy is not considered to impact the survey results on this day. Similar to the Block 48 study area, the Lot 1 study area experiences higher wind speeds than the urban Barton study area. As GSM is known to persist and be recorded at Lot 1 in these conditions, the wind speeds recorded on 14 December 2017 were considered appropriate for GSM survey on this date.

GSM was confirmed at within one (1) discrete patch of NTG in the Lot 1 study area. No other moths were observed during this survey.

The number of flying male moths recorded within this patch of habitat is consistent with results from Jessop (2014b). Previous records for Lot 1 have indicated that there are a number of other small, discrete patches of GSM habitat present throughout the site (Robert Jessop, 2014b n=6; Umwelt, 2016c n=1).

3.3 Habitat Survey and Assessment Results

3.3.1 Barton Study Area

Two (2) step-point transects were surveyed within the Barton study are; one (1) in the NTG and the other in the exotic grassland at the back of Block 3 (**Figure 2.4**). The results of the transect surveys are summarised in **Table 3.5**.

The NTG has greater structural diversity, demonstrated by the fair distribution of both small and large tussocks, and cover types. The NTG also has a high percentage (18.45%) of GSM feed species present, of which 16.07% was native spear grasses. Though not captured in the step-point transect wallaby grasses were also noted within the NTG. Bare ground was relatively low (1.19%), however thatch cover was quite high. It is not clear what effect this may have on GSM, especially whether females will utilise thatch for displaying purposes.

Conversely, the exotic grassland structure is dominated by large tussocks interspersed by bare ground. The amount of bare ground is not uniform across the back of Block 3; areas with a large amount of bare ground seem to have been affected by previous erosion and/or scarring from earth works. Other areas showed limited bare ground, dominated by large tussocks. Chilean needle grass cover was much higher in this area (5.37%), and was supplemented by the presence of some native GSM feed species, including wallaby grass (0.67%).

Table 3.5 Step-point Transect Results – Barton Study Area

Vegetation Type	NTG	Exotic Grassland
Large Tussock	2.98%	7.38%
Small Tussock	4.76%	3.36%
Thatch	14.29%	8.05%
Litter	0.60%	-
Bare Ground	1.19%	13.42%
Lichen/Moss	8.33%	0.67%
Exotic Annual Grass	19.65%	11.41%
Native Forb/Sedge/Rush	5.96%	4.03%
Exotic Forb/Other	7.74%	16.77%
Exotic Perennial Grass	4.17%	26.17%
Native Perennial Grass	30.35%	8.72%
Native GSM Feed Species	16.07%	2.68%
Exotic GSM Feed Species	2.38%	5.37%

No formal habitat transects were undertaken within the median strips. Observations from Umwelt ecologists during flora and GSM surveys noted the following:

- Dominated by exotic species, including Chilean needle-grass and a high number of exotic forb species (e.g. *Hirschfeldia incana* (hoary mustard), *Hypochaeris radicata* (cat's ear), and *Plantago* spp. (plantains)).
- Native species that were present were predominantly spear grass and wallaby grass.
- Moderate cover of bare ground.
- High disturbance – both median strips are accessed daily by pedestrians, and informal paths have been created though the western median strip. Both median strips appear to be mowed regularly.
- The planted trees along the perimeter of the median strips are unlikely to shade out GSM at present. As they get larger, they are likely to have a greater impact over time.

3.3.2 Block 48

Seven (7) step-point transects were surveyed at Block 48. The results of the transect surveys are summarised in **Table 3.6**.

Transect C was located in the primary patch of known GSM habitat at Block 48. This habitat chiefly contains small grass tussocks, interspersed with bare ground; with large tussocks, rock, lichen, and thatch having a moderate presence. There is a high percentage (21.37%) of GSM feed species, of which, 16.24% is wallaby grass.

Transect E was located partially within an area of potential GSM habitat, with all GSM feed species being identified at the western end of the transect. This transect generally showed a higher incidence of exotic annual weeds (38.92%), less structural diversity, and no native non-grass species.

GSM feed species were also recorded at Transects A and B in low numbers. As the cover of GSM feed species is less than 1% within Transect A it is not considered to constitute habitat for the species. It is unknown whether the 6.21% cover of GSM feed species at Transect B is sufficient to support the species.

No GSM feed species were recorded at transects D, F, and G.

Table 3.6 Step-point Transect Results – Block 48 Study Area

Vegetation Type	Transect A	Transect B	Transect C	Transect D	Transect E	Transect F	Transect G
Large Tussock	4.44%	5.59%	5.13%	4.44%	7.03%	4.79%	3.80%
Small Tussock	7.78%	4.97%	12.82%	6.67%	5.41%	11.38%	4.43%
Thatch	11.11%	10.56%	4.27%	12.22%	10.81%	8.98%	21.52%
Litter	-	-	1.71%	-	-	-	-
Bare Ground	3.33%	1.24%	8.55%	4.44%	3.24%	4.19%	1.27%
Rock	0.56%	3.11%	7.69%	-	-	-	-
Lichen/Moss	1.11%	8.07%	6.84%	-	0.54%	-	-
Exotic Annual Grass	36.67%	36.03%	8.55%	36.11%	38.92%	22.16%	10.13%
Native Forb/Sedge/Rush	1.11%	-	3.42%	-	-	1.20%	1.27%
Exotic Forb/Other	5.00%	11.8%	5.98%	9.45%	7.56%	11.38%	17.09%
Exotic Perennial Grass	13.89%	0.62%	-	6.11%	0.56%	10.78%	36.07%
Native Perennial Grass	15.01%	18%	35.05%	20.56%	25.94%	25.15%	4.43%
Native GSM Feed Species	0.56%	6.21%	21.37%	-	3.24%	-	-
Exotic GSM Feed Species	-	-	-	-	-	-	-

3.3.3 Lot 1 Study Area

Eight (8) step-point transects were surveyed at Lot 1 (results summarised in **Table 3.7**). Given the variation in GSM records and mapped habitat at the Lot 1 study area since 2011 (see **Section 3.1**), the habitat step-point transects were located within the largest patch of previously identified NTG (Umwelt, 2016c) where GSM had also been recorded. This area was considered to be most likely to contain GSM habitat during the meandering survey. No GSM feed species were recorded along Transects A, B, and H; all of which were dominated by kangaroo grass. These areas are not considered to be GSM habitat.

Transect F had the highest cover of GSM feed species (10.10%); with Transects C, D, E, and G all having low levels of GSM feed species. No GSM were recorded in these areas so it is unclear whether the cover of GSM feed species is high enough to support the species. For this reason, none of these areas have been mapped as GSM habitat as part of this survey (see **Section 3.4**).

Table 3.7 Step-point Transect Results – Lot 1 Study Area

Metric	Transect A	Transect B	Transect C	Transect D	Transect E	Transect F	Transect G	Transect H
Large Tussock	6.32%	10.93%	9.86%	4.49%	2.98%	1.01%	3.05%	5.19%
Small Tussock	1.72%	2.19%	-	2.56%	1.79%	4.04%	3.05%	3.90%
Thatch	10.92%	13.11%	21.83%	12.82%	23.81%	16.67%	17.26%	15.58%
Litter	-	-	-	-	2.98%	-	-	-
Bare Ground	2.30%	0.55%	1.41%	0.64%	-	-	0.51%	1.30%
Rock	6.32%	-	-	5.13%	0.60%	2.53%	2.03%	3.25%
Lichen/Moss	3.45%	0.55%	-	5.13%	2.98%	4.04%	3.55%	1.95%
Poisoned	0.57%	-	-	-	-	-	-	-
Exotic Annual Grass	32.76%	38.80%	33.80%	24.36%	44.05%	34.85%	43.15%	29.22%
Native Forb/Sedge/Rush	0.57%	2.19%	2.82%	4.49%	2.98%	4.04%	2.03%	6.49%
Exotic Forb/Other	13.22%	6.01%	9.15%	10.90%	1.79%	4.55%	2.54%	7.14%
Exotic Perennial Grass	0.57%	6.01%	-	-	-	2.02%	5.58%	-
Native Perennial Grass	21.26%	19.67%	21.13%	29.49%	16.07%	26.26%	17.26%	25.97%
Native GSM Feed Species	-	-	2.82%	1.28%	1.79%	10.10%	2.54%	-
Exotic GSM Feed Species	-	-	-	-	-	-	-	-

3.4 Overall Habitat Extent and Quality

GSM habitat throughout the Project Area was determined based on the observations of flying male moths and the presence of C3 grasses. The habitat quality was assessed using the criteria described in **Section 2.3**. **Table 3.8** summarises the extent and quality of GSM habitat identified throughout the Project Area.

Table 3.8 GSM Habitat Extent and Quality within the Project Area

Habitat Quality	Barton Study Area (ha)	Block 48 Study Area (ha)	Lot 1 Study Area (ha)	Total (ha)
Land Area	**1.65**	**57.95**	**108**	**167.6**
Low	0.40	0	0	0.40
Moderate (Disturbed)	0.74	0	0	0.86
Moderate	0	0.45	0.64	1.09
High	0.32	4.35	0	4.67
Total GSM Habitat	**1.46**	**4.8**	**0.64**	**7.02**

3.4.1 Barton Study Area

The Barton study area is 1.65 hectares in size, of which 1.46 hectares is mapped as GSM habitat (**Figure 3.1**).

The GSM habitat within the Barton study area occurs within three (3) vegetation types (as identified by meandering survey):

- natural temperate grassland, 0.32 hectares within the York Park Conservation Area;
- exotic grassland dominated by GSM feed species, totalling 0.74 hectares within Block 3 outside of the York Park Conservation Area); and
- exotic highly disturbed grassland of the Sydney Avenue median strips, totalling 0.4 hectares.

As the NTG is a native and structurally diverse grassland community, which contains moderate cover of wallaby and spear grasses and a diversity of native forbs, it is considered high quality GSM habitat (see **Figure 3.1**).

Exotic grassland within Block 3 (but outside of the York Park Conservation Area) is dominated by Chilean needle grass, has little structural diversity, yet supports a moderate number of GSM. It is assessed as moderate (disturbed) GSM habitat (see **Figure 3.1**).

The median strips are considered low quality habitat given the high cover of exotic forb species, disturbance posed by the regular use of the median strips and their management (see **Figure 3.1**).

This survey identified an additional 1.14 hectares of GSM habitat than previously mapped. The additional areas of habitat are associated with:

- Both of the Sydney Avenue median strips surveyed were confirmed to contain 0.4 hectares of low quality habitat, consistent with the observations made in 2007 (Richter et al, 2009).
- The portion of Block 3 that occurs outside of the York Park Conservation Area has also been confirmed as moderate (disturbed) GSM habitat by this study. This portion of Block 3 has not been previously

recorded as GSM habitat and was assessed as containing very few feed species (i.e. limited to scattered wallaby grasses) (Rowell, 2007). Since this time, it appears that Chilean needle grass has invaded and established to the point of dominance and GSM have been able to extend their habitat within Block 3.

3.4.2 Block 48 Study Area

Block 48 is 57.95 hectares, of which 4.80 hectares is considered GSM habitat (**Figure 3.2**). This is similar in extent to the habitat mapped by Umwelt (2016b).

The primary habitat area is located on a ridge-top and has demonstrated consistent records of flying GSM, over 20% cover of GSM feed species, and inter-tussock space for female display. For these reasons, this habitat is considered high quality (**Figure 3.2**).

Additional habitat has also been mapped along the creekline south of the primary, high quality habitat. While assessments along the habitat Transects F and G (both located in and near this area) did not identify any GSM feed species, GSM were recorded in the area (and the adjoining areas with similar vegetation) during targeted GSM survey. These observations were primarily closer to the edge of the creek, where exposed ground included wallaby grass that was not captured in the Habitat Transects. As this patch (and proximate patches of similar floristics) is dominated by kangaroo grass with limited GSM feed species, yet has records of GSM flying, it is considered moderate quality GSM habitat.

The extent of habitat mapped in this study (4.80 hectares) is larger than mapped in 2015 (3.06 hectares) (Umwelt, 2016b), however habitat is generally within the same location.

Conversely, habitat Transects A and B both identified GSM feed species in low numbers (see **Table 3.6**), however these areas have not been included as GSM habitat in this report. Robert Jessop (2014a) recorded GSM in this area, but they have not been identified since (Umwelt, 2016b). These areas should be considered as potential habitat for the species.

3.4.3 Lot 1 Study Area

Lot 1 is 108 hectares, of which 0.64 hectares has been mapped as GSM habitat (**Figure 3.3**).

GSM records and assessment of GSM habitat within Lot 1 have been patchy and highly variable since 2011 (see **Section 3.1**). The reasons for this are not well understood, however may be due to fluctuations in availability of preferred grasses over this time rather than survey effort. GSM feed species appear to be wide spread throughout the study area (identified in five (5) of eight (8) Habitat Transects, refer **Table 3.7**), however records of flying male moths have been within small, isolated areas (Umwelt, 2016c; Robert Jessop, 2014b). Given this trend and the limited survey undertaken as part of this study, 0.64 hectares of GSM habitat is considered a conservative calculation.

As discussed in **Section 2.3**, the Habitat Step-point Transects were located within the largest patch of previously identified NTG (Umwelt, 2016c) as it was considered to be most likely to contain GSM habitat during the meandering survey. Despite this, no moths were recorded in areas where habitat transect surveys were undertaken. In addition, habitat areas could not easily be delineated using old records of flying males (ie. from Umwelt, 2016c and Robert Jessop, 2014b) given the vegetation characteristics of the study area. As such, none of these areas were mapped as GSM habitat in this study; rather they should be considered potential habitat and surveyed again in future flying seasons. Based on previous mapping, a maximum of 4.47 hectares may be considered as potential GSM habitat.

The two (2) patches of habitat shown on **Figure 3.3** have been included as GSM have been consistently recorded in these areas (Umwelt, 2016c; Jessop, 2014b). As no detailed habitat survey was undertaken in these areas, vegetation mapping from Umwelt (2016c) has been relied upon to determine habitat quality.

The southern patch has been previously recorded as moderate quality NTG; while the northern patch is native pasture, dominate by spear grasses. Given the low numbers of moths, small patch size, and unknown cover of GSM feed species, they are considered to be moderate quality.

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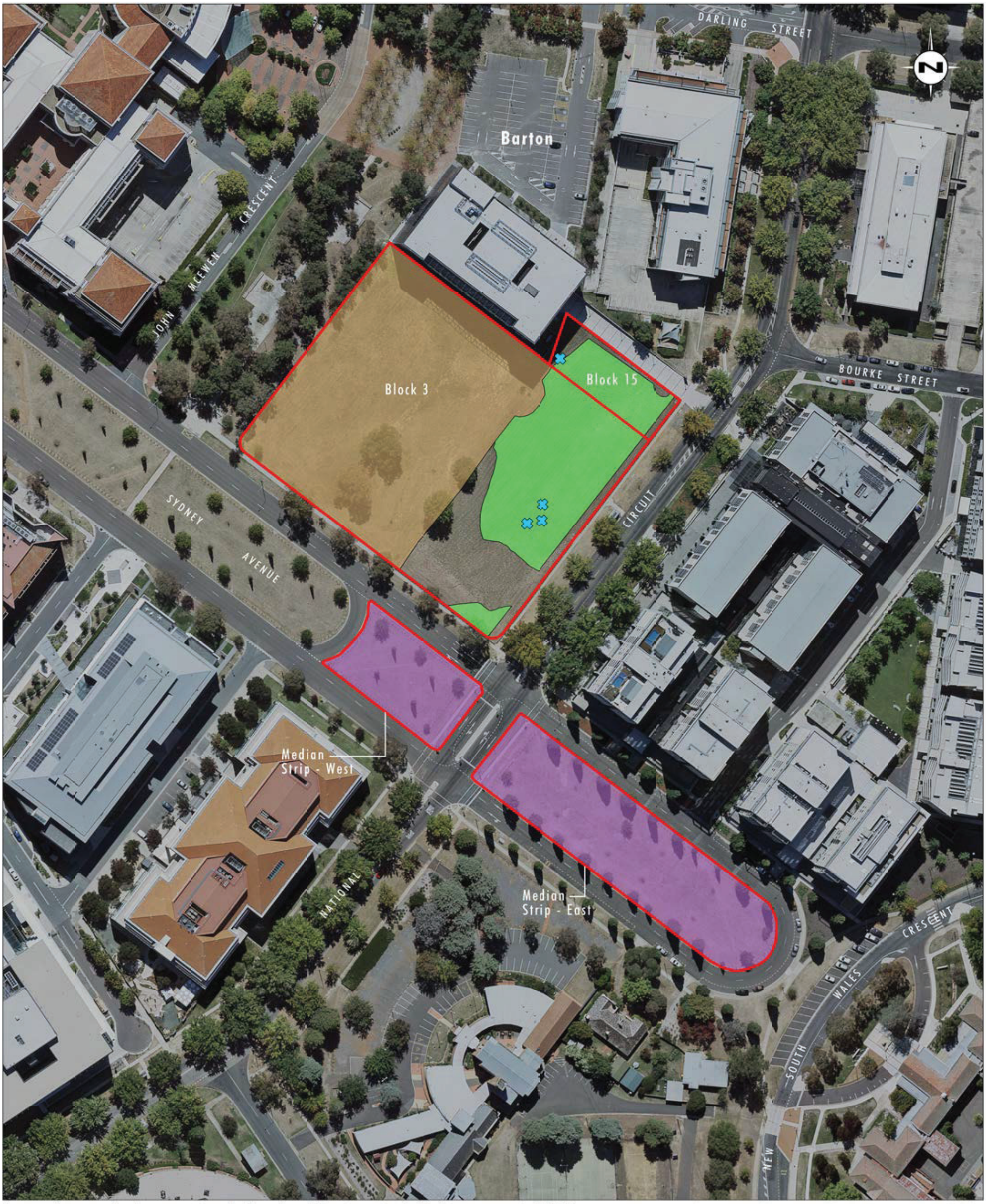

Image Source: Environment and Planning Directorate, ACT Government (2016)

0 25 50 100m
1:2 000

Legend

- Study Area
- High Quality GSM Habitat
- Moderate - Disturbed Quality GSM Habitat
- Low Quality GSM Habitat
- Female GSM Points

FIGURE 3.1

Barton Study Area GSM Habitat

Image Source: Environment and Planning Directorate, ACT Government (2016)

0 100 250 500m
1:10 000

Legend
Study Area
State/Territory Boundary
High Quality GSM Habitat
Moderate Quality GSM Habitat

FIGURE 3.2

Block 48 Study Area
GSM Habitat

Image Source: Environment and Planning Directorate, ACT Government (2016)

0 100 250 500m
1:10 000

Legend

- Study Area
- State/Territory Boundary
- Moderate Quality GSM Habitat

FIGURE 3.3

Lot 1 Study Area GSM Habitat

4.0 Impact Assessment

The EPBC Referral submitted for this Project assessed the impacts to GSM based on the direct loss of 0.32 hectares of high quality NTG habitat within the York Park Conservation Area and the indirect impact to a maximum of 0.4 hectares of unknown quality habitat on the Sydney Avenue median strips. The impact assessment submitted with the Referral determined that this impact (i.e. total loss of 0.72 hectares) is considered significant as the area is small (less than 10 hectares) and fragmented and the Commonwealth impact guidelines for GSM (DEWHA, 2009) stipulate that any loss of habitat in such circumstances is significant.

This study has identified 1.46hectares of GSM habitat within the Barton study area to be directly and/or indirectly impacted by the proposed action. For the same reasons applied in the Referral, this impact is a significant impact and the Project will include an Offset Strategy that compensates for this loss.

5.0 Conclusion

Umwelt undertook GSM surveys across three study areas to confirm the extent and quality of GSM habitat present. The conclusions of this report will be used to inform the Preliminary Documentation assessment of an EPBC Referral (2017/8028), submitted on behalf of Finance for the proposed divestment of Block 3, Section 22, Barton, ACT.

GSM were confirmed to be present at each of the three (3) study areas, occupying habitat of varying quality. The results of this survey supersede those of previous years' and those submitted with the Referral in 2017.

The extent of GSM habitat at the Barton study area identified during these surveys was greater than previously mapped due to the larger survey area (ie. many previous surveys targeted York Park Conservation Area only). While the area of GSM habitat within the York Park Conservation Area is unchanged, the findings of this survey are that the entire east and west median strips and the western portion of Block 3 provide habitat for GSM. The total impact area for the Project is now considered to be 1.46hectares.

Results for the proposed potential offset areas (Block 48 study area and Lot 1 study area) were generally consistent with previous years' records. A total of 4.80 hectares of GSM habitat was mapped at Block 48 study area, and 0.64 hectares at the Lot 1 study area.

Umwelt (2017) completed an impact assessment for the Project as part of the Referral. At the time, a total of 0.72 hectares of GSM habitat was known to occur within the Barton study area; all of which would be impacted by the Project. This impact was considered likely to be significant, when assessed against the relevant criteria (Umwelt, 2017); which was confirmed by DoEE in its determination of the Project as a Controlled Action. Given that the total of GSM habitat present within the Barton study area has now increased to 1.46 hectares, due to the increased study area, the findings of the initial assessment are unchanged and the Project is still considered to have a significant impact on the species.

The proposal to develop Block 3 and 15, must therefore include an offset strategy that compensates for the loss of 1.46 hectares of GSM habitat. The offset strategy should be prepared in accordance with the EPBC Offset Policy and be submitted as part of the Preliminary Documentation Package.

6.0 References

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SCIENTIFIC HERITAGE IMPACT ASSESSMENT

EPBC Referral 2017/8028
Blocks 3 and 15, Section 22 Barton
'York Park Conservation Area'

FINAL

June 2018

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EPBC Referral 2017/8028
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FINAL

Prepared by
Umwelt (Australia) Pty Limited
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Executive Summary

The Commonwealth Department of Finance (Finance) is proposing to divest Blocks 3 and 15, Section 22, Barton, Australian Capital Territory (ACT) 2600. Prior to sale, the land will be cleared, resulting in a full impact to all environmental values currently present.

As a Commonwealth agency, Finance must identify, assess, and manage any impacts of the proposed action on the environment, including heritage value. An assessment of the Indigenous, natural and historic heritage values of the Project Area was prepared in 2016 (ERM, 2016).

This action was Referred (2017/8028) to the Commonwealth Department of the Environment and Energy (DoEE) under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act) on 25 August 2017.

Umwelt (Australia) Pty Ltd (Umwelt) was engaged by Finance to provide further advice and assessment of the scientific heritage value of the Project Area (as it relates to natural heritage value), the significance of the impact of the proposed action on scientific heritage values, and potential mitigation and management options.

This report provides this advice to Finance and has been prepared to support the Preliminary Documentation (PD) to be submitted to DoEE for assessment of the proposed action.

Definition of Scientific Heritage Value

The Burra Charter (ICOMOS, 2013b) defines the basic principles and procedures to be followed in the assessment and management of heritage places in Australia. The 2013 Practice Note to the Burra Charter: 'Understanding and Assessing Cultural Significance' (ICOMOS, 2013a) provides a definition of scientific value of heritage places:

'Scientific value refers to the information content of a place and its ability to reveal more about an aspect of the past through examination or investigation of the place, including the use of archaeological techniques. The relative scientific value of a place is likely to depend on the importance of the information or data involved, on its rarity, quality or representativeness, and its potential to contribute further important information about the place itself or a type or class of place or to address important research questions.'

Heritage and Impact Assessment Scope

The presence, extent, and importance of scientific heritage value was assessed for the Project Area in consideration of:

- the results of a literature review of published research relating to golden sun moth (*Synemon plana*, GSM) and its grassland habitat;
- relevant Commonwealth and ACT guidelines; and
- consultation with representatives from the Australian National University (ANU), the University of Canberra (UC), and the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Based on the identification and description of the scientific heritage value of the Project Area, an impact assessment was undertaken. This was prepared in accordance with the Commonwealth Significant Impact Guidelines 1.2 for proposed actions on, or impacting upon, Commonwealth land, and actions by Commonwealth Agencies (DSEWPaC, 2013).

Results

The scientific heritage assessment concludes that the Project Area has local (i.e. ACT) scientific heritage significance when the perspectives of research stakeholders are taken into account. ACT heritage criteria (a) and (b) apply.

The Project Area is an example of an accessible place that illustrates the scientific community culture of Canberra. A combination of accessibility and tenure has facilitated early recognition and a long monitoring record of the GSM population at the Project Area. Other research work, while making a contribution to knowledge of the diversity and resilience of the species, has been sporadic. However, in combination, the record from the Project Area is rare and has been influential on subsequent GSM research.

Although the place meets local scientific heritage criteria, the impact assessment concludes that the impact of the proposed action is not considered to be significant for the following reasons:

- The heritage value of the Project Area is underpinned by the existing monitoring dataset for the scientific work that has been undertaken to date. This dataset will not be affected by the proposed action and will always be available as a resource for future research.

- The local heritage value of the Project Area is a 'snapshot in time'. It is unlikely that the rarity or influence of scientific work at the Project Area will continue into the future, regardless of whether the Project Area is cleared or developed. The local scientific heritage significance of the Project Area is expected to diminish over time because its condition, rarity, and influence will decline.

- A wide range of GSM grassland habitat sites are now known within the ACT, New South Wales and Victoria, including the proposed biodiversity Offset Area at Hall for the proposed action. These sites are in conservation management, and/or are more resilient than the Project Area, and are readily accessible to the scientific community (both academic researchers and citizen scientists) for the purposes of future observation, monitoring, or research.

- There is no commitment from the stakeholder institutions to continue research at the Project Area.

- Ongoing threats to the condition of the Project Area, associated with it being an isolated remnant of habitat within a developed urban context, means that despite relatively intensive management the value of the fabric of the site will decline over time.

There is opportunity in the short term for Finance to facilitate further data collection at the Project Area. This may include collection of material for modern genetic profiling studies before the Project Area is cleared and disposed of. The proposed management actions would optimise the potential data contribution of the Project Area; however would not affect the results of the impact assessment.

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1.0 Introduction

The Commonwealth Department of Finance (Finance) lodged a Referral (EPBC 2017/8028) to the Commonwealth Department of the Environment and Energy (DoEE) in August 2017 seeking approval for the proposed divestment of Block 3 and Block 15, Section 22, Barton in the Australian Capital Territory (ACT) 2600 (Block 3 and Block 15 respectively) (the proposed action).

On 11 October 2017, the proposed action was determined to be a 'controlled action' due to the likelihood of significant impacts to threatened species and communities, and as a Commonwealth action (i.e. undertaken by a Commonwealth Agency). As such, the proposed action is being assessed through Preliminary Documentation (PD). Subsequent to Notification of the Referral decision and assessment approach confirmation, Finance received advice from DoEE identifying the additional information requirements for the PD, including:

> **Scientific Heritage**: document any consultations held with the scientific community to date relating to the site's scientific heritage value. If required, conduct further consultation so that the specific scientific heritage value can be quantified and assessed against the Significant Impact Guidelines 1.2 (DSEWPaC, 2013) and mitigated.

Umwelt (Australia) Pty Limited (Umwelt) was commissioned by Finance to prepare this scientific heritage assessment and heritage impact assessment to support the PD for assessment of the controlled action. This report:

- documents consultation with the scientific community relating to scientific heritage value of the Project Area;
- quantifies and assesses the scientific heritage value of the Project Area;
- assesses the significance of the impact of the proposed action on scientific heritage value using the Significant Impact Guidelines 1.2 (DSEWPaC, 2013); and
- identifies potential avoidance, mitigation, and offsetting (if required) options relevant to the scientific heritage significance.

1.1 Project Area

The Project Area includes Block 3 (owned by the Commonwealth) and the adjacent Block 15 (owned by the ACT Government). The Project Area is located on the corner of Sydney Avenue and National Circuit within the highly developed suburb of Barton (see **Figure 1.1**), near Parliament House in Canberra. Block 15 and the south-eastern portion of Block 3 are known as 'York Park Conservation Area'.

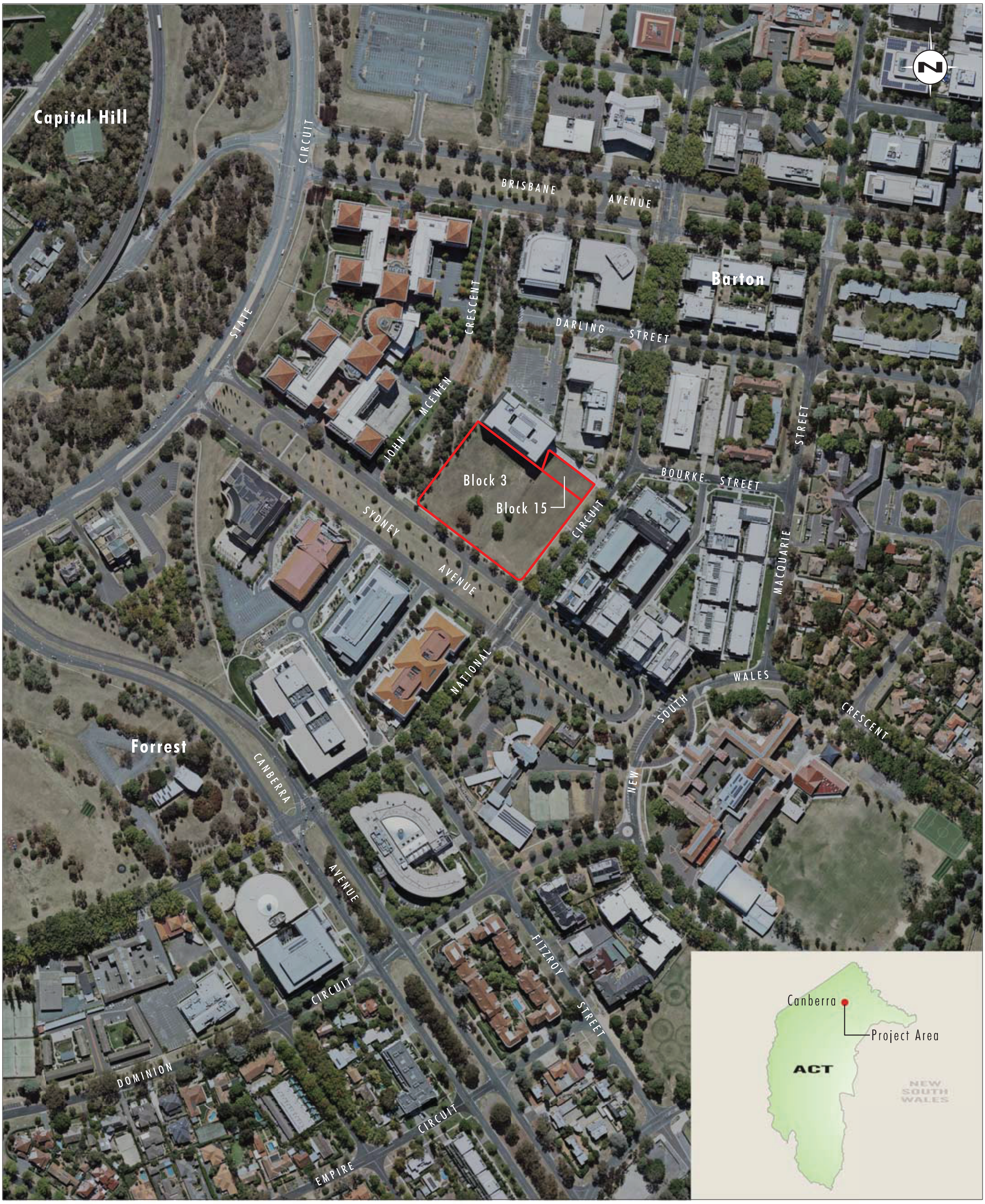

Image Source: Environment and Planning Directorate, ACT Government (2016)

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Legend
Project Area

FIGURE 1

Project Area Locality Plan

1.2 Previous Heritage Assessment of the Project Area

A heritage assessment of potential Indigenous, natural, and historic value was completed for Block 3 in April 2016 by Environmental Resources Management Australia (ERM) (2016). ERM (2016) note that Block 3 is not included in any Australian or ACT heritage list for its Indigenous, natural, or historic heritage value.

It is noted that Block 3 supports a population of golden sun moth (*Synemon plana*, GSM), a critically endangered invertebrate species protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act); and a critically endangered ecological community: Natural Temperate Grassland of the South Eastern Highlands (NTG). At the time, both values were understood to be located within the York Park Conservation Area .These ecological values contribute to the natural heritage value of Block 3 (ERM, 2016).

ERM (2016) present an evaluation of the natural heritage value of Block 3 against ACT and Australian heritage criteria, including a comparative analysis of these values with other places in the ACT. This assessment primarily considers the size, habitat quality, and level of protection available at other sites supporting GSM and NTG in the region; and the implications of alternative sites available for research that would add knowledge of value regarding an understanding the ACT's natural history.

ERM (2016) provide detailed explanatory notes to support their analysis, based on additional guidance that is provided in the ACT Heritage Assessment Policy (Australian Heritage Council, 2015). Tables 5.6 and 5.7 in ERM (2016) present the outcomes of the assessment against Australian (national) and local (ACT) criteria.

In relation to the Australian criteria, ERM (2016) found that none of the criteria are met. In particular, in relation to criterion (c), they comment:

> *The GSM population of the site has been the subject of past studies and is the subject of ongoing monitoring. These studies have the potential to reveal important information relating to the species' life cycles and habitat requirements. However, this is not considered to be a significant natural heritage value, as other places can yield the same kind of information* (p. 40, ERM, 2016).

Similarly, in relation to the ACT heritage assessment criteria, ERM (2016) found that criterion (c) is not met. The rationale for not meeting ACT Criterion (c) is summarised below (from ERM 2016, pp. B7 and ing):

- The GSM population and NTG remnant at Block 3 have provided significant scientific information in the past (e.g. as documented in Umwelt (2014)) and these studies have been conducted over 20 years or more. However, it is not likely that these various studies have occurred in York Park Conservation Area because it is the only or best available occurrence of these features, but perhaps due to convenience, being located in the national capital district of Canberra.

- The existence of a significant body of information about a site is not applicable to criterion (c), which is about future research potential that can provide substantial and important new knowledge.

- While Block 3 could provide further new knowledge, it is not the only relevant site; similar knowledge could be gained from a number of other urban and urban fringe sites (ERM (2016) lists a large variety of these, with information about land use, size, and ACT conservation category).

- The large number of GSM populations in publically accessible reserves in the ACT means that the value of Block 3 as a reference site is diminished. The ACT grassland strategy (ACT Government, 2005) reports that (at that time) the York Park population is not considered viable in the medium-long term (because of small-size and poor connectivity) and therefore its value as a reference site or for other research will further diminish.

In relation to ACT criterion (g), ERM (2016, p. B11) note that, although there have been multiple ecological studies at Block 3 over the last 20 years and the site likely holds social values for ecologists involved in those surveys (past and continuing), **an ordinary person would not be able to recognise that association**. In addition, ecologists, as a professional or special interest group, do not meet the definition of 'community' in the ACT Heritage Assessment Policy (ACT Heritage Council, 2015). They conclude that the threshold for ACT criterion (g) is not met.

ERM (2016) concluded that Block 3 does not meet thresholds for ACT or Australian heritage value relating to scientific heritage.

1.3 Why is Further Heritage Assessment Required?

As part of the request for additional information to support the PD, DoEE identified the potential for scientific heritage value to be associated with the York Park Conservation Area natural values. A general case for this potential was set out in the request for additional information. DoEE's comments and further requirements are provided in **Box 1.1**.

Box 1.1 – DoEE Additional Information Requirements regarding Scientific Heritage Assessment

'*Scientific heritage values of the York Park site have been described by Hogg (2012), who notes that these values relate to the fact that the GSM population at the site has been monitored periodically since the 1990s and has been subject to detailed population estimates. It is the most intensively studied GSM site in the ACT out of approximately 60 sites and hence it is of significant scientific importance in the context of this species.*

Rowell (2008) notes that the York Park GSM population is of scientific value due to its research history, and may suffer adverse impacts from development of the adjacent part of Block 3. Clarke (1998) also considers that this site warranted special attention due to its 'high profile and considerable research focus in past years'.

The heritage impact study (HIS) submitted to the Department as part of the referral acknowledges these scientific heritage values and references a previous consultant report (Umwelt 2014) that states that York Park has been subject to a large number of ecological studies, particularly for the GSM population, including long-term studies focusing on population dynamics and genetic studies for more than 20 years.

The Department considers that because apparently limited consultation with the scientific community has taken place during the preparation of the referral documentation, the scientific heritage values of the proposed action area may have been underestimated by the proponent. Values underestimated include the scientific heritage values associated with longitudinal survey data on basic biology, persistence on small sites, response to shading etc.'

The requirements acknowledge but question the conclusions presented by ERM (2016). Specifically, DoEE requires further evaluation of the scientific heritage values of the Project Area to take into account consultation with scientific community stakeholders.

This heritage assessment provides further information, analysis, and assessment of the scientific heritage significance of the Project Area, taking into account additional information from consultation with stakeholders, as required by DoEE.

It is assumed that, other aspects of heritage significance as assessed by ERM (2016) were addressed to the satisfaction of DoEE.

2.0 Assessment Method and Logic

This section provides an overview of the relevant definitions, step-by-step processes, and guidance that have been applied in this heritage assessment to evaluate the scientific heritage significance of the Project Area and the impact of the proposed action on identified scientific heritage values.

2.1 Defining Scientific Heritage Value

The EPBC Act defines heritage value as including '*the place's natural and cultural environment having aesthetic, historic, **scientific** or social significance, or other significance, for current and future generations of Australians*'.

Australian Government heritage guidelines do not provide detailed advice on the definition and interpretation of scientific heritage. However, the Burra Charter (ICOMOS, 2013b) provides best practice guidance on the theory and practice of cultural heritage management. It can be applied to all types of places of cultural significance; including natural, Indigenous, and historic places with cultural values.

The Burra Charter defines the basic principles and procedures to be followed in the assessment and management of heritage places in Australia. The 2013 'Practice Note to the Burra Charter: Understanding and Assessing Cultural Significance' (ICOMOS, 2013a) provides a definition of scientific value of heritage places:

> ***Scientific value** refers to the information content of a place and its ability to reveal more about an aspect of the past through examination or investigation of the place, including the use of archaeological techniques. The relative scientific value of a place is likely to depend on the **importance of the information or data involved, on its rarity, quality or representativeness, and its potential to contribute further important information about the place itself or a type or class of place or to address important research questions**. To appreciate scientific value, ask: Would further investigation of the place have the potential to reveal substantial new information and new understandings about people, places, **processes** or practices **which are not available from other sources**?"* (p. 3, ICOMOS, 2013a (emphasis added)).

The value may be associated with a particular researcher, field sites that are the basis for research, a laboratory, a piece of equipment, library, or a collection of records and reports. **The research value of a place may be supplemented in some cases by a social value to a 'community' of scientists or other interested parties**.

2.2 Assessing Heritage Significance

The Australian Heritage Council (AHC) is the Australian Government's independent, expert, advisory body on heritage matters. Its roles include:

- Promote the identification, assessment, conservation, and monitoring of heritage.
- Advise the Minister on various heritage matters, including the preparation and amendment of heritage strategies and management plans for Commonwealth areas and agencies.
- Prepare guidance on assessing places for the National Heritage List (NHL), identifying Commonwealth heritage values, and establishing a heritage register.

- Nominate and/or assess places for the NHL and Commonwealth Heritage List (CHL).

The AHC (2010) provides guidance about how to determine the level of significance of a place using criteria and thresholds. The Project Area is land owned or managed by a Commonwealth agency (Finance) therefore, the criteria for assessing Commonwealth heritage significance must be applied to the heritage assessment. These criteria are set out in section 10.03A of *Environment Protection and Biodiversity Conservation Regulation 2000* (EPBC Regulation) and are included in **Table 2.1**.

Additional considerations for the identification of heritage values of a place that is owned or controlled by a Commonwealth agency are also outlined in the EPBC Regulation. These considerations include:

- All natural and cultural heritage values, including recognising that Indigenous people are the primary source of information on the significance of their heritage and must be offered an opportunity to participate in identifying and assessing those values.

- Commonwealth heritage criteria.

- Expert advice on necessary levels of documentary and field research to provide the evidence for the assessment.

- Use of a comparative thematic approach. The degree of significance can only be considered by comparing the place to other, similar types of places. This approach therefore determines a place to be unique or 'more' or 'less' significant compared to other similar places. The degree of significance can also relate to the geographic area, for instance, the extent of a place's significance locally, regionally, nationally, or internationally.

- Consult widely, as appropriate with government agencies, stakeholders, and the community.

2.2.1 Thresholds for Heritage Significance

Threshold indicators may be used to help determine the relative significance of a heritage place (ICOMOS 2013b). The Department of the Environment, Water, Heritage and the Arts (2008) provides summary guidelines about thresholds for different levels of heritage listing.

- To reach the threshold for the NHL, a place must have **outstanding** heritage value to the Nation against one or more of the Commonwealth heritage criteria listed in **Table 2.1**.

- The threshold for inclusion on the CHL is that a place must have **significant** heritage value against one or more of the Commonwealth heritage criteria listed in **Table 2.1**.

> The thresholds are elaborated in '*Identifying Commonwealth Heritage Values and Establishing a Heritage Register – a Guideline for Commonwealth Agencies*' (AHC, 2010).
>
> **The threshold for inclusion on the CHL is defined further as a place being of local heritage significance** (p. 7, AHC, 2010). **That is, a place is considered to have Commonwealth heritage value (i.e. meet the 'significant heritage value' identified above) if it is assessed as having local heritage significance.**
>
> For the purpose of this assessment, the ACT heritage criteria are used to understand the scale of local heritage significance.

Local heritage places contribute to the individual character of a town or landscape, and are often related to the economic or natural history of a local area. The threshold is defined as a place being of importance or significance to the local community. In the ACT, local heritage is incorporated in the ACT heritage criteria and thresholds, as there is no local government as is the case in Australian states.

Therefore, to fully understand and assess the significance of the scientific heritage of the Project Area, both the Commonwealth and ACT heritage criteria have been applied. As appropriate, the criteria have been considered together with relevant threshold guidance.

A place meets the significance threshold for having Commonwealth heritage values if it meets one or more or the criteria in **Table 2.1** at an appropriate threshold level. This approach to assessment of the significance of a heritage place is consistent with the approach taken by ERM (2016) in the previous heritage assessment of Block 3.

Further information about the application of thresholds for local and Commonwealth heritage value is included in guidelines prepared for assessing places which may be of National heritage significance (AHC, 2009), Commonwealth heritage significance (AHC, 2010), or ACT heritage significance (ACT Heritage Council, 2018). Based on these relevant guidelines, detailed information about the interpretation and application of the heritage assessment framework at different levels of significance is provided in **Appendix 1**. This includes a comparative analysis and specific exclusions and inclusions in relation to the criteria and thresholds.

An assessment of the heritage significance of the Project Area against the framework provided by Commonwealth and ACT heritage criteria, thresholds, and guidance is provided in **Section 3.5.**

Table 2.1 Commonwealth and ACT Heritage Criteria

Commonwealth Heritage Criteria (s. 10.03A EPBC Regulation)	ACT Heritage Criteria (used as an indication of local significance)
(a) the place has significant heritage value because of the place's importance in the course, or pattern, of Australia's natural or cultural history (b) the place has significant heritage value because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history (c) the place has significant heritage value because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history (d) the place has significant heritage value because of the place's importance in demonstrating the principal characteristics of: (i) a class of Australia's natural or cultural places; or (ii) a class of Australia's natural or cultural environments (e) the place has significant heritage value because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group (f) the place has significant heritage value because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period (g) the place has significant heritage value because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons (h) the place has significant heritage value because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history (i) the place has significant heritage value because of the place's importance as part of Indigenous tradition	(a) Important to the course of the ACT's cultural or natural history (b) Has uncommon, rare or endangered aspects of the ACT's cultural or natural history (c) Potential to yield information that will contribute to an understanding of the ACT's natural or cultural history (d) Importance in demonstrating the principal characteristics of a class of cultural or natural places or objects (e) Importance in exhibiting particular aesthetic characteristics valued by the ACT community or a cultural group in the ACT (f) Importance in demonstrating a high degree of creative or technical achievement for a particular period (g) Has a strong or special association with the ACT community, a cultural group in the ACT for social, cultural or spiritual reasons

Note: the criteria that relate to scientific heritage value (as defined in the Burra Charter) are highlighted in blue. All other criteria are not considered relevant for the assessment of scientific heritage value. See **Section 3.1** for further discussion regarding the relevant criteria used in this heritage assessment.

2.3 Significant Impact Assessment Framework

The proposed action has been determined to be a Commonwealth Action (i.e. it is being undertaken by a Commonwealth Agency). Therefore, DoEE must consider potential impacts of the proposed action on the ‘environment’ (as defined under the EPBC Act).

To assist DoEE in this consideration, this report includes an assessment of the potential for a significant impact as a result of the proposed action to scientific heritage identified within the Project Area.

The Significant Impact Guidelines 1.2 (DSEWPaC, 2013) defines a significant impact ‘*as an impact that is notable or of consequence, having regard to its context and intensity’* (p.3). ‘Context’ includes the sensitivity, quality, and value of the environment and ‘intensity’ incorporates duration, magnitude, and spatial extent. A significant impact is considered likely if there is a real and not remote chance or possibility of it occurring (DSEWPaC, 2013).

An assessment of the significance of the impact to scientific heritage value as a result of the proposed action is provided in **Section 4.** The steps undertaken for this impact assessment are provided in **Figure 2.1**.

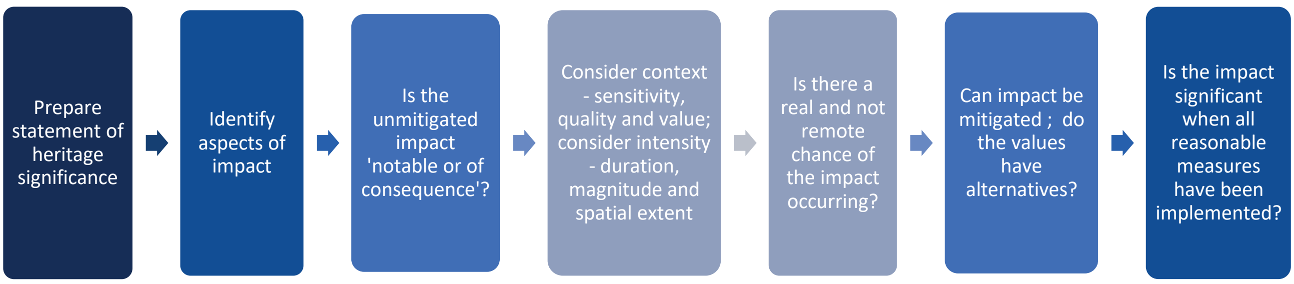

Figure 2.1 Heritage Impact Assessment Process

3.0 Scientific Heritage Assessment

This section presents the method, data, analysis, and results of the additional scientific heritage significance assessment required to assist DoEE in the assessment of the proposed action. Key considerations are summarised in **Figure 3.1**.

Figure 3.1 Key Heritage Assessment Considerations

3.1 Relevant Scientific Heritage Assessment Criteria

A heritage assessment would normally consider all of the Commonwealth heritage criteria. In this case, a broad heritage assessment of the Project Area has been completed (see **Section 1.2**). This section therefore only considers the heritage criteria identified in **Table 2.1** as relevant to scientific heritage.

The most relevant criterion for scientific heritage significance, based on the definition in the Burra Charter, is Commonwealth criterion (c):

> *The place has significant heritage value because of the place's potential to yield information that will contribute to an understanding of* ***Australia's natural or cultural history****.*

To understand the importance of scale in the assessment, the ACT government criterion (c) is also considered:

> *The place has potential to yield information that will contribute to an understanding of* ***the ACT's cultural or natural history****.*

Commonwealth criteria (a) and (b) are also considered as they rely on similar types of evidence from the fabric of the place and documentary sources.

The ACT criterion (a) is considered in the sense that the place shows the continuity of an important species, in a way that may be rare and distinctive. The ACT criterion (b) is considered, not with respect to the presence of GSM, but because of the potential for the place to have made a '*strong, noticeable or influential contribution to the ACT's environment*'.

Because scientific heritage significance may also derive from association with particular field sites or a 'community' of scientists (or citizen scientists) Commonwealth criteria (g) and (h) and ACT criterion (g) are also considered.

3.2 Assessment Context – Contributory Research Themes

To understand the scientific context of the work undertaken at or relating to the Project Area a literature review has been undertaken. This literature review analyses broad, National scale research themes to provide evidence of the contribution the work undertaken at the Project Area has had on these themes. Further, this review determines the extent to which the Project Area could continue to contribute to these research themes in the future and helps to understand the perspective of the stakeholders.

Most of the scientific work that has been carried out at the Project Area relates to the critically endangered GSM. This section provides an overview of the research themes that were identified in the literature review at a National scale. This includes academic research and citizen science conducted in Melbourne, across western Victoria, in Canberra, the ACT (including at the Project Area) and NSW. The overview is not intended to be a comprehensive review of the purpose and outcomes of all research involving GSM, but to highlight the issues that have been and continue to be of interest. Nor, is it the intent of the overview to suggest that other research themes relevant to the GSM would not emerge in the future.

The literature review identified that research into GSM falls into the following broad categories:

- genetic diversity;
- population change over time;
- links between population vulnerability and habitat quality (and what defines quality habitat for this species);
- the resilience of the species to major events and gradual change;
- the value of flagship species and accessible urban sites in driving or supporting conservation outcomes and awareness; and
- the broader issues around decision making for effective conservation management.

Several of the research publications available cover multiple themes, building from basic ecological research to broader issues of conservation management processes and effectiveness.

Examples of work and commentary on the strength of interest in these research themes are included in **Appendix 2**.

3.2.1 Research and Monitoring Reports in the ACT

At a regional scale, studies into GSM populations and habitat characteristics have been conducted across many large and small habitat areas. This body of scientific work provides the local context for the work undertaken at the York Park Conservation Area. Further information about specific studies conducted at or referring to the Project Area is in **Section 3.2.2**.

The work that has been conducted in the ACT can be broadly categorised in four types, as summarised in **Table 3.1**. All of these are broadly 'science' but they have different purposes, yield different types of information, and their alignment with scientific heritage significance criteria are different. There is some overlap between these categories, particularly when the results of studies conducted for development assessment or landscape scale strategic planning are subsequently incorporated into published scientific reviews.

Table 3.1 Types of GSM Scientific Study Conducted in the ACT

Project Type	Research themes and discussion
Specialist scientific research This includes research conducted by academic staff and students at the major research institutes in Canberra. These generally focus on small sites or specific technical issues (e.g. genetic analysis of populations).	Individually, these studies may not contribute much to the National scale GSM research themes. However, when considered together this specialist scientific research contributes to the following themes: • population change over time; • links between population vulnerability and habitat quality (and what defines quality habitat for this species); and • the resilience of the species to major events and gradual change. The studies may provide evidence to support strategic planning and land management decisions.
Studies required for development assessment purposes As GSM occur within lowland areas of the ACT, they often occur within development areas. As GSM are protected under Commonwealth and ACT legislation, studies are often required to support development applications and approvals processes. This type may include peer review or strategic studies undertaken for planning purposes; but many are undertaken by consultants or researches that operate in a consultancy context.	Hogg (2010) provides a list of 41 such reports completed prior to 2010, for at least 25 different sites. Many others would have been prepared since that time. These studies provide information relevant to themes such as • population change over time; • links between population vulnerability and habitat quality (and what defines quality habitat for this species); • the resilience of the species to major events and gradual change; and • the value of flagship species.
Monitoring This includes studies undertaken on a regular basis, usually by land owners, managers, or their delegates due to the known presence of protected species. This work is primarily conducted by consultants on behalf of ACT or Commonwealth Governments; but as above, may be conducted by academic researchers also.	This type of work can provide information that can support analysis of population change over time and factors influencing the vulnerability or resilience of threatened species.

Project Type	Research themes and discussion
Regional scale conservation planning This includes baseline survey, monitoring, or targeted management research conducted generally by public authorities as part of regional scale conservation planning and priority setting.	Edwards (1994) is the earliest of these types of surveys identified by the literature review, with other strategic conservation reviews prepared by (as examples) Richter *et al* (2009) and Hogg (2010). ACT Government (1998; 2005; and 2018) are also examples of strategic conservation management plans that integrate scientific studies into management priorities.

3.2.2 Research Undertaken at the Project Area

York Park Conservation Area has been the site of several examples of the above types of scientific studies and reports since the mid-1990s. A list of studies, reports, and assessments conducted at or referring to York Park Conservation Area are outlined in **Appendix 2**.

The number of investigations, monitoring events, assessments and reviews reflects the land use planning challenges of a small site in central Canberra; located within a core national capital development area, but also in close proximity to key research institutions. The combination of planning pressures and the Project Area's accessibility, mean that it has attracted local interest. Much of the interest has been documented in reports. The contribution of scientific work at this site to research themes is a key factor to be considered in assessing its scientific research potential. Other factors include the condition and resilience of the site.

Some broader community interest in the site (e.g. by citizen scientists, community naturalists, schools, or other education institutions) is unlikely to have been reported in the scientific literature. However, this interest and use of the site is relevant to the question of whether the association between the research and the scientific value of the site would be evident to an 'ordinary person' as required by the ACT guidelines.

Appendix 2 also provides a review of the types of natural heritage science work conducted in the ACT and an analysis of how the research and monitoring work that has been undertaken at Block 3 and Block 15 in the past, and could be undertaken there in the future, is related to the key research themes.

3.3 Identify and Consult Stakeholders

The Project Area has been recognised as habitat for the GSM for more than 20 years. From a scientific heritage perspective, the primary stakeholders are people who have conducted scientific research at the site, or who have used data available from work at the site to develop conservation and management proposals for the critically endangered ecological community and the critically endangered species that occur there.

Finance considered a number of potential stakeholders and identified three institutions with an association with the Project Area and/or with research on GSM grassland habitats or ecology in the ACT. These institutions are the Fenner School of Environment and Society at the Australian National University (ANU), the University of Canberra (UC), and the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

Finance recommended these stakeholder organisations to DoEE, and they were endorsed as appropriate for the purposes of this scientific heritage assessment. .

Deloitte (acting for Finance) wrote to each of the organisations in February 2018 inviting them to participate in this consultation process and to nominate a representative who would be available for interview about scientific heritage issues. A copy of the initial letter sent to CSIRO is included in **Appendix 3**.

After further email and phone correspondence, each organisation confirmed a representative:

- Dr David Yeates, Director Australian National Insect Collection, Senior Principal Research Scientist, CSIRO. Dr Yeates participated in a face to face interview on 14 March 2018 and also provided some follow up suggestions, references and contacts.

- Associate Professor Will Osborne, Institute for Applied Ecology, UC. Dr Osborne provided a preliminary email response and more detailed follow up email response to specific questions.

- Dr Philip Gibbons, Fenner School of Environment and Society, ANU. Dr Gibbons provided a brief email response.

In correspondence and discussion, these key stakeholders also referred to the research work of colleagues either at the Project Area specifically or more broadly on related biodiversity and conservation issues in the ACT and beyond.

3.3.1 Information and Consultation Process

Each stakeholder received a short written briefing about the purpose of the consultation and the specific matters to consider when evaluating scientific heritage significance under the EPBC Act.

The scope of issues that were proposed to be the focus of face to face meetings or written submissions (where a stakeholder was not able to be available for a meeting) is outlined below.

These questions sought input from researchers about the research value of the Project Area (especially York Park Conservation Area), based on how the previous studies at the blocks have contributed to the understanding of GSM and NTG in Australia and how the Project Area could continue to contribute new knowledge and understanding in the future.

Stakeholders were also asked to comment on potential/feasible communication, interpretation, and other measures to mitigate potential impacts on the scientific heritage values of the Project Area.

Ten questions organised in four clusters, guided discussion as follows:

- The value of the previous research and monitoring, in relation to the Australian criteria.

    1. How do you see that previous research on GSM and its habitat at this site has contributed to scientific knowledge and conservation management in the ACT?

    2. How has the research conducted at the Project Area since the 1990s supported or informed more recent work in native grasslands and GSM habitat and populations in the ACT and surrounding areas?

    3. How would you describe the significance of that research, in terms of special insights on the natural heritage of the ACT and surrounding areas? What value has your organisation received from this research output? What are the key themes that it addresses? Examples could include species persistence on small sites, species response to shading, grassland composition, and grassland management/disturbance.

- The value of the Project Area as a continuing research site:

  4. What is the current focus of GSM research in the ACT and surrounding areas?

  5. How does York Park Conservation Area fit with current and proposed future research effort on native grasslands and GSM in the ACT and surrounding areas? Which components of future research could this site contribute to?

  6. What do you see as the role of small urban land parcels in natural heritage research and conservation?

- Mitigation of potential impacts of the proposed action on scientific heritage values:

  7. Is enhancement of the scientific components of the natural heritage value of the Project Area feasible in-situ? How could that be achieved?

  8. How could the scientific community's interest in native grasslands and GSM be demonstrated, communicated, or interpreted to the broader community?

  9. Should the history of scientific studies at the Project Area be part of that communication or interpretation? Why is the Project Area valuable for that purpose and how could that best be done? Which themes would be the focus of interpretation – for instance, about the role of landscaping and conservation in the 'bush capital'?

- Offsetting of scientific heritage value

  10. Could you suggest approaches to offsetting the scientific heritage values of the Project Area, which could be included in an offset strategy?

3.4 Consultation Outcomes and Analysis

The consultation invitations resulted in one face to face meeting and two email submissions. **Table 3.2** presents the responses from the stakeholders as they relate to the key questions outlined in **Section 3.3**.

Table 3.2 Stakeholder Responses

Key questions/Responses
How do you see that previous research on the GSM and its habitat at this site has contributed to scientific knowledge and conservation management in the ACT?
Scientific knowledge Dr Yeates referred to the work of Clarke and Dwyer (1998) and earlier studies by Edwards (1993 and 1994), which investigated the genetic diversity of the GSM across its distribution, in the ACT, southern NSW and Victoria. The results of this work showed that the five ACT sites sampled for those studies were relatively closely related genetically, i.e. the ACT populations are a genetic cluster. Samples from further away (e.g. western Victoria) were more different and today could perhaps be regarded as a subspecies. There have been several important developments in genetic research since this work was done in York Park, which was able to use few genetic markers. Modern research would provide a lot more information about genetic distinctiveness and connectedness. Opportunities for genetic research include the capacity to sample from dead specimens in collections (including some material currently held at Wollongong University which may be from Clarke's collection); new genetic material could also be collected at York Park, to be analysed with modern techniques. **Conservation management** The continuing population at York Park demonstrates that the critically endangered GSM does have resilience. It can persist (as far as the 20 to 25 years overall of studies demonstrate) in small patches of habitat. Habitat fragmentation around this site has been ongoing for at least 80 years. The GSM has a generation time of 2 to 3 years. The monitoring information from York Park therefore covers approximately 10 generations. This is a longer monitoring record than at other grassland or GSM sites in the ACT. There are also observations that the GSM can adapt to habitat provided by an invasive species (Chilean needle grass), which has a structure and chemical composition similar to the native grass habitat. Given the Weeds of National Significance (WoNS) listing of Chilean needle grass and its widespread, but recent incursion into temperate grasslands in the ACT, this raises complex conservation policy and management questions. Dr Osborne considers that the previous research on the GSM and its habitat at Block 3 has made a significant contribution to the knowledge of the species and its conservation management. He commented on the reliability of the population (i.e. stable numbers) and suggested this was useful to researchers and environmental consultants. He also referred to the value of the isolation of the site from other GSM habitat as being valuable for comparative study. He commented 'It is an important site that has contributed significantly to our ability to calculate extinction probabilities for the species in sites of different sizes, as documented in Annet Richter's PhD thesis – What makes a species vulnerable to extinction following habitat fragmentation and degradation – a test using insect fauna from native temperate grasslands in South eastern Australia (University of Canberra, 2010). The site has been used to test methods for tracking population stability, including visual and mark/recapture release methods of monitoring moths (Richter et al 2013 provide a good example; see also Rowell, A. 2012). Dr Osborne suggested that findings from the York Park research have contributed considerably to the development of the action plan for the species in the ACT and referred to the ACT Native Grassland Conservation Strategy and Action Plans 2017 pp 184-206).

Key questions/Responses
How has the research conducted at Block 3 since the 1990s supported or informed more recent work in native grasslands and GSM habitat and populations in the ACT and surrounding areas?
See above in relation to Chilean needle grass. There are further research questions on the connectivity of primary grassland habitat for the GSM and how the presence of Chilean needle grass affects connectivity. The existing knowledge does not consider the potential impacts of invasive invertebrates or predator species on the mortality rates of the GSM. This in part relates to the encroachment of tree cover around the margins of grassland communities, particularly as climate change linked temperature rise affects habitat distribution. The moths are vulnerable to birds. The research dating back to the 1990s is part of the scientific culture of Canberra as a small city with major research institutions that are nationally and internationally recognised for their excellence. Canberra has huge universities right in the centre of town, and the CSIRO. The attention to Blocks 3 and 15 is part of this old Canberra scientific culture, where convenient and accessible in town sites are valued for local research and teaching opportunities. Dr Yeates was not sure what level of scientific significance this would mean (and it would apply to multiple sites, not just Blocks 3 and 15), but it is a distinctive Canberra cultural heritage feature. Dr Osborne suggested that York Park is an example of high quality natural temperate grassland. The presence of moths in disturbed median strips adjacent to the site (both in native grassland and sites dominated by Chilean needle grass) makes it a suitable site for the study of habitat restoration. He considered that the site has high significance as a site for continuing research, addressing key questions about population persistence within an urban matrix.
How would you describe the significance of that research, in terms of special insights on the natural heritage of the ACT and surrounding areas? **What value has your organisation received from this research output?** **What are the key themes that it addresses? Examples could include species persistence on small sites, species response to shading, grassland composition and grassland management/disturbance.**
Key themes in the research at this site include threatening processes affecting small populations on isolated sites and what limits their viability. GSM is a flagship species for conservation management. ACT organisations that have contributed research – at this site and at other sites across the ACT have benefitted from the scientific profile of a flagship species. Although, in time the length of record can be replicated at other sites, it was suggested that this small site is unique (nationally and potentially internationally) as a case study of an endangered species on a tiny urban site. (Note however, that if another site emerged from research across the ACT with similar resilient population, uniqueness would be reduced).

Key questions/Responses
What is the current focus of GSM research in the ACT and surrounding areas?
Research themes highlighted included the impact of invasive species and predators on these small isolated populations. Examples include other exotic grass species (already present in general rural landscapes across the ACT), the role of ants in the subsoil habitat component of the GSM life cycle, and the potential for other predators species such as European wasps. The survival and enhancement of endangered species populations in urban contexts is a general interest of conservation scientists, but the research addresses a wide range of species, not just those occurring at this site. Further research on the impacts of landscaping and access management on small remnant areas – e.g. further habitat dissection by informal walking paths across grassland, mowing practice, and locations and species of trees planted; also watering protocols. Note: ACT Government mapping and monitoring is only on land owned by the ACT Government. There are opportunities for greater coordination of monitoring on land owned by Defence or other Commonwealth agencies.
How does this site fit with current and proposed future research effort on native grasslands and GSM in the ACT and surrounding areas? **Which components of future research could this site contribute to?**
The scientists who provided input did not directly address the broad spectrum of research interests that are discussed in Section 3 of this report. However, they did refer to some continuing research interests, at the ACT scale. These include: • What contributes to the vulnerability or resilience of endangered species in isolated urban habitat? The value of such research is in part dependent on the relative significance of that fragmented urban habitat to the continuation of the species in the Act or across its broader range. • The value of sites that illustrate the capacity of GSM to adapt to significant changes to the species composition of 'native' grassland, including the native species mix and by invasive Chilean needle grass in recent years, as opposed to the habitat losses associated with earlier disruptive land management techniques and other invasive species. The mix of other invertebrates could also be included in this research. • The value of habitat rehabilitation and citizen science in urban areas as part of a multifaceted approach to improving ecological awareness in the community. This could include the effects of interpretation opportunities on the scientific culture of a university city.

Key questions/Responses
What do you see as the role of small urban land parcels in natural heritage research and conservation?
Dr Osborne noted the attention to Block 3 over the years, and that it had been visited and used many times by consultants, entomologists, research students and members of the public who have an interest in 'this unusual day flying moth and its natural grassland habitat'. Dr Osborne also thought that the level of scientific and community science interest in the site would not have been documented. People who have conducted research or visited the site in relation to the conservation values included Dr Ted Edwards (CSIRO), Dr Annet Richter (a site used as part of her PhD project, at the University of Canberra) and a community engagement program (the GSM count) organised by the Friends of Grasslands group. Dr Osborne commented on the accessible and inner city location of Block 3, as a site 'embedded deep within the urban matrix of Canberra and in one of the earliest parts of the city'. Dr Gibbons commented that the Fenner School at ANU has not been involved in active research at York Park; their interest at the site is restricted to teaching. The site is used to discuss the issues associated with the conservation of small populations, including undertaking a PVA based on available published data. The use of the site for teaching is linked to its central location, close to the ANU and the existing monitoring data available for the site, commissioned by the Commonwealth government because of the presence of the critically endangered GSM. Dr Yeates commented on the community education value of small urban sites partly independent of the scientific research value. He also noted that based on the existing evidence, the site is not critical in a genetic sense, because of its similarity to the genetic composition of other ACT sites.
Is enhancement of the scientific components of the natural heritage value of the site feasible in-situ? How could that be achieved?
The scientists consulted did not provide a comment on this topic.
How could the scientific community's interest in native grasslands and the GSM be demonstrated, communicated or interpreted to the broader community?
It was suggested that native grasslands could be presented to the broader community as a type of 'surprise package' in terms of their potential to yield scientific information. Native grasslands may look simple and familiar, but on closer inspection they can include diverse and important (threatened and endangered) species with interesting ecology/life cycles. The potential to use social media and local signage, as well as develop an ACT ecological science trail for interpretation, was noted. It was also suggested that major academic and research institutions could promote the science culture of Canberra as a city with and large remnants of natural landscape that are easily accessible. 'Science/nature on your street'. Note these suggestions do not relate specifically to the Project Area, but are about broad opportunities for interpretation of native grassland communities (which are widespread across the Canberra locality) to the people of the ACT.

Key questions/Responses
Should the history of scientific studies at this site be part of that communication or interpretation? **Why is this site valuable for that purpose and how could that best be done?** **Which themes would be the focus of interpretation – for instance, about the role of landscaping and conservation in the 'bush capital'?**
Yes, with respect to small and isolated sites still supporting relatively stable populations of critically endangered species – how and why? Generally about the conservation role of connected sites (noting the limited connectivity of this site beyond its immediate context).
Could you suggest approaches to offsetting the scientific heritage values of the site, which could be included in an offset strategy?
Dr Yeates discussed opportunities to use this site as part of an ecological/insect science communication strategy across Canberra. If the site were to be developed, he also suggested options such as: • A summary of the research and monitoring which has been conducted at the site, which could be published – as a minimum in publications about ACT natural heritage, or by organisations/museums that interpret the city's scientific culture to the community. • Intensive sampling of the GSM population to preserve the genetics of the site and in the first instance to review its genetic connections to other sites in the ACT. For instance collecting new samples would provide a much fresher and more useful set of genetic material than the material currently stored at Wollongong University (the quality of storage of this material and its scientific research value cannot be certain at the moment). • Signage at this and other sites about change and manipulation of urban open space as habitat conservation and recreation areas – and how these can be integrated. E.g. about the impact of informal paths across native grassland parks on their habitat value; where trees should and should not be planted. • Also signage about the biodiversity of urban land – particularly the biodiversity that people can't see as it is below ground.

3.5 Assessment against Heritage Criteria

Table 3.3 uses the information presented in **Sections 3.1** to **3.4** to evaluate scientific heritage significance of the Project Area using the relevant Commonwealth and ACT criteria, thresholds, and further qualification of scientific heritage value, taking into account factors such as site integrity, rarity, importance, and representativeness.

As discussed in **Section 2.2**, if the heritage values of a property owned by the Commonwealth meet the local heritage significance criteria (in this case ACT heritage criteria), then the Commonwealth's management of the land must be consistent with that heritage significance, whether or not the heritage value also meets the AHL criteria.

> The analysis in **Table 3.3** indicates that the place defined by the York Park Conservation Area **currently** meets the ACT Heritage criteria (a) and (b).
>
> It does **not** meet guidance for national scale criteria (a) or (b).
>
> The analysis shows that the place does **not** currently meet other relevant criteria ((c), (g) or (h)) at local or national scales.

3.5.1 Qualification

It is important to note that this assessment represents a snapshot in time of the scientific heritage value of the Project Area.

There are a number of factors which indicate that the scientific heritage significance of the place will decline in the future. Two key considerations are:

- The accessibility of the Project Area appears to be an important reason for the early recognition of GSM on site. This early recognition has led to the extensive monitoring record, linked to obligations under the EPBC Act and approval requirements. Now that a large number of other GSM sites are known in and around the ACT, and broad based monitoring and conservation programs are being implemented at diverse habitat sites, the significance of the scientific record from Blocks 3 and 15 will decline over time. It is one snapshot of the population dynamics of the species, from a site that is not representative of the range of sites on which the GSM and its grassland habitat are now known to occur. This suggests that the relative significance of the Project Area will decline over time and therefore the significance of the impact of development would also decline.

- Scientific heritage value in relation to future research prospects depends in part on the condition and integrity of the fabric of the place in relation to the research issues. It is important to note that the integrity of the fabric of the Project Area is vulnerable to a range of urban and isolation threats, and to invasive species, particularly Chilean needle grass.

  In the short term, this provides further research opportunity to study how the population responds over time to these urban pressures. The life cycle of the moth (at two to three year cycles) means that changes emerge relatively slowly, potentially with a time lag behind the threats.

  In the medium term, the value of the place in relation to criteria (a) and (b) is expected to decline, even if the site is not sold and developed. The place could quickly lose the integrity that gives it scientific meaning. The place is already more intensively managed than many other grassland sites in the ACT, in an effort to maintain its habitat and GSM population. This has not prevented substantial changes to the habitat (including invasion by Chilean needle grass). The future trajectory and rate of change of the habitat and population is expected to result in a loss of habitat integrity and decline of population, but the rate is uncertain.

While the documentation of scientific work on the GSM at the Project Area has had a seminal influence on research on GSM populations in the ACT, and there is community interest, it is anticipated that the future research value, the value of the existing record and the extent of community interest in the place will decline below the threshold for local significance over time.

Table 3.3 Scientific heritage significance assessment

Considerations	Relevant evidence about the place in relation to scientific heritage value of Block 3 and Block 15	Meets ACT Heritage threshold (local)	Meets national heritage significance threshold
AHL Criterion (a) the place has significant heritage value because of the place's importance in the course, or pattern, of Australia's natural or cultural history ACT HP Criterion (a) Important to the course of the ACT's cultural or natural history			
AHL Places that meet criterion (a) from an ecological perspective maintain or demonstrate, to an exemplary degree, ongoing biological processes, including life cycle processes; this will include intact ecosystems and places of high integrity. **ACT** the place has a clear and important association with (amongst other natural characteristics) an ecological community, species, biodiversity in the ACT's history; and the **association of the place is evident in the physical fabric of the place, documentary resources** or oral history. Consider: • Representativeness, distinctiveness, exceptionality, extensiveness • Intactness /integrity, rarity • **Have had seminal early influence, long association and influential association** • **Demonstrated extent and degree of community interest**. • A place may be eligible for registration for its natural heritage significance if it maintains or shows the continuity of (amongst other things) ecological community, species, biodiversity in the ACT's natural history.	**Overall, Block 3 is considered to meet criterion (a) at the local level now. The changes taking place mean that it may not continue to meet criterion (a) in five years or ten years.** The various types of scientific work conducted at this site in the past mean it meets a number of the inclusion characteristics. The long research and monitoring interest in the site can be seen to have had an influence on other work on GSM in the ACT. There is community interest (citizen science and general) in the site and interpretation information is currently provided around the site boundary for the benefit of visitors. However, the site is also vulnerable, because of its small size and urban context. It is expected that the value of its fabric will decline; and other larger sites elsewhere in Canberra will provide meaningful baseline and ongoing data. The place is part of York Park Conservation Area. Other parts of York Park Conservation Area are identified as having cultural heritage significance because of Federation period plantings and landscaping. This is not relevant to Block 3 and Block 15, which in contrast maintain a small example of the native temperate grassland landscape of the valley floors of the ACT and southern tablelands. There are other less centrally urban sites where changes to the grassland landscape (in terms of species, incursion of trees/ecotone between grassy woodland and grassland; and implications for insect species) can be studied. Part of the place is currently fenced and managed to reduce impacts on the grassland habitat (e.g. from mowing, trampling). Management does not reduce the threat from Chilean needle grass (nationally significant weed species). There is an as yet unresolved debate about the sustainability of GSM populations in Chilean needle grass habitats. Open space provided by the site has an aesthetic/natural outlook use or value for adjacent office workers – as a place to observe and walk around (but generally not across).	Yes	No

Considerations	Relevant evidence about the place in relation to scientific heritage value of Block 3 and Block 15	Meets ACT Heritage threshold (local)	Meets national heritage significance threshold
• A place would not meet this criterion if it provides evidence of a quality that is common or is of low or questionable importance to the ACT; or the evidence of association is not clearly established or is not in some way distinctive or special; or **the place has been so altered that it can no longer provide evidence of its meaning**.	The research and monitoring that have been conducted at this site over close to 20 years mean that it does provide a record of local scale environmental change (to the grassland habitat) and the resilience of an important and readily recognised endangered species in Canberra. This is recorded in a range of 'scientific' documents, monitoring reports and reports on citizen science. The documentary evidence from Block 3 about the GSM and its habitat can (at this time) be considered 'rare', and the work there can be considered to have had a 'seminal early influence, long association and influential association' in the ACT. Because of the ownership, location and management history of the place, it cannot be considered to be representative of the broader grassland (or urban grassland) landscape of the ACT. Blocks 3 and 15 are not the only, or the best sites in Canberra and surrounding districts to investigate insect conservation issues, but they are currently the most studied site, benefitting from their central, accessible and conspicuous location. This will change over time, as monitoring is established at key conservation sites in the ACT. Rarity can be expected to decline, as robust monitoring of important conservation sites becomes more common. Community interest in Block 3 is strong for a small group of scientists and their citizen science partners, with some latent community interest in the broader community. This latent interest could be stimulated by future interpretation of the broader scientific culture of Canberra. However, this interpretation issue is not relevant to criterion (a). An important consideration for Block 3 is the integrity of the fabric of the place and how this influences its future research value. The ACT guidance suggests a place should not be considered as meeting criterion (a) if 'it has been so altered that it can no longer provide evidence of its meaning'. It is apparent that the place is increasingly affected by Chilean needle grass, overshadowing and other urban edge effects. While in the short term, these impacts may allow research on the resilience or demise of the species present at the place, there is a timeframe within which that value will decline because the place is so altered.		

Considerations	Relevant evidence about the place in relation to scientific heritage value of Block 3 and Block 15	Meets ACT Heritage threshold (local)	Meets national heritage significance threshold
AHL Criterion (b) the place has significant heritage value because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history **ACT HP Criterion (b) has uncommon, rare or endangered aspects of the ACT's cultural or natural history.**			
AHL: • The only and/or only extant nationally important example with integrity or authenticity. • A place with a specific nationally significant associated history. • The rarity or uncommonness is intended to apply to rarity of biological (e.g. habitats of rare flora and fauna species), geomorphological or palaeontological attributes, with significant conservation values. **ACT** • The place must have a clear association with an aspect of the ACT's cultural or natural history and this must be evident in the physical fabric of the place or in documentary sources or oral history. The aspect of history must have made a strong, noticeable or influential contribution to the ACT's society or environment. • The intent of this criterion is to apply to places which provide significant habitat for rare, threatened, uncommon, at limits of range species. • Rarity and uncommonness are judged in the context of similar places elsewhere in	**Overall, it is considered that Block 3 and Block 15 does meet criterion (b) at the local (ACT) scale, but does not meet it at the national scale.** The value of the place as an example where long standing scientific interest has demonstrated the survival of an endangered species on a small and isolated parcel of land. This is related to the value of the place as one of the sites that reflect the scientific culture of the ACT. **The ongoing threats to the condition and integrity of the site is a challenge to the continuity of the heritage value (as for criterion (a))** The scientific stakeholders did not suggest that this is a rare site in terms of the species that are present, or that it has outstanding conservation values for the GSM. The site does not make a significant contribution to the conservation of the species. There are multiple other sites in the ACT with substantial conservation values for the GSM. The question here is whether the scientific and community interest in the site (which arose in part from its location and accessibility to major research institutions in Canberra) makes it a place with a nationally (or locally) significant associated history; and a place which has made a strong, noticeable or influential contribution to the ACT's society or environment. The scientific stakeholders highlighted the length of time over which investigations or monitoring have occurred at this site and the insights it has/could provide about the survival of rare of endangered species on urban habitat fragments as its key value. Although, in time the length of record can be replicated at other sites, it was suggested that this small site may be unique (nationally and potentially internationally) as a case study of an endangered species on a tiny urban site. (Note however, that if another site emerged from research across the ACT with similar resilient population, uniqueness would be reduced). The research on insect species in Melbourne suggests that other small urban sites with endangered insect species (such as the Eltham Copper Butterfly reported by New 2018) do exist.	**Yes**	**No**

Considerations	Relevant evidence about the place in relation to scientific heritage value of Block 3 and Block 15	Meets ACT Heritage threshold (local)	Meets national heritage significance threshold
the ACT or a wider context. • A place may be included if it is the only or only extant example, with high integrity or authenticity; few examples of its kind existed originally; few examples of its kind remain because the original population has decreased due to destruction; it has a mix of features that is rare or uncommon in the ACT, or it has unusual richness or diversity. • A place that is uncommon rare may not have sufficient integrity to demonstrate those qualities.	The association with natural history cannot be considered to be uniquely evident in the fabric of the place. However, as an example of a widespread phenomenon in the grassland community, the place could be considered to illustrate processes that are replicated elsewhere and to provide important insights into the management of small open spaces in urban areas. Many more sites of this type may have existed when records were first made at Block 3 and Block 15. Although there is now much better mapping of GSM sites in the ACT, there is still limited long term monitoring of population dynamics at individual small sites.		
AHL Criterion (c) the place has significant heritage value because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history **ACT HP Criterion (c) Potential to yield information that will contribute to an understanding of the ACT's natural or cultural history**			
• Demonstrably significant in that it could contribute to scientific studies that have led or could lead to greater understanding of the natural history of Australia, or the place is significant as a place of a discovery which has potential to yield information. • 'Information' does not include educational or interpretation value. • Potential does not mean 'possibility'. There must be evidence of real, proven or established potential (from expert testing or professional examination). • Potential to yield information may include records, collections, oral	**The research opportunities at this site do not necessarily make a major contribution to the conservation of the GSM across its range, which includes large and contiguous areas of grassland – in the ACT, southern NSW and Victoria.** The fabric of the site does have research potential, but its value beyond the short term is degraded by threats to its integrity. Its monitoring history is considered in relation to criteria (a), (b), (g) and (h). The question here is not whether there are existing scientific records from the place, but whether the place has real potential to contribute new information in the future. If it does have that potential, is the information that could be provided of local or wider significance to the understanding of natural heritage? The distinguishing features of the place are its accessible and visible central Canberra location and the long period over which scientists and citizen scientists have made observations there. In many ways, the second feature is a corollary of the first. Umwelt 2014 and 2017, Hogg 2010 and input from UC, ANU and CSIRO demonstrate that the place has provided a site for research, monitoring and assessment over 20	**No**	**No**

Considerations	Relevant evidence about the place in relation to scientific heritage value of Block 3 and Block 15	Meets ACT Heritage threshold (local)	Meets national heritage significance threshold
traditions, biological material, fabric etc. • For the national heritage list, potential research value must be shown to relate to a contribution of national importance. For the Commonwealth heritage list, a contribution of local, regional or state importance will meet the threshold, but the level of significance must be clear. • Potential to yield information may be fully realised or exploited, in which case a place would not meet criterion (c). However, the guideline suggests that in this case, a place may meet criterion (a) as a place where a nationally significant scientific discovery has been made. • A reasonable likelihood exists that the place contains substantial physical evidence of defined research interest. • That physical evidence is not currently visible. • The evidence is of a likely high integrity and/or condition to yield information. • Consider rarity, representativeness, distinctiveness, exceptionality, extensiveness, intactness/integrity or relevance to key periods of natural history. • Sites usually display 'layering of fabric', where there is a strong presumption of research potential in one of a variety of fields of (scientific) scholarship.	years. This is the longest record available for any GSM site in and around Canberra. The reason for this appears to be accessibility and visibility, rather than special or unique natural or conservation attributes of the place. Longevity of previous monitoring is not a value to be included in assessing scientific heritage (future research value). In addition, that information is now documentary evidence, so is excluded. However, the existence of a long record does allow future tracking of population (as long as the habitat is maintained). Hogg's comment (2010) is 'The most important of the Central Canberra sites is probably York Park, particularly for its cultural scientific value and extensive monitoring records, rather than necessarily the quality of its habitat'. He says it has high scientific significance (for the longevity of the record), but doesn't say at what scale – given the work was for the ACT Government, perhaps assume he is referring to significance in the ACT. The existing records contribute to the scientific value of the place, but are not the key consideration for criterion (c). Hogg's comment on the quality of the habitat at the site goes to the integrity, extensiveness, distinctiveness of the fabric of the place, which affects its future research potential. There is no doubt that the place contains material that may be of research interest. UC suggested the place (including the records of previous GSM population change) presents an important opportunity to study the resilience of small urban populations and the factors contributing to the conservation of small populations of endangered species on small, poorly connected sites. This is one of many current research themes for the conservation of endangered species. Research on critically endangered insect species in urban contexts is progressing for a number of species at sites in NSW, ACT and Victoria (New 2018). The place is an example of a small urban site. It is unlikely to be representative of the landscape context of other GSM sites in urban contexts, because of the nature of land management that has existed there. Generally this is a much more carefully managed place than most other GSM habitat (partly because of its Commonwealth tenure, visibility and accessibility). The condition of the site is threatened by its increasingly urban and commercial context, which has encroached closer over time. The small size and isolation of the		

Considerations	Relevant evidence about the place in relation to scientific heritage value of Block 3 and Block 15	Meets ACT Heritage threshold (local)	Meets national heritage significance threshold
• In the ACT, the potential to provide information must relate to the physical evidence available at the place itself and not the associated documentary evidence related to the place (which may be relevant to criterion (a)). Criterion (c) is concerned with potential information; if the information is already known, this criterion does not apply.	site introduce significant risks for future long term research as the quality of the site is very vulnerable to various urban and isolation threats to habitat integrity. Small and isolated sites are vulnerable to catastrophic shocks such as invasive plant species, predators, diseases, even extended drought or a change to land management practice (such as watering or not watering). The site offers potential to continue to study the impact of Chilean needle grass on habitat value for the GSM. The increasing impact of Chilean needle grass on the habitat is also a threat to the continuing scientific value of the place, despite the past evidence of resilience of the GSM population. This site is vulnerable to loss of its natural heritage values that support the scientific heritage. The invasion of Chilean needle grass into grassland habitats is widespread in the ACT, so the opportunity is not unique or rare. The site is of interest in the ACT, but other sites with potential for future research of the key themes exist. The existing genetic research at this place is not rare and in the context of currently available technologies for genetic typing, not high quality. However, it does suggest that the population at York Park is not genetically unique – but related to the populations across the ACT. This is consistent with historical continuity of habitat in the area, and clear separation of this population from those in Victoria.		
AHL (g) the place has significant heritage value because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons **ACT HP (g) Has a strong or special association with the ACT community, a cultural group in the ACT for social, cultural or spiritual reasons**			
• This social criterion is intended to apply to 'places in the public consciousness for which a community or cultural group exhibits a strong or special attachment'. • 'Note that for a place to be considered significant against either criterion (e) aesthetic values or (g) social values, it is necessary to identify a specific community or cultural group for whom	The place has low value as a site for national scale interpretation about below the ground habitat, or isolated habitat. The block is not listed in the ACT Heritage Register The community association with this site and its occasional role in teaching or citizen science are outside the intent of criterion (g) and do not meet the ACT threshold Social aspects of scientific heritage significance at this site derive from its urban location (accessibility, identity) and the interest of citizen science groups. This is related to the scientific culture of the Canberra community (suggested by CSIRO and UC).	**No**	**No**

Considerations	Relevant evidence about the place in relation to scientific heritage value of Block 3 and Block 15	Meets ACT Heritage threshold (local)	Meets national heritage significance threshold
the place is significant. The definition of a community or cultural group does not include a professional group, such as architects, engineers or designers, but it may include artists, writers, musicians, filmmakers etc. who have been creatively inspired by the place.' • Special interest groups do not constitute a community or cultural group. Common expertise is not sufficient by itself to define a group. • The community association for social and cultural traditions is expected to have longevity. Places must be recognised and used by the community or cultural group. • To meet the national criterion, the community recognition is expected to be beyond the region or state. • ACT - Clear evidence exists of an association between the place and the ACT community for social, cultural or spiritual reasons. There is evidence that the association is strong or special, applying criteria such as distinctiveness, exceptionality, extensiveness, intactness/integrity, length of association, cultural practices. • For the purpose of the ACT policy, significance means that an ordinary person should be easily able to recognise the association between the community or cultural group and the place or object.	ANU visits the site with students. Accessibility is a key driver for this, not a particular association with the place. This accessibility contributes to a self-perpetuating monitoring record. UC in particular commented on the citizen science interest in the site and how that had been harnessed to support research projects (UC PhD studies). In this sense, the place is an example of a class of places of interest to the community. The nature of the Canberra landscape means that although much interest has historically concentrated at this place (20 years of scientific interest, perhaps 10 of occasional and not well documented citizen science interest), there are other opportunities that are accessible to people across the city. The citizen science interest in the place is relatively diffuse (these people also have interests in several other sites around Canberra) and may also be considered to be the interest of a 'special interest group' associated with scientists, rather than the broader community. The history of use at this place, while an example of community interest in citizen science, cannot be considered to contribute significantly to culture or natural history at the national scale. The group involved is small and there are multiple alternative sites for ongoing citizen science activities. Umwelt 2014 and 2017, Hogg 2010 and input from UC, ANU and CSIRO demonstrate that the place has provided a site for research, monitoring and assessment over 20 years. There is widespread knowledge in the scientific (ecology/conservation) community (including a small group of citizen scientists) about the length of the GSM monitoring record at Block 3. This knowledge does not extend into the general community and there is no evidence that community awareness of the site extends outside Canberra. CSIRO also commented on the value of modest looking sites as 'surprise packages' for community interpretation – that they can still be habitat to species- value of soil as habitat etc. The place has potential for local scale interpretation, as part of a network of places across the city that illustrate the scientific research culture of a city that has a proportionally high population of scientists, living and working in a 'bushland' context.		

Considerations	Relevant evidence about the place in relation to scientific heritage value of Block 3 and Block 15	Meets ACT Heritage threshold (local)	Meets national heritage significance threshold
Further, professional groups and special interest groups do not constitute the community or a cultural group. • Community attachment to the place is demonstrable and enduring, with 20 years as a guide. • The community has a deep sense of ownership/stewardship and/or connectedness to the place.	This part of York Park is not part of the Federation period planting and landscaping, but was originally intended to be part of the broad capital city uses of Barton.		
AHL (h) the place has significant heritage value because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history			
• The key to criterion (h) is the strength of association of a person or group with a place, related to the particular and important contribution made by the person or group to Australia's natural history. • The association with the place is acknowledged as an achievement of (national) importance and is generally to have been demonstrated to have been outstanding in the person or group's lifetime. • For national significance, the place may have had an important formative effect on a nationally recognised person (such as a scientist) or group or the achievements of the person or group occurred at the place. • In relation to a Commonwealth heritage assessment, the spatial scale of	At the national level, the key to this criterion is the link between a person or group and the place, through a 'particular and important' contribution to science. While this is a site that has been of interest to scientists in the ACT (for reasons that are not entirely to do with its scientific merit), this site is not a key site for the work that is recognised as being of national importance, or having a formative effect on the career of a nationally recognised scientist, or group of scientists. Such a scientist would need to be widely recognised as a national leader in the field of entomology, or insect conservation. CSIRO and UC both commented on the length of the monitoring record at Block 3, arising because of the site's proximity to ANU and therefore value for local research dating back to the early 1990s. This meant it was a known site (on Commonwealth land) when the EPBC Act introduced critically endangered species listing. The view was expressed that the effect of these circumstances is that this this small site is unique (nationally and potentially internationally) as a case study of an endangered species on a tiny urban site. It was also noted however, that there are multiple urban GSM sites in Canberra (less studied) and that if another site emerged from research across the ACT with similar resilient population, uniqueness would be reduced. CSIRO also commented on the heritage value of the place as an example of the scientific culture of Canberra – as a small city with several major research institutions. Block 3 is one of several sites in central Canberra that have been of interest to local scientists because their location made early observations there easy (establishing a	**No**	**No**

Considerations	Relevant evidence about the place in relation to scientific heritage value of Block 3 and Block 15	Meets ACT Heritage threshold (local)	Meets national heritage significance threshold
significance of the achievement or recognition may be local, regional or state, as well as national.	base case of future monitoring of sensitive species), and their accessibility encourages local scientists and academic researchers/teachers to use the site for coursework field trips. At the local scale, this is a valuable feature of the place, but the ACT heritage criteria do not include an equivalent to criterion (h). The place cannot have local heritage significance because of the attachment of a group of scientists to the place through the significance of their work		

4.0 Heritage Impact Assessment

The assessment in **Table 3.3** identifies that the scientific heritage values of the Project Area are **local** scale, based on consideration of the ACT heritage criteria as an indication of local scale. The place meets the ACT heritage criteria for:

(a) importance to the course or pattern of the ACT's cultural or natural history; and

(b) has uncommon, rare or endangered aspects of the ACT's cultural or natural history.

These values are partly embodied in the fabric of the place as an isolated fragment of habitat which illustrates the resilience of a critically endangered species. More importantly, the values also derive from the documentary evidence of the persistence of GSM, obtained from the Project Area from 20 years of observations by scientists and citizen scientists. This interest has made the scientific work at the Project Area rare and influential in the development of research themes for GSM.

These previous observations have been made in part because of the early identification of the place as a grassland remnant which supports a population of the GSM. That early identification is in part due to the scientific culture of the ACT and in part due to the central and accessible location of the place (relative to research institutions).

The definition of a significant impact from MNES and Commonwealth guidelines refers to impacts on the assessed heritage values of a place, which:

- are **notable or of consequence taking into account sensitivity, quality and value of the environment and the extent, duration and magnitude of the proposal**. If the blocks are sold for development the entire block is likely to be permanently affected. The importance of this extent and duration of the proposal needs to be considered in the context of the sensitivity, quality and value of the environment.

- **have a real or not remote chance of occurring**. Given the context of the place and the criteria against which it has local scientific heritage value, is there a real chance of a significant impact occurring, or is there a real chance that the impact would the impact be less than significant?

Table 4.1 applies the criteria set out in Commonwealth Significant Impact Guidelines 1.2 (DSWEPAC 2013) for impacts on heritage values, taking into account the sensitivity, quality and value of the place.

The analysis in **Table 4.1** indicates that the significance of the impact of the proposal on scientific heritage values is not as great as could be initially concluded from the extent, duration and magnitude of the proposal.

The proposed clearing and disposal of the Project Area will clearly impact on its fabric. However, its local heritage significance does not relate specifically to the future research potential of the fabric of the place (heritage criterion (c)); rather it relates to the rarity and influence of past work. This past value is not affected by the proposed clearing and disposal.

The proposed clearing and disposal of the Project Area will not have a significant impact on the local scientific heritage value of the site, for the criteria that it is assessed as meeting.

Further explanation of the rationale for this conclusion is provided in **Section 4.1**.

Table 4.1 Significance of the Impact of the Action on Heritage Values

Consideration/Criterion	Response
Is there a real chance or possibility that the action will:	
Permanently destroy, remove or substantially alter the fabric (physical material including structural elements and other components, fixtures, contents, and objects) of a heritage place	The local scientific heritage value of the place relates to the contribution, rarity, and influence of the past research and monitoring that has taken place there, not to its future research potential, which is declining. The proposal will remove the fabric of the place (i.e. what would enable it to be used for future field based research). The existing monitoring record of past change will not be impacted. The significance of this impact must be considered in the context of the existing trends in integrity and the future quality of the environment of the place, which are already diminishing its future research value and influence. Overall, in relation to the heritage criteria that apply to the place, the impact of clearing and disposal is not significant, provided the records of past influential work are maintained. **A significant impact of value associated with criteria (a) and (b) is not likely.**
Involve extension, renovation, or substantial alteration of a heritage place in a manner which is inconsistent with the heritage values of the place	Not applicable
Involve the erection of buildings or other structures adjacent to, or within important sight lines of, a heritage place which are inconsistent with the heritage values of the place	Not applicable
Substantially diminish the heritage value of a heritage place for a community or group for which it is significant	As noted in **Section 3.5.1**, the local heritage value of the place is expected to decline, irrespective of the proposed development. The current local value of the place to local researchers and citizen scientists as an example of an early and influential scientific research site in the ACT will decline as the new research opportunities and records from other more sustainable sites change the scientific relevance of small isolated sites of declining integrity. **A significant impact to the heritage value is not considered likely**.

Consideration/Criterion	Response
Substantially alter the setting of a heritage place in a manner which is inconsistent with the heritage values of the place, or	The proposed action is not considered likely to substantially alter the setting of a heritage place as the setting has been previously modified by urban development
Substantially restrict or inhibit the existing use of a heritage place as a cultural or ceremonial site?	Not applicable

4.1 Factors influencing the likelihood of a significant impact on scientific heritage value

The likelihood of a significant impact is modified by several factors and trends affecting the condition, integrity and research context of the Project Area. These include:

- The records of past monitoring exist. The disposal of the Project Area will not affect these records and they will continue to be available for further analysis where there are relevant research or management questions.

- The local heritage value of the Project Area is linked to the scientific culture of Canberra as a city which holds several nationally important research and environmental management institutions. This institutional context has influenced the research and community interest in Block 3 and Block 15, which are centrally located and accessible.

- The accessibility of the Project Area appears to be an important reason for the early recognition of GSM on site. This early recognition has led to the previous research and extensive monitoring record, linked to obligations under the EPBC Act and/or approval conditions for adjacent development. The early commencement of scientific work on the Project Area is an important factor in its local scientific heritage value, positioning the scientific work at the Project Area as influential on GSM research themes.

  Now that a large number of other GSM sites are known in and around the ACT, and broad based monitoring and conservation programs are being implemented at diverse habitat sites, the significance of the record from Blocks 3 and 15 will decline over time. It is one snapshot of the population dynamics of the species, from a site that is not representative of the range of sites on which the GSM and its grassland habitat occur. This suggests that the relative significance of the Project Area will decline over time and therefore the significance of the impact of development would also decline.

- Beyond the requirements of the EPBC Act for the land owner, monitoring and research conducted at the Project Area by CSIRO, ANU or UC scientists has been somewhat opportunistic and patchy, with the key studies having taken place in the mid to late 1990s and then in 2006 and 2010. Other publications refer to these earlier studies. Although there is recognition and interest in the site, there is no commitment from these institutions to continue new research into the GSM at this site. The Project Area has provided valuable information about some key conservation issues which continue to attract research interest in Australia – but now with research opportunities across a wide range of grassland habitat sites in the ACT, NSW and Victoria.

- The Project Area has been used intermittently for student coursework for ANU and UC courses, benefiting from its central location and long recognition. There are other grassland sites throughout the valleys of the ACT which could be used for such tutorial/excursions. These other sites are also generally accessible.

- The culture of Canberra, and the central location and accessibility of the Project Area have also influenced its value for citizen science, with intermittent community monitoring adding to the overall body of monitoring work and to the recognition of the site by the broader community as a place of scientific interest. However, these community scientists also monitor other GSM sites, and the value of their contribution at Blocks 3 and 15 must be considered in the context of the annual monitoring required under the EPBC Act. In this context, occasional community monitoring (whether recorded or not recorded) demonstrates interest and commitment but is not scientifically significant.

- The integrity of the fabric of the place is vulnerable to a range of urban and isolation threats, and to invasive species. In the short term, this provides a further research opportunity to study how the population responds to isolation and local threats over time. In the medium term, the value of the place in relation to criteria (a) and (b) is expected to decline as the quality of the fabric of the place declines, even if relatively intensive conservation management is maintained. Intensive management to date has not prevented substantial changes to the habitat (including invasion by Chilean needle grass and shading from adjacent buildings). In comparison to other sites, the value of the fabric of the place has a limited lifespan.

- With the changes to the condition of the fabric of the place, the research opportunities at the Project Area will not necessarily make a major contribution to knowledge that will support the conservation of the GSM across its range, which includes large and contiguous areas of grassland – in the ACT, southern NSW and Victoria.

- There are opportunities to continue to build knowledge of the survival of the GSM on isolated urban sites (and other sites) from continuing structured monitoring programs across land owned by ACT Government and the Commonwealth Government.

4.2 Significant Impact Assessment Conclusion

The assessment of the scientific heritage significance of Blocks 3 and 15 at Section 22 Barton considered:

- the broad spectrum of ‘scientific’ work that has been conducted at or relates to the grassland community or the GSM population on site; and

- the perspective of scientific researchers in Canberra with interests in the dynamics and conservation of insect populations.

The assessment found that the scientific value of the Project Area does not meet the requirements of any National heritage criterion.

The Project Area currently meets two criteria that are relevant to scientific heritage value at the local (ACT) level. Local heritage significance is the threshold for recognition the Commonwealth Heritage List. The local criteria which are met at the Project Area are:

- ACT Criterion (a) - Important to the course of the ACT’s cultural or natural history; and

- ACT Criterion (b) - has uncommon, rare or endangered aspects of the ACT’s cultural or natural history.

These ACT (local) heritage criteria are met because of the early recognition of the site as GSM habitat and its accessible location in the centre of a city with major research organisations and long-standing citizen science interest. The research and monitoring conducted at the site over twenty years was initially rare and has been influential on GSM research and management.

This value is based on association and the record of previous research, rather than the continuing research value of the fabric of the Project Area.

The local heritage value reflects a snapshot in time. The future scientific heritage value of the Project Area depends on its continuing suitability for meaningful and influential scientific research, to provide further valuable insights and understanding of the GSM, its habitat and its management. The evidence suggests that this continuing local scientific heritage value of the Project Area is vulnerable to multiple influences and impacts, separate to the direct impact of potential disposal, clearing and development of the Project Area.

While in the past the research conducted at the site can be considered to have been influential, there are now many accessible sites where scientific work is continuing across a range of research and management themes. This broader context changes the scientific value of the Project Area for future influential research.

Other factors include the edge effects of adjacent development, the increasing presence of the invasive species Chilean needle grass and climate change. The Project Area and its context is not representative of GSM habitat with long term conservation potential. These all affect the future scientific heritage value of the Project Area.

The research value of the Project Area is relatively diffuse, not sharply defined in terms of high profile research programs. It cannot be said that the Project Area is central to any current or proposed major entomology or conservation research program, although it has provided useful information about the resilience of an isolated local population of a critically endangered species.

At the same time, there are now many known GSM sites on public and private land across the ACT, NSW and Victoria which present good opportunities for scientific research, including sites where similar research themes to those which have been illustrated at Blocks 3 and 15 could be continued.

The net result of these considerations is that although the Project Area is assessed as having local heritage significance because of the influence of scientific work that has occurred there in the past, the scientific heritage value of the place as a physical entity is not expected to continue into the future. This diminution of heritage value will occur irrespective of development decisions about the Project Area.

In summary:

- The Project Area has local scientific heritage significance now, based on local culture, central location, early recognition and the influence of data acquired from research statutory monitoring programs on GSM research and management themes.
- This scientific heritage value relates to past site specific and contextual conditions and is not affected by the future use of the Project Area.
- The local scientific heritage significance is expected to decline due to factors other than the disposal and development of the Project Area.
- The local scientific heritage significance of the Project Area is also already being modified by new scientific research programs across a broader range of sites. Citizen science interest is and can also be encouraged in these sites.

Based on this analysis, the scientific heritage impact of the proposed disposal and development of the Project Area is not significant.

The potential impact of disposal and development on this Project Area can be further mitigated by:

- Maintaining the documentary evidence of past research and monitoring in a secure but accessible form.

- Strengthening science and citizen science programs and conservation measures for more resilient sites of GSM habitat.

Management options are further discussed in **Section 4.3**.

4.3 Management Options

Finance may choose to permit local scientists and citizen science groups to implement a number of management options designed to hold and preserve records of the evidence that underpins the local scientific heritage value of the Project Area. This value is linked to the rare (because of its length) and influential record of scientific work at the Project Area, which provides an example of endangered species resilience in an isolated habitat fragment in an urban area. The links between this early scientific work and the scientific culture of the ACT add to the local scientific heritage significance.

Options that Finance may consider include:

- Continue with existing management obligations to manage the Project Area to minimise impacts on MNES, until the proposed action is undertaken.

- Prior to clearance, permit research opportunities including collection of specimens from Block 3 and Block 15 which can be used for genetic profiling using modern techniques, and can also be stored using modern techniques to improve longevity and future usefulness for research.

- Work with scientists and/or scientific libraries at CSIRO or universities in Canberra to make sure copies of past research and monitoring data and reports are maintained and accessible for future researchers.

In addition to these measures that relate to the scientific heritage value of the Project Area, Finance could permit scientists and citizen scientists to facilitate future scientific research on the GSM on land that it owns where quality GSM habitat can be maintained. This could include the proposed offset site at Block 48 at Hall. Finance could:

- outline the location of other GSM sites available throughout the ACT, including the offset site;

- invite relevant scientific stakeholders to participate in the management of the offset property;

- arrange access to the site for research and teaching purposes, which could help build up a record of change over time; and

- make any previous and future survey results of this site readily available.

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Hogg, D. (2010*) A strategic approach to the conservation and environmental assessment of golden sun moth sites in the Canberra region*, Interim revised report to Land Development Agency, Canberra.

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Parsons Brinckerhoff (2008) *Natural Temperate Grassland Maintenance Plan Block 3 Section 22 Barton, ACT*, unpublished report prepared for the Department of Finance, Canberra.

Richter, A. (2010) *What makes Species Vulnerable to Extinction Following Habitat Fragmentation and Degradation? A test using the insect fauna and native temperate grasslands of south eastern Australia*, thesis submitted for PhD, University of Canberra.

Richter, A., Osborne, W., Robertson, G. and Hnatiuk, S. (2009) *Community Monitoring of Golden Sun Moths in the Australian Capital Territory Region, 2008-2009*, Threatened Species Network, Canberra.

Richter, A., Osborne, W., Hnatiuk, S., and Rowell, A. (2013) *Moths in fragments: insights into the biology and ecology of the Australian endangered golden sun moth Synemon plana (Lepidoptera: Castniidae) in natural temperate and exotic grassland remnants*, Journal of Insect Conservation: 17, 1093-1104.

Richter, A., Osborne, W., and Traugott, M. (2010) *Dietary Specialisation in the golden sun moth Synemon plana – the key to understanding habitat requirements and site rehabilitation for this critically endangered species*, Institute of Applied Ecology, University of Canberra and Institute of Ecology University of Innsbruck report prepared for Biodiversity Policy and Programs Branch, Victorian Department of Sustainability and Environment,

Robert Jessop Pty Ltd (PJPL) (2014a) *Potential shading impacts on York Park: Golden Sun Moth monitoring plan*, unpublished report prepared for Section 22 Barton Pty Ltd, Canberra.

Robert Jessop Pty Ltd (PJPL) (2014b) *York Park Golden Sun Moth monitoring (2013)*, unpublished report prepared for Section 22 Barton, Canberra.

Robert Jessop Pty Ltd (PJPL) (2015) *York Park Golden Sun Moth monitoring (2014)*, unpublished report prepared for Section 22 Barton, Canberra.

Rowell, A. (2007) *Survey and Impact Assessment at Golden Sun Moth Synemon plana site, blocks 3 and 7, Section 22 Barton (York Park)*, unpublished report prepared for Parsons Brinckerhoff, Canberra.

Rowell, A. (2012) *Five (5)-year Monitoring Event for Golden Sun Moth*, unpublished report prepared for Parsons Brinckerhoff, Canberra.

SMEC (2016) *Golden Sun Moth Monitoring 2015 York Park*, unpublished report prepared for Section 22 Barton, Canberra.

SMEC (2017) *Golden Sun Moth Monitoring 2016 York Park Conservation Area,* unpublished report prepared for Section 22 Barton, Canberra.

Umwelt (2014) *Natural Temperate Grassland Maintenance Plan Block 3 Section 22 Barton ACT*, unpublished report prepared for the Department of Finance and Deregulation, Canberra.

Umwelt (2015) *Natural Temperate Grassland Condition Assessment and Golden Sun Moth Monitoring Event*, unpublished report prepared for the Department of Finance, Canberra.

Umwelt (2016) *Offset Analysis Report, Block 3, Section 22 and Proposed Offset Sites*, unpublished report prepared for the Department of Finance, Canberra.

Umwelt (2016) *Golden Sun Moth and Natural temperate Grassland Vegetation Management Plan: Block 3, Section 22 Barton*, unpublished report prepared for the Department of Finance, Canberra.

APPENDIX 1

Commonwealth and ACT Heritage Guidance and Interpretation

Table A1.1 provides the assessment framework for Commonwealth heritage criteria, in order of priority for scientific heritage assessment. This is based on advice provided by AHC (2009).

Table A1.1 Commonwealth Heritage Assessment Framework

Criterion	Heritage Assessment Framework
(c) the place has significant heritage value because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history	This criterion applies to places with potential to provide information (including scientific information) from a variety of sources as a research resource. The information potential may be embodied within, be at, or associated with the place; sources may include records, collections, oral traditions, biological material or the place's fabric. Places that meet this criterion may also meet other related criteria, but this is not always the case. To meet this criterion, it must be demonstrated that the place significantly contributes to scientific studies that have led or could lead to greater understanding of the natural history of Australia; or the place is significant as a place of a discovery that has potential to yield information that could contribute to an understanding of the natural history of Australia. For the NHL, potential research value must be shown to relate to a contribution of national importance. For the CHL, a contribution of local, regional, or state importance will meet the threshold, but the level of significance must be clear. It is noted for this criterion that: • 'information' does not include educational or interpretational value (this is not a national heritage value, rather an action that may be implemented after the heritage value has been determined); • potential does not mean 'possibility', there must be evidence (from expert testing or professional examination) of real, proven, or established possibility of occurring; and • potential to yield information may be fully realised or exploited, in which case a place would not meet this criterion.
(a) the place has significant heritage value because of the place's importance in the course, or pattern, of Australia's natural or cultural history	Criterion (a) is intended to identify natural environment places that contain 'exemplary' evidence of past or continuing natural processes (including biological processes). For a place to satisfy this criterion there must be evidence that the place has been recognised because of its importance in the course or pattern of Australia's (i.e. for NHL consideration) or regional level (i.e. for CHL consideration) natural history. The place may demonstrate ecological processes, environmental richness or diversity, or refugia Places that meet this criterion from an ecological perspective maintain or demonstrate ongoing biological or evolutionary processes important at the relevant scales. It may include intact ecosystems or places of high integrity, or centres for richness or diversity.

Criterion	Heritage Assessment Framework
(b) the place has significant heritage value because of the place's possession of uncommon, rare, or endangered aspects of Australia's natural or cultural history	This criterion is principally about the rarity of the value (i.e. biological, geomorphological, or palaeontological) of a place. The context of the rare value is very important for assessing whether it meets this criterion. Uncommonness or rarity is not sufficient by itself to meet this criterion. Rather, the uncommonness or rarity must be understood in consideration of the importance of the value to the scale considered (i.e. either national or regional). For example, to meet this criterion a place may: • be the only and/or only extant example at that scale, that retains integrity or authenticity; or • represent the rare and threatened species that possess significant conservation values at the relevant scale.
(g) the place has significant heritage value because of the place's strong or special association with a particular community or cultural group for social, cultural, or spiritual reasons	This social criterion applies to places in the public consciousness, for which a community or cultural group exhibits a strong or special attachment. This criterion is intended to apply to places that have strong community associations because of social or cultural traditions. The association is expected to have longevity and contain a deep sense of ownership; and the place must be recognised and used by the community or cultural group. The definition of community is the key to the application of criterion (g). Communities may be any group of people whose members share a locality, government, or cultural background. A special interest group or professional group does not constitute a community or social group for this criterion as common expertise is not sufficient on its own to define a group.
(h) the place has significant heritage value because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history	The key to this criterion is the strength of the association of a person or group with a place that is related to the particular and important contribution made by that person or group to the natural history of Australia (i.e. for NHL consideration) or a local area, region, or state (i.e. for CHL consideration). It is important to note that for this criterion not only does a strong association between people and place need to be demonstrated, but also the importance of the person or group to the relevant scale.

Table A1.2 provides the assessment framework for ACT heritage criteria, in order of priority for scientific heritage assessment. This is based on advice provided by ACT Heritage Council (2018).

Table A1.2 ACT Heritage Assessment Framework

Criterion	Heritage Assessment Framework
(a) importance to the course or pattern of the ACT's cultural or natural history	This criterion is met if the place has a clear and important association with an element of the ACT's natural history (e.g. ecological community, species, or biodiversity); and this **association is evident in the physical fabric** of the place or in documentary resources. The association must have made a strong, noticeable, or influential contribution to the evolution or pattern of the ACT's natural history. The place may be the product or evidence of former, present, or continuing natural processes (such as demonstrating the integration between different ecological communities in a landscape); shows evidence of a significant ecological community/species/biodiversity; or demonstrates a distinctive association to the above. The interaction between natural value, scale, and integrity is of importance to this criterion/ Places that meet the threshold for significance for this criterion will have: • representativeness, distinctiveness, exceptionality, and/or extensiveness; • intactness, integrity, and/or rarity; • had seminal or early influence, or long and influential association; and/or • demonstrated extent and degree of community interest. A place would not meet this criterion if it provides evidence of a 'common' quality in the ACT, is of questionable importance to the ACT, the evidence is not clearly established, is not in some way distinguished or special, or the place has been so altered that it can no longer provide evidence of its meaning.
(b) has uncommon, rare, or endangered aspects of the ACT's cultural or natural history	To meet this criterion a place must have a clear association with an aspect of the ACT's cultural or natural history that has made a strong, noticeable, or influential contribution to the ACT's society and environment; and this association is evident in the physical fabric of the place or in documentary resources. It is intended that this criterion applies to places that provide significant habitat for rare, threatened, uncommon, or at-limits-of-range species. Rarity and uncommonness should be judged in the context of similar places elsewhere in the ACT, while the place must be of sufficient integrity to demonstrate these qualities. A place may be included if it is the only or only extant example within the ACT; has a high integrity or authenticity; has a mix or composition that is rare in the ACT; or it has unusual richness, diversity, or significant transitions of flora, fauna, or natural landscapes.

Criterion	Heritage Assessment Framework
(c) potential to yield information that will contribute to an understanding of the ACT's natural or cultural history	To meet this criterion there must be a reasonable likelihood that the place contains substantial, currently non-visible physical evidence of archaeological or other defined research interest that is likely of an integrity/condition to yield information that will provide a substantial contribution to an understanding of the ACT's cultural or natural history. This criterion would normally apply to archaeological sites and natural sites that develop over time through 'layering' of fabric or have potential to yield information across a variety of fields of study. The potential to provide information must relate to the physical evidence available at the place and not the associated documentary evidence related to the place. The place must have the potential to yield important or substantial information and not simply replicate or confirm evidence provided by other sources (i.e. if the information is already known, then this criterion does not apply). A place would also be more important if it is the only known source of information of its kind. Furthermore, the area of research relevant to the place must be demonstrated. A place would not meet this criterion if: • the place no longer has capacity to contribute to a better understanding (e.g. significant disturbance detracts from the research potential); • the information is readily available from other sites; and/or • the potential research relates to documentation rather than the fabric of the place.
(g) has a strong or special association with the ACT community, or a cultural group in the ACT for social, cultural or spiritual reasons	This criterion applies if there is clear evidence of a social, cultural, or spiritual association between the place and the ACT community or a cultural group in the ACT. The evidence for this association should relate to criteria such as distinctiveness, exceptionality, extensiveness, intactness, integrity, length of association, or cultural practices; and should conclude that the place is held in special or high regard. An ordinary person should be able to easily recognise the association between the community or cultural group and the place. Professional groups and special interest groups do not constitute the community or a cultural group for the application of this criterion. This criterion may apply if the attachment is demonstrable, broadly based, enduring (i.e. approximately 20 years), or out of the ordinary; there is a deep sense of ownership/stewardship/connectedness to the place from the community or group. This criterion is not likely to apply if the attachment is demonstrated only through petition or form letter etc or the place is valued only for amenity or utility reasons.

APPENDIX 2

Scientific Research Themes

The following sections describe in detail the National scale research themes identified in the literature review. These research themes are:

- genetic diversity;
- population change over time;
- links between population vulnerability and habitat quality (and what defines quality habitat for this species);
- the resilience of the species to major events and gradual change;
- the value of flagship species and accessible urban sites in driving or supporting conservation outcomes and awareness; and
- the broader issues around decision making for effective conservation management.

For ease of discussion, these themes have been grouped in the following sections. Genetic diversity, population change over time, and links between population vulnerability and habitat quality are discussed in **Section A2.1**. Conservation management issues relating to flagship species and GSM resilience are discussed in **Section A2.2**; while broader conservation management decision making is discussed in **Section A2.3**.

A2.1 GSM Species and Population Issues

Research topics that sit within the National research themes of genetic diversity and population change over time include the following:

- Determining the life cycle of GSM and how it relates to soil and grassland conditions. This information has primarily been obtained from monitoring results. Richter *et al* (2013) reports on earlier work undertaken by Edwards (1994), states that based on the size classes of larvae observed in the soil; GSM appear to remain underground for at least two years.
- Genetic variability and diversity of GSM across a broad range of habitats. Areas include temperate native grasslands of south-eastern Australia and grassy woodlands. Edwards (1994) is an example of early work in this field.
- Identifying the habitat and food tolerances/preferences of GSM. In particular, this relates to building an understanding of the role and value of the Weed of National Significance Chilean needle grass (*Nassella neesiana*) for GSM; and how it may affect the distribution and survival of the species in the future. Specific examples include:
    - Richter *et al* (2012 and 2013) highlights the limited knowledge about GSM larval ecology; but notes the larvae are surviving in remnants of native grasslands as well being present (as eggs, larvae, and adults) in areas either partly or wholly dominated by Chilean needle grass.
    - Richter *et al* (2013) refer to earlier work undertaken in the ACT (Braby and Dunford, 2006) and Victoria (Gilmore *et al*, 2008) that also record GSM in exotic grasslands. Richter *et al* (2013) propose explanations for these observations and note the potential for future research on GSM conservation and determining the grassland assemblage that is most favourable for its survival. Also note the significant challenges for managing Chilean needle grass.

- Hogg (2010) also refers to the role of Chilean needle grass as GSM habitat – noting the 'circumstantial evidence' that the exotic grass as physical (i.e. structural) or chemical properties that are attractive to GSM. Hogg (2010) notes that there is limited research on the longer-term population changes that may occur on sites of various sizes with various assemblages of native grasses and Chilean needle grass.

- Hogg (2010) also notes that even on disturbed sites in the ACT, low population densities of GSM may continue at relatively stable levels, as recorded over a maximum of around 10 years.

- Identifying methods for population monitoring, given that GSM spends most of its life-cycle underground and only emerges to fly for a short period of time in summer. Richter *et al* (2013) refer to the difficulty of formulating specific conservation actions for GSM because of the lack of a standardised monitoring protocol and limited knowledge of GSM ecology. They report a number of monitoring methods that may be applied that have varying levels of complexity, skill requirements, and time requirements. They concluded that different methods provide more or less reliable estimates of population size and are suitable for different types of research. It was apparent that the time of day for monitoring is also important.

Of importance to GSM within the ACT, research into the value of small, urban habitat patches for the conservation of the species has also been undertaken. Hogg (2010) suggests that locations where GSM occur in central Canberra are on land that was likely withdrawn from rural land use early in Canberra's development. These land parcels were likely retained (generally unmanaged) as grassland remnants or only limitedly modified by rural uses that would have precluded GSM habitat regeneration. Despite this value, these sites are generally more vulnerable to edge effects or catastrophic events due to their size and isolation, and have generally low species diversity. The long-term biodiversity potential of these sites needs to be considered.

Research undertaken by Hogg (2010) as part of this broader research theme also notes the conservation value of existing, longer-term monitoring programs. Specifically, any sites that have a long and reliable monitoring history, which would be difficult to replicate elsewhere or are otherwise scientifically significant (e.g. because of their use for major grassland rehabilitation trials).

A2.2 Broader Conservation Issues

GSM research also links into themes concerning broader conservation issues. Examples of this research are as follows:

- The use of GSM as a 'flagship' species for insect conservation. Hogg (2010) notes that GSM (particularly flying males) is probably the easiest of the threatened grassland species to detect, despite the limited time period and conditions of activity. This increased ability to detect the moth increases its cultural value, irrespective of its conservation status. Over 20 years, GSM has gone from being a species studied only by a handful of scientists, to one that has attracted wide community interest Note that this observation relates to the value of the species, not to any individual site at which it may be seen.

- Some studies also discuss and highlight the value of citizen science in urban areas, including the role of 'friends' groups.

    - Richter *et al* (2013) report the role of volunteers who participated in surveys in Canberra in 2012 and collected some 650 pupal cases from 11 grassland areas.

    - Hogg (2010) highlights the importance of 'friends' groups in insect conservation campaigns. This includes their capacity to encourage large numbers of participants to join in field monitoring exercises. The ease of access and lack of travel costs for people working in their local area means that people can potentially visit a site on multiple occasions, provide photographic records and increase the database of observations, and raising the profile of insect diversity. From a scientific perspective, well trained citizen scientists are a large and enthusiastic labour force for both spatially extensive and detail intensive programs. Richter *et al* (2009) echoes these sentiments, noting that citizen science is a significant opportunity to gain widespread data about presence, absence, timing, and numbers of flagship (or other) species. In the case of GSM in the ACT, a cross-city survey organised by the University of Canberra and Friends of Grasslands (reported in Richter *et al*, 2009) was able to distinguish several urban sites where GSM had previously been observed but were not as part of this survey, or where apparent suitable habitat was present but the species was not observed.

- Opportunities to promote and strengthen habitat for insect species conservation in urban areas is discussed by Hogg (2010). These include more natural landscaping approaches (in home gardens and public parks), use of locally indigenous species, maintaining dead wood and leaf litter in urban parks and reserves (where feasible), and a range of interpretation and information options. A number of researchers have investigated the effectiveness of these approaches in terms of restoring habitat and populations for threatened or endangered insect species.

A2.3 Conservation Management Decision-making

Research themes identified in conservation management decision-making and stimulating conservation attitudes include:

- Determining conservation priorities in contested land use contexts:
    - Hogg (2010) notes that it is inevitable that future developments will adversely affect some GSM habitat; but that conservation of the species does not necessarily mean conserving every site at which it has been recorded. Rather, a strategy should be developed to build on major initiatives that the ACT Government has already undertaken by improving habitat quality or implementing indirect offsets in those areas of highest conservation value and/or greatest long-term security.
    - This is still an issue for GSM conservation today. New (2018) notes that conservation considerations include deciding which sites may be the least significant and might be sacrificed.
- The value of interpretation is identified by New (2018). The use of government sponsored publicity for flagship species to disseminate knowledge of natural history and increase awareness of conservation needs and how these may be pursued.
- Richter *et al* (2013) discusses how monitoring is a powerful tool in conservation biology and how species such as butterflies and moths may be used as environmental indicators used in long-term monitoring. The benefit of such indicators is the way it can be used by citizen scientists, allowing larger and cheaper monitoring events.
- Research into the impact of climate change on insect populations:
    - Richter *et al* (2013) and New (2018) refer to the potential for climate change to greatly modify the habitat value of temperate grasslands naturally located in frost prone areas at low to moderate elevation. This will influence the survival of endangered ecological communities and their insect fauna. Details of specific ecological impacts are a subject for further research, to support conservation efforts.

A2.4 Research conducted at Blocks 3 and 15, Section 22 Barton.

Table 1 organises the reports into the four categories identified in **Section 3** of the main text. Where appropriate, **Table 1** also highlights the broad research theme to which the work was relevant.

Table A2.1 Scientific Studies At or Referring to York Park Conservation Area

ACT Research Category 1: Specialist scientific research:
Clarke, G. M. and O'Dwyer, C. (1998) *Genetic Analysis of Populations of the Endangered Golden Sun Moth, (Synemon plana)*, unpublished report for the Threatened Species Unit (NSW National Parks and Wildlife Service, Southern Zone) and the Wildlife Research and Monitoring Unit (Environment ACT), CSIRO Division of Entomology, Canberra. Braby, M.F. and Dunford, M. (2006) Field observations of the ecology of the golden sun moth, *Synemon plana walker* (*Lepidoptera: Castniidae*). Australian Entomologist 33, 103-110 Richter, A. (2010) What makes species vulnerable to extinction following habitat fragmentation and degradation? A test using the insect fauna and native temperate grasslands of south eastern Australia. Thesis submitted for PhD, University of Canberra. Richter, A., Osborne, W., Hnatiuk, S. and Rowell, A. (2013) Moths in fragments: insights into the biology and ecology of the Australian endangered golden sun moth *Synemon plana* (*Lepidoptera: Castniidae*) in natural temperate and exotic grassland remnants. Journal of Insect Conservation 17, 1093-1104
ACT Research Category 2: Studies for development assessment purposes:
Biosis (2015) Blocks 3 and 15, Section 22 Barton ACT – EPBC Act Offset Assessment Options and Recommendations. Environmental Resources Management Australia (ERM) (2005) Strategic advice on the development potential of Block 3, Section 22: York Park, Barton. Report to the Department of Finance and Administration. Robert Jessop Pty Ltd (RJPL) (2014a) Potential shading impacts on York Park. Golden Sun Moth monitoring plan. Report prepared for Section 22 Barton Pty Ltd by Robert Jessop Pty Ltd, Canberra Rowell, A. (2007) Survey and Impact Assessment at Golden Sun Moth *Synemon plana* site, Blocks 3 and 7, Section 22 Barton (York Park), unpublished report prepared for Parsons Brinckerhoff, Canberra. Umwelt (2016) *Offset Analysis Report, Block 3 Section 22 and Proposed Offset Sites*, unpublished report prepared for the Department of Finance, Canberra.

ACT Research Category 3: Monitoring or management required of the land owner:
Cook, L. and Edwards, E.D. (1993) Population monitoring of the endangered moth *Synemon plana* 1992-93, York Park, Barton. CSIRO report to National Capital Planning Authority Cook, L. and Edwards, E.D. (1994) Population monitoring of the endangered moth *Synemon plana* 1993-94, York Park, Barton. CSIRO report to National Capital Planning Authority Davis MS and Hogg D (1992) York Park, Barton. Botanical survey. Report to National Capital Planning Authority by David Hogg Pty Ltd. Edwards, E.D. (1995) Provisional Management Recommendations for York park moth site. Report to the National Planning Authority. CSIRO Division of Entomology, Canberra. Harwood. T., Narain, S. and Edwards, E.D. (1995) Population monitoring of endangered moth *Synemon plana* 1994-95, York Park, Barton. CSIRO Australia. Report to National Capital Planning Authority Parsons Brinckerhoff (2008) *Natural Temperate Grassland Maintenance Plan Block 3 Section 22 Barton, ACT*, unpublished report prepared for the Department of Finance, Canberra. RJPL (2014b) York park Golden Sun Moth monitoring (2013). Report prepared for Section 22 Barton by Robert Jessop Pty Ltd, Canberra. RJPL (2015) York Park Golden Sun Moth Monitoring (2014). Report prepared for Section 22 Barton by Robert Jessop Pty Ltd, Canberra. Rowell, A. (2007) 'Survey and Impact Assessment at Golden Sun Moth *Synemon plana* site, Blocks 3 and 7, Section 22 Barton (York Park)'. This survey was completed to support an understanding of the environmental factors for Block 3 and included capture-mark-release techniques to estimate the population size. Rowell, A. (2012) 'Five (5)-year Monitoring Event for Golden Sun Moth'. The GSM Maintenance Plan for the York Park Conservation Area included five (5)-yearly population monitoring that utilised a capture-mark-release method (Parsons Brinckerhoff, 2008). This report provides the results of the 2011 surveys. SMEC (2016) 'Golden Sun Moth Monitoring 2015 York Park' and SMEC (2017) 'Golden Sun Moth Monitoring 2016 York Park Conservation Area'. GSM monitoring report for York Park Conservation Area only, prepared as a condition of approval under EBPC Referral 2012/6606. Monitoring includes a count of flying moths, pupae case survey, vegetation survey, and soil temperature monitoring. Umwelt (2014) 'Natural Temperate Grassland Maintenance Plan Block 3 Section 22 Barton ACT'. An update to the Parsons Brinkerhoff (2008) Maintenance Plan for York Park Conservation Area only. Provided management recommendations to maintain the NTG and associated GSM values at the site. Umwelt (2015) 'Natural Temperate Grassland Condition Assessment and Golden Sun Moth Monitoring Event'. Provides the results of the 2014 monitoring event as recommended by Umwelt (2014). The monitoring targets GSM and NTG within York Park Conservation Area (as amended following the approval of the proposed development of Little National Hotel on the adjacent block (EPBC Referral 2012/6606)). Umwelt (2016) Golden Sun Moth and Natural temperate Grassland Vegetation Management Plan. Block 3, Section 22 Barton. Draft Report prepared for Department of Finance, January 2016. Umwelt (2016a) 'Golden Sun Moth and Natural Temperate Grassland Vegetation Management Plan Block 3, Section 22, Barton ACT'. Provides the results of the 2015 monitoring event as recommended by Umwelt (2014). The monitoring targeted GSM and NTG within the York Park Conservation Area.

ACT Research Category 4: Regional scale baseline studies for conservation management:

These reports are not always specifically about the Project Area, but refer to the Project Area.

ACT Government (1997) Natural temperate grassland: an endangered ecological community. Action Plan No. 1. Environment ACT

ACT Government (1998) Golden sun moth (Synemon plana): An endangered species Action Plan No. 7. Environment ACT.

ACT Government (2005) A Vision Splendid of the Grassy Plains Extended: ACT lowland native grass conservation strategy. Action Plan No. 28 Arts, Heritage and Environment, ACT.

Clarke, G.M. and O'Dwyer, C. (1997) A survey of native grassland sites in south eastern NSW for the endangered golden sun moth, Synemon plana. Report to Threatened Species Unit, NSW NPWS

Frawley, K. (1995) Planning for urban native grassland conservation: York Park, Barton ACT.
In: Management of relict lowland grasslands. Proceedings of a workshop and public seminar. 1993

Hogg, D. (2010) Semi quantitative assessment of golden moth sites. Appendix K in Golden sun moths in the Canberra area, 2009, Report to Land development agency by David Hogg Pty Ltd, Alison Rowell and NHG Environmental.

Hogg, D. (2010) A strategic approach to the conservation and environmental assessment of golden sun moth sites in the Canberra region. (Interim revised report) Report to Land Development Agency.

New, T.R., (2018) Promoting and developing insect conservation in Australia's urban environments. Austral Entomology (2018) doi:10.1111/aen.12332

Richter et al (2009) 'Community Monitoring of Golden Sun Moths in the Australian Capital Territory Region, 2008-2009'. This project was a pilot GSM monitoring program that surveyed a number of sites across the ACT and the surrounding region, including the York Park Conservation Area and Sydney Avenue median strips. Surveys were undertaken by community members supervised and trained by ecologists.

Richter, A., Osborne, W. and Traugott, M. (2010) Dietary specialisation in the golden sun moth Synemon plana – the key to understanding habitat requirements and site rehabilitation for this critically endangered species. Final report to Biodiversity Policy and Programs Branch, Victorian Department of Sustainability and Environment. Institute of Applied Ecology (Canberra University) and Institute of Ecology University of Innsbruck.

APPENDIX 3

CSIRO Initial Letter

Australian Government

Department of Finance

Dr David Yeates
Commonwealth Scientific and Industrial Research Organisation
Director of ANIC
GPO Box 1700
Canberra ACT 2601

Dear Dr Yeates

Scientific heritage values at Block 3, Section 22, Barton, ACT

Block 3, Section 22, Barton, ACT (the Property), which is owned by the Department of Finance (Finance), has been identified as surplus to Commonwealth requirements and is proposed to be sold in a single open market sale to a private purchaser for the purpose of development.

I understand that your organisation may have an interest in the environmental attributes of the Property. You may be aware that a section of the Property, referred to as York Park Conservation area, includes grassland that supports a threatened ecological community *Natural Temperate Grasslands of the South Eastern Highlands* and a critically endangered species, *Synemon plana* (Golden Sun Moth), protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In order to progress the sale, Finance submitted an EPBC Act referral to the Department of the Environment and Energy (Environment) seeking approval to clear the site and divest.

On the 11 October 2017, a delegate of the Minister for the Environment and Energy decided that the proposal will require assessment and approval under the EPBC Act before it can proceed. As part of the assessment process, Finance is now preparing preliminary documentation to enable Environment to assess the nature and extent of impacts of the proposal and determine the adequacy of avoidance, mitigation and compensatory measures.

As part of the assessment process, we are considering the Property's potential scientific heritage values for the Golden Sun Moth. To assist with this, Finance would appreciate any contributions you may have on scientific heritage values of this site, in relation to:

- longitudinal survey data on basic biology.
- the species persistence on small sites.
- the species response to shading and pasture composition.
- In addition, Finance would appreciate any information that you can share on: what value(s) your organisation/community receives from this data, and whether this can this be sourced elsewhere.
- suggested approaches to offsetting scientific heritage values of the site as part of an offset strategy that will aim to protect and support the continued growth of the grassland community and Golden Sun Moth population at a separate and appropriate location for these communities and species to thrive.

Australian Government

Department of Finance

Deloitte Touche Tohmatsu (Deloitte), Finance's Strategic Property Adviser, will be managing the consultation process. If you wish to contribute please contact Ben Ripley, Deloitte on 0474 738 753 to arrange a suitable time to discuss, or alternatively you may provide a written response by email to bripley@deloitte.com.au, no later than 10:00am Monday, 26 February 2018.

Additional information relating to the referral can be found at http://epbcnotices.environment.gov.au/referralslist/. Otherwise, if you have any questions please contact Deloitte on the details listed above.

Yours sincerely

Elizabeth Hickey
A/g Assistant Secretary
Property Divestment Taskforce

14 February 2018

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Blocks 3 and 15, Section 22, Barton

FINAL

September 2018

Australian Government
Department of Finance

PRELIMINARY DOCUMENTATION REPORT

EPBC Referral 2017/8028
Blocks 3 and 15, Section 22, Barton

FINAL

Prepared by
Umwelt (Australia) Pty Limited
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Report No.	8147/R04/Final
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Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
Draft Final	Naomi Buchhorn	28 June 2018	Naomi Buchhorn	28 June 2018
Final	Naomi Buchhorn	19 September 2018	Naomi Buchhorn	19 September 2018

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Our Ref: 8147_Department of Finance_Todd_20180919_ltr

19 September 2018

Mike Smith
Director Southern NSW & ACT Assessments
Department of the Environment and Energy
GPO Box 787
Canberra, ACT 2601

Dear Mr Smith,

Re: Addendum Report - Response to Public Submissions (Appendix 9) - Additional Information required for Preliminary Documentation Divestment of Blocks 3 and 15, Section 22, Barton, Australian Capital Territory (EPBC 2017/8028)

The Department of Finance (Finance) submitted a Referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 25 August 2017 for the proposed divestment of Blocks 3 and 15, Section 22, Barton, Australian Capital Territory (ACT), 2600.

The Department of the Environment and Energy (DoEE) determined the proposal to be a Controlled Action due to impacts to 'threatened species and communities' and as a 'Commonwealth action', and would be assessed on Preliminary Documentation. The Notice of Assessment (dated 2 November 2017) stated that DoEE would require additional information to assess the proposed action. The Preliminary Documentation Package addressing the additional information requirements was submitted on 29 June 2018.

On 20 July 2018, DoEE provided instructions to Finance under Section 95A(3) of the EPBC Act to proceed with the public consultation process. The Preliminary Documentation Package was placed on public exhibition from 4 August 2018 to 17 August 2018. Two submissions were received within the exhibition period and Finance's consideration of these submissions has been included in the Preliminary Documentation Package as an addendum report in Appendix 9.

Based on the responses provided to the issues raised in the submissions it has been determined that there is no need to alter the proposal or conclusions of the Preliminary Documentation.

Yours sincerely

Naomi Buchhorn
Principal Environmental Consultant

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29 June 2018

Mike Smith
Director Southern NSW & ACT Assessments
Assessments (NSW, ACT) and Fuel Branch, Department of the Environment and Energy
GPO Box 787
Canberra, ACT 2601

Dear Mr Smith,

Re: Additional Information required for Preliminary Documentation Divestment of Blocks 3 and 15, Section 22, Barton, Australian Capital Territory (EPBC 2017/8028)

The Department of Finance (Finance) submitted a Referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 25 August 2017 for the proposed divestment of Blocks 3 and 15, Section 22, Barton, Australian Capital Territory (ACT), 2600.

The Department of the Environment and Energy (DoEE) determined that the proposed action is a Controlled Action due to impacts to threatened species and communities and as a Commonwealth action; and would be assessed on Preliminary Documentation. The Notice of Assessment (dated 2 November 2017) stated that DoEE would require additional information to assess the proposed action. The enclosed Preliminary Documentation Package aims to address DoEE's information requirements regarding EPBC Referral 2017/8028.

The table below outlines the specific information requested by DoEE and the relevant sections of the Preliminary Documentation Package that address these requirements.

The Preliminary Documentation Report (this document) aims to provide DoEE with all of the additional information requested. Where required, the Preliminary Documentation Report is supported by detailed technical studies, which have been included in this Preliminary Documentation Package as appendices to the Preliminary Documentation Report.

Yours sincerely

Amanda Mulherin
Environmental Scientist

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Additional Information Requested	Relevant Package Section
Please provide additional information/clarification on surveys carried out for GSM habitat in the proposed action area since 2007 to substantiate the statement in the referral that GSM habitat in the proposed action area is equivalent to the area of NG (0.32 ha).	Section 2.1.2 Appendix 4
Please contact the ACT Government and/or other sources to ensure that you have provided the most current information on SLL at the site to verify its location, abundance and other supporting information (e.g. survey methodology used and survey reports documenting the recording).	Section 2.1.3 Appendix 5
Based on the above information make an assessment of whether the population of SLL at the site is likely to forma an <u>important population</u> using the criteria included in: • *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance, Department of the Environment, Water, Heritage and the Arts* (2013) (significant impact guidelines) • *Conservation Advice Delma impar, striped legless lizard, Threatened Species Scientific Committee* (2016) (striped legless lizard conservation advice) • *Environment Protected and Biodiversity Conservation Act 1999 referral guidelines for the vulnerable striped legless lizard, Delma impar* (2011) (striped legless lizard referral guidelines)	Section 3.3.1 Appendix 5
Please document consultations held with the scientific community to date relating to the site's scientific heritage values and/or carry out further consultation with the scientific community to quantify the specific scientific heritage values of the proposed action area.	Section 2.2 Appendix 6
Based on the additional information/clarification on the extent of GSM habitat in the proposed action area, discuss impacts to the species associated with the proposed action.	Section 3.2 Appendix 4
Please assess the likelihood of significant impacts to the SLL population in the proposed action area using the criteria included in the striped legless lizard conservation advice, striped legless lizard referral guidelines and the significant impact guidelines (as they relate to a vulnerable species).	Section 3.3.2 Appendix 5
Based on the additional information on the scientific heritage values of the site, please confirm the nature and extent of potential impacts on these values.	Section 3.4 Appendix 6
Please assess the likelihood of significant impacts to scientific heritage values in the proposed action area using the criteria included in *Significant Impact Guidelines 1.2 – Action on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies, Department of the Sustainability, Environment, Water, Population and Communities* (2013).	Section 3.4 Appendix 6
To the extent relevant, specific and detailed descriptions of proposed avoidance and mitigation measures are required for the impacts identified **for each MNES**.	Section 4
Include for each measure: i. An assessment of the expected or predicted effectiveness of the measures in reducing impacts to the community and other MNES. Include supporting evidence and details of the expected on-ground benefits to be gained through each of these measures. ii. Environmental objectives; performance criteria and measurability of outcomes; monitoring; corrective actions (including trigger points or thresholds for actions) and adaptive management; responsibility; and timeframes for proposed mitigation measures. iii. Demonstrated willingness and capability of achieving outcomes. Clear commitments about how these measures will be reported and audited (by whom, to whom, how often). iv. Predicted cost of mitigation and management measures and how they will be funded in perpetuity (and by whom). v. Any statutory or policy basis for the mitigation measures.	Section 4

Additional Information Requested	Relevant Package Section
vi. A risk analysis associated with achieving the outcomes and the level of control the proponent will have in achieving environmental objectives. vii. The mechanisms (and the period of operation) for ensuring the actions and protections are maintained. viii. Plans should refer to relevant conservation advices, recovery plans, threat abatement plans, and other guidance documents publish by the Department.	
Based on the assessment of likelihood of significant impacts to scientific heritage values in the proposed action area; provide information on measures (following on from discussion with the scientific community) which can be adopted to mitigate these impacts.	Section 4.3 Appendix 6
The PD should include details of any offset package proposed to be implemented, along with: • a description of how the offset package meets the requirements of the *EPBC Act Environmental Offsets Policy* (October 2012) and accompanying Offsets Assessment Guide; or • details of how the offset meets an endorsed state offsets policy.	Section 5 Appendix 8
The PD must provide information on the relevant economic and social impacts of the proposed action (positive and negative). Consideration of economic and social maters should include: • costs as well as benefits • consideration of different scales where relevant • specific dollar or other numeric values where relevant.	Section 3.5 Appendix 7
The information provided must include details of any proceedings under Commonwealth, state or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against: (a) the person proposing to take the action; and (b) for an action for which a person has applied for a permit, the person making the application.	Section 7

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Acronyms and Abbreviations

Acronym / Abbreviations	Definition
ACT	Australian Capital Territory
AICOMOS	Australia International Council of Monuments and Sites
ANU	Australian National University (Fenner School of Environment and Society)
Block 3	Block 3, Section 22, Barton, Australian Capital Territory 2600
Block 15	Block 15, Section 22, Barton, Australian Capital Territory 2600
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DoEE	Commonwealth Department of the Environment and Energy
Draft Amendment 88	Draft Amendment 88 of the NCP
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cwth)
ERM	Environmental Resources Management
Finance	Commonwealth Department of Finance
GSM	golden sun moth (*Synemon plana*)
MNES	Matter of National Environmental Significance
NCA	National Capital Authority
NCP	*National Capital Pan 1990* (Cwth)
NTG	Natural Temperate Grassland of the South Eastern Highlands
PD	Preliminary Documentation
RAI	DoEE's Request for Additional Information
SLL	striped legless lizard *(Delma impar*)
UC	University of Canberra
Umwelt	Umwelt (Australia) Pty Ltd

1.0 Introduction

A Referral (EPBC 2017/8028) was submitted seeking endorsement from the Minister for the Environment and Energy under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to clear all vegetation from, and then sell Blocks 3 and 15, Section 22, Barton, Australian Capital Territory (ACT), 2600.

The Referral was determined to be a 'controlled action' on 11 October 2017 and will be assessed on Preliminary Documentation (PD).

This package forms the Preliminary Documentation (PD) to be submitted to the Commonwealth Department of the Environment and Energy (DoEE). In addition to providing the Referral and initial supporting documentation (see **Appendix 1**), this PD provides a response to the request for additional information required for PD assessment.

1.1 Title of the Action

The title of the proposed action is 'Divestment of Blocks 3 and 15, Section 22, Barton, Australian Capital Territory'. Reference number: EPBC 2017/8028.

1.2 The Proponent

The proponent for the proposed action is the Commonwealth Department of Finance (Finance).

1.3 Proposed Action

This section describes the proposed action in detail, including its purpose and justification.

1.3.1 Description of the Proposed Action

The Referral, made under Part 9 of the EPBC Act, is seeking approval to clear Blocks 3 and 15, Section 22, Barton, ACT 2600. The proposed action includes divestment of the blocks in a single, open market sale to a private purchaser for the purpose of development.

To prepare the land for sale, the proponent will clear all of the vegetation present and subsequently maintain the blocks. Clearing will occur between exchange and completion of contracts for sale, prior to transfer.

The blocks are a total of 1.25 hectares in size (Block 3 – 1.15 hectares and Block 15 – 0.1 hectares); and are known to contain EPBC protected values: natural temperate grassland of the South Eastern Highlands (NTG), golden sun moth (*Synemon plana*, GSM) habitat, and striped legless lizard (*Delma impar*, SLL) habitat. The Sydney Avenue median strips adjacent to the blocks are also known to contain 0.4 hectares of low quality GSM habitat. The proposed action will directly impact the NTG, SLL and GSM habitat within the blocks and indirectly impact the GSM population on the median strips.

A description of the EPBC protected ecological values and extent of habitat present within Blocks 3 and 15 is provided in **Section 2** of this report. Based on this information, a detailed impact assessment is provided in **Section 3**. Both of these sections are supported by technical studies, which have been appended to this report as relevant.

Impacts to SLL and scientific heritage values of the blocks were assessed as being not significant under the EPBC Act, with consideration of relevant guidelines. This is discussed further in **Section 3** of this PD report.

An offset strategy, consistent with the EPBC Act Environmental Offsets Policy (DSEWPaC, 2012) has been developed to compensate for significant ecological impacts as a result of the proposed action to NTG and GSM. Part of Registered Rural Block 48, Hall, ACT (Block 48), located on Wallaroo Road, is proposed for use as a direct offset. The proposed part of Block 48 is believed to exceed the offset requirements for the proposed action and adequately compensate for the loss of NTG and GSM habitat; this is further discussed in **Section 5**.

A conservation agreement will be developed to ensure the protection and continued growth of NTG and GSM habitat at Block 48.

Block 3 is National Land, managed by the Proponent. Block 15 is Territory Land, managed by the ACT Government. Accordingly, the proposed action will be undertaken by the proponent with agreement from the ACT Government to include Block 15.

1.3.2 Location of the Proposed Action

The proposed action encompasses the entirety of Block 3 and Block 15; amounting to 1.25 hectares. The blocks are located on the corner of National Circuit and Sydney Avenue in Barton, ACT (**Figure 1.1**). It has been assumed that the proposed action will impact upon all existing values present within both blocks.

An approximately 0.5 hectare portion of Blocks 3 and 15 was set aside as 'York Park Conservation Area' (**Figure 1.1**), and is managed to maintain the ecological values present (described in detail in **Section 2**). The boundary of the York Park Conservation Area was amended to an area of 0.51 hectares in 2013, following the approval of the proposed development of an access road for the Little National Hotel on the adjacent block (EPBC Referral 2010/5548).

An impact assessment (Umwelt, 2017) completed as part of the original Referral process (see **Appendix 1**) identified that the proposed action is likely to impact upon natural values present within the easternmost median strips of Sydney Avenue (see **Figure 1.1**). This is discussed in detail in **Section 3**.

The proposed Impact Area (**Figure 1.1**) consists of the entirety of Block 3, Block 15; and the two south-easternmost Sydney Avenue median strips.

1.3.3 Related Actions

The proposed action does not impact or interact with any other EPBC actions that have been or are currently being undertaken in the region. It is not part of a larger action or part of a staged development.

There are no other actions related to the proposed action.

Image Source: Environment and Planning Directorate, ACT Government (2016)

0 50 100 200m
1:5 000

Legend

- Proposed Action Area
- York Park Conservation Area

FIGURE 1.1

Location of the Proposed Action

1.3.4 Background to the Divestment

Both Blocks 3 and 15 are 'designated land' under the *National Capital Plan 1990* (as amended) (NCP); being land having 'special characteristics of the National Capital' (s. 1.2, *National Capital Plan 1990*). The Blocks are located within the Barton Precinct, which is adjacent to Capital Hill and the Parliamentary Zone.

The Barton Precinct Code, as set out in the NCP, notes that Barton is characterised by a series of large buildings set in a generous landscape setting. Historically, the Barton Precinct Code has prioritised the use of the area by Australian Government agencies and complimentary private businesses, as befits its location. In recent years, this has progressed to include mixed use and medium density residential development. Barton is now a highly urbanised precinct that caters for a broad range of land uses under the NCP.

In 2011, Finance sought to divest Block 3 with the provision of conserving the natural environmental values present and with restricted building allowances. Following expression of interest and request for tender processes, Finance elected not to proceed with the divestment.

Since this time, Block 3 has remained surplus to Commonwealth requirements and is proposed for divestment again. The current divestment strategy has allowed for a broader range of future land uses at Block 3 and has not proposed to retain the environmental values present. This decision has been based on specialist advice and the preparation of a detailed divestment strategy report and subsequent feasibility assessments. The proposed divestment approach is consistent with the Commonwealth Property Disposal Policy (DoF, 2017).

1.4 Current Status

An EPBC Referral for the proposed action was submitted on 25 August 2017. The Referral and the attachments provided to DoEE at the time are provided in **Appendix 1**.

The proposed action was determined to be a controlled action under the EPBC Act on 11 October 2017, due to the likelihood of significant impacts to threatened species and communities, and as a Commonwealth action (i.e. undertaken by a Commonwealth Agency). As such, it is to be assessed through Preliminary Documentation (PD). This document, including its appendices comprises the PD and is to be submitted to DoEE to assist in the assessment of the controlled action.

The PD includes information updated since the Referral was submitted, in response to DoEE's request for additional information (RAI) (**Appendix 2**). In particular, this PD provides clarification on five key information areas, as requested by DoEE, to allow for a complete assessment to be made, specifically:

- **GSM:** additional information on the surveys undertaken for GSM since 2007 to substantiate the statement in the Referral that GSM habitat in the proposed action are is equivalent to the area of NTG (i.e. 0.32 hectares directly impacted). If required, update the provided impact assessment based on this additional information.

- **SSL:** confirm that SLL has been recorded at the site; including its location, abundance, and any other supporting information. If so, provide an assessment of the importance of the population and the potential for significant impacts to occur in accordance with relevant Commonwealth guidelines (TSSC, 2016a; DoE, 2013; and DSEWPaC, 2011a).

- **Scientific Heritage:** document any consultations relating to the site's scientific heritage values held with the scientific community to date. If required, conduct further consultation with the scientific community. Clarify the nature and extent of potential impacts to these values, and assess the likelihood of a significant impact to these values using relevant Commonwealth guidelines (DSEWPaC, 2013).

If relevant, note whether any avoidance or mitigation measures have been considered during this assessment.

- **Economic and Social Matters:** provide information on the relevant economic and social impacts of the proposed action, including consideration of costs and benefits across multiple scales as appropriate.

- **Offset Strategy:** provide information on the proposed offset strategy for any residual significant impacts to matters protected under the EPBC Act. Include an assessment of the offset strategies against the EPBC Act Environmental Offsets Policy (DSEWPaC, 2012).

As the proposed action affects Designated Land it is not subject to ACT planning and land use legislation. The National Capital Authority (NCA) is a Commonwealth Agency that has responsibility for the preparation and administration of the NCP, which sets out the detailed planning conditions for all designated land. Any future development of Blocks 3 or 15 post divestment would be subject to approval from the NCA. In order to facilitate this process, the Proponent submitted a proposed amendment to the NCP (Draft Amendment 88).

The primary aim of Draft Amendment 88 is to permit a broader range of development opportunities on the land by allowing mixed land use. Draft Amendment 88 was released for 30 business days of public comment on 12 August 2017, which concluded on 22 September 2017. No changes to the draft amendment were recommended by the NCA following review of the public comments received. Draft Amendment 88 was approved on 5 December 2017 by the Acting Minister for Regional Development, Local Government and Territories, Hon. Darren Chester MP; and was gazetted on 8 February 2018 (**Appendix 3**).

1.5 Preparation of Documents

Table 1.1 identifies the staff from Umwelt (Australia) Pty Limited (Umwelt), Purdon Planning, and other supporting organisations who prepared this Preliminary Documentation and lists the tasks they undertook.

Table 1.1 Project Team Roles

Name	Job Title, Company	Tasks Undertaken
Naomi Buchhorn	Principal Ecologist/Environmental Scientist, Umwelt	Oversight and review of the PD and Umwelt supporting reports.
Amanda Mulherin	Environmental Scientist, Umwelt	Primary author of the PD report and Umwelt ecological reports. Assistance in preparation of the Umwelt offset report. Assistance with ecological surveys.
Pam Dean-Jones	Principal Consultant Communities and Landscapes, Umwelt	Technical Director for all scientific heritage aspects of the PD. Chaired the stakeholder meetings. Primary author of the heritage impact assessment.
Alison Riley	NSW Ecology Work Area Manager, Umwelt.	Technical review of the Umwelt offset report and the PD report.

Name	Job Title, Company	Tasks Undertaken
Erica MacIntyre	Ecologist, Umwelt	Primary author of the Umwelt offset report. Assistance with ecological surveys.
Shawn Capararo	Senior Ecologist, Umwelt	Coordinated Umwelt ecological surveys.
Bill Wallach	Senior Ecologist, Umwelt	Assistance with ecological surveys.
Ryl Parker	Graduate Ecologist, Umwelt	Assistance with ecological surveys and ecological report preparation.
Richard Nash	Senior Urban Planner, Purdon Planning	Coordinated and oversaw the preparation of the social and economic impact assessment letter.
Emily Leemhuis	Urban Planner, Purdon Planning	Primary author of the social and economic impact assessment letter prepared by Purdon Planning.
George Hibbard	Urban Planning Assistant, Purdon Planning	Assisted Emily Leemhuis with the preparation of the social and economic impact assessment letter prepared by Purdon Planning.
Natalie Coyles	Architect, Cox Architecture	Preparation of site concept plans used in the analysis of social and economic impacts of the proposed action.
David Field	Principal Civil Engineer, Northrop	Preparation of the following reports that supported the social and economic impact assessment completed by Purdon Planning: • Current and Available Capacity of Services and Utilities; • Stormwater; and • Traffic and Transport Services.

2.0 Environmental Values

Section 3 of the Referral document described the general environmental values present at Blocks 3 and 15 (**Appendix 1**). This section provides further details of the environmental values present, as requested in the RAI.

DoEE determined that the proposed action was a controlled action under the EPBC Act (**Appendix 2**) due to the likelihood of significant impacts to the following:

- Threatened species and communities: protected as Matters of National Environmental Significance (MNES) under the EPBC Act (discussed in **Section 2.1**).
- The 'Whole of the Environment', which must be considered as the Proponent is a Commonwealth Agency and the proposed action will occur on National Land (discussed in **Section 2.2**).

2.1 Identification of MNES

The original Referral identified two MNES that would likely be significantly impacted by the proposed action; while a third was identified by DoEE's RAI as requiring further consideration:

- Natural Temperate Grassland of the South Eastern Highlands (natural temperate grassland, NTG), a critically endangered ecological community;
- golden sun moth (*Synemon plana*, GSM) a critically endangered invertebrate species; and
- striped legless lizard (*Delma impar* , SLL), a vulnerable reptile species.

The following sections summarise the information provided in the original Referral relating to these MNES and additional information as requested by DoEE (see **Section 1.5**) in relation to GSM (see **Section 2.1.2**) and SLL (see **Section 2.1.3**).

2.1.1 Natural Temperate Grassland

Umwelt (2017 and 2016) determined that 0.32 hectares of NTG occurs within Blocks 3 and 15. The NTG occurs as two patches, both located within the York Park Conservation Area.

The original Referral was based on data from 2015 (Umwelt, 2016), which determined that the NTG varied between high to moderate quality based on the diversity of native, non-grass flora species. Since this time, NTG has been re-listed under the EPBC Act and new parameters developed to determine its quality (TSSC, 2016b). The original data from Umwelt (2016) has been reviewed and the quality of NTG is considered to be very-high to high (Umwelt, 2018c).

The extent and quality of NTG within the proposed Impact Area is shown in **Figure 2.1**.

No further information regarding the presence and extent of NTG within the blocks was requested by DoEE. Please see the original Referral (**Appendix 1**) for further detail.

Image Source: Environment and Planning Directorate, ACT Government (2016)

0 25 50 100m
1:2 000

Legend

Proposed Action Area

High Quality NTG

FIGURE 2.1

NTG Habitat Extent and Quality within the Proposed Action Area

2.1.2 Golden Sun Moth

The original Referral documentation identified 0.32 hectares of GSM habitat within Blocks 3 and 15 (consistent with the extent of NTG) and a further 0.4 hectares of likely habitat on the Sydney Avenue median strips. This information was based on the then most recent GSM surveys undertaken at the blocks from 2015 (Umwelt, 2016) and a desktop review of relevant databases in 2017 (ACT Government, 2015).

The RAI sought further information on the surveys undertaken for GSM since 2007 so that the extent of GSM habitat within and adjacent to the proposed Impact Area could be confirmed. To provide this information, Umwelt (2018a) undertook targeted GSM survey and assessment that included the following steps:

1. Desktop literature review to identify the GSM surveys undertaken since 2007 and confirm the extent of GSM habitat recorded within the proposed Impact Area since this time.

2. Undertake targeted flying male GSM surveys at the proposed Impact Area. The methodology included transect counts of flying males in accordance with Commonwealth GSM survey guidelines (DEWHA, 2009).

3. Targeted female GSM surveys at Blocks 3 and 15, using meandering searches.

4. Detailed habitat assessment using a combination of 50 metre step-point transects and meandering survey methodology.

The results of Umwelt's (2018a) survey are summarised in the following sections; the full report is provided as **Appendix 4**.

2.1.2.1 GSM Surveys Undertaken since 2007

The desktop review (Umwelt, 2018a) identified a large number of ecological surveys that have been conducted within the proposed Impact Area since 2007. Many of these targeted the known GSM and NTG values within the York Park Conservation Area; and ranged in theme including ongoing monitoring, vegetation management plans, and population studies.

A GSM Maintenance Plan was prepared by Parsons Brinckerhoff (2008) to provide a framework for ongoing best-practice management of the ecological values associated with the then proposed development and use of Blocks 3 and 15 (then Blocks 3 and 7, Section 22). The proposed development was part of the 2011 proposed divestment discussed in **Section 1.3.4**. The Maintenance Plan (Parsons Brinckerhoff, 2008) noted that approximately 0.5 hectares of GSM habitat occurred within the York Park Conservation Area. This was based on ACT Government data from the late 1990s and 2005. The GSM Maintenance Plan also established ongoing monitoring methodology for GSM and NTG which formed the basis of many of the surveys described below.

The surveys undertaken since 2007 are summarised as follows:

- Rowell (2007) 'Survey and Impact Assessment at Golden Sun Moth *Synemon plana* site, Blocks 3 and 7, Section 22 Barton (York Park)'. This survey was completed to support an understanding of the environmental factors relevant to Block 3 and included capture-mark-release techniques to estimate the population size.

- Richter *et al* (2009) ‘Community Monitoring of Golden Sun Moths in the Australian Capital Territory Region, 2008-2009’. This project was a pilot GSM monitoring program that surveyed a number of sites across the ACT and the surrounding region, including the York Park Conservation Area and Sydney Avenue median strips. Surveys were undertaken by community members supervised and trained by ecologists.

- Rowell (2012) ‘Five-year Monitoring Event for Golden Sun Moth and Condition Assessment of Natural Temperate Grassland’. This survey included the five-yearly population monitoring within the York Park Conservation Area as required by the GSM Maintenance Plan (Parsons Brinckerhoff, 2008).

- Umwelt (2014) ‘Natural Temperate Grassland Maintenance Plan Block 3 Section 22 Barton ACT’. An update to the Parsons Brinkerhoff (2008) Maintenance Plan for the York Park Conservation Area only. Umwelt (2014) provided management recommendations to maintain the NTG and associated GSM values at the site.

- Umwelt (2015) ‘Natural Temperate Grassland Condition Assessment and Golden Sun Moth Monitoring Event’. Provided the results of the 2014 monitoring event as recommended by Umwelt (2014). The monitoring targeted GSM and NTG within the York Park Conservation Area (as amended following the pending construction of the access road for the Little National Hotel on the adjacent block (EPBC Referral 2010/5548)).

- SMEC (2016) ‘Golden Sun Moth Monitoring 2015 York Park’ and SMEC (2017) ‘Golden Sun Moth Monitoring 2016 York Park Conservation Area’. These surveys were undertaken as part of GSM monitoring requirements that are a condition of approval under EBPC Referral 2012/6606. GSM monitoring occurred within the York Park Conservation Area and included counts of flying male GSM, pupae case survey, vegetation survey, and soil temperature monitoring.

- Umwelt (2016a) ‘Golden Sun Moth and Natural Temperate Grassland Vegetation Management Plan Block 3, Section 22, Barton ACT’. This report provided the results of the 2015 monitoring event as recommended by Umwelt (2014). The monitoring targeted GSM and NTG within the York Park Conservation Area.

During the preparation of the referral in 2017, an Umwelt ecologist re-visited York Park, and confirmed the extent of GSM habitat was 0.32 hectares as previously reported (Referral 2017/8028). It was also noted at this time, that the ACT Government (2015) had mapped the two south-eastern median strips of Sydney Avenue as being GSM habitat. These areas had not been surveyed since the 2008/2009 season, when they were confirmed as habitat (Richter *el al*, 2009).

The results of these surveys are summarised in **Table 2.1**; and demonstrate a decrease in the extent of GSM habitat within the York Park Conservation Area since 2013.

Table 2.1 GSM Habitat (hectares) from Literature Review Results

Year	York Park Conservation Area	Remaining area of Block 3	Sydney Avenue median strips	Total Area
2006 (Rowell, 2007)	0.56	0	0 Entirety could be rehabilitated to habitat	0.56
2008 (Richter *et al*, 2009)	-	-	Unknown area, but GSM recorded	Unknown
2011 (Rowell, 2012)	0.56	-	-	0.56
2013 (Umwelt, 2014)	0.56	-	-	0.56
2014 (Umwelt, 2015)	0.34	-	-	0.34
2015 (Umwelt, 2016a)	0.32	-	-	0.32
Referral	0.32	0	0.4*	0.72

Indicates that there is no data for these areas during the years indicated.
* The Entirety of the Sydney Avenue median strips was assumed to be GSM habitat for the purposes of the original Referral.

The primary reasons for this decrease in habitat are described as follows:

- EPBC approved impact associated with EPBC Referral 2010/5548. This Referral was for the construction of an access road off National Circuit to support the construction of the Little National Hotel. The driveway directly impacted upon approximately 0.04 hectares of NTG in the north of the York Park Conservation Area. The impact occurred between the 2013 and 2014 survey seasons (see **Table 2.1**).
- Weed incursion has also been recorded (Umwelt, 2016a; and 2015) within York Park Conservation Area, primarily through the southern portion of Block 3. The weed species have been recorded as *Dactylis glomerata* (cocksfoot) and *Phalaris aquatica* (phalaris). While male GSM have been observed flying over the area of weed incursion, as neither cocksfoot nor phalaris are GSM feed species (i.e. C3 grasses), this area is not considered GSM habitat. The weed incursion separated the previously contiguous patch of GSM habitat into two patches (see **Figure 2.2**).
- Upgrades to the footpath adjacent to National Circuit disturbed the grassland of York Park. This area was re-planted with native *Themeda triandra* (kangaroo grass), which is not a GSM feed species, therefore these works also reduced the area of GSM habitat present within York Park Conservation Area (Umwelt, 2016a).

2.1.2.2 GSM Habitat Extent and Quality

To clarify the extent of GSM habitat within the proposed action area, Umwelt (2018a) undertook habitat assessments in the following locations:

- York Park Conservation Area;
- the remaining portion of Block 3; and
- the two south-easternmost Sydney Avenue median strips.

GSM habitat was defined based on consideration of the presence of flying males, presence of females, and presence of GSM feed species (i.e. C3 grasses, particularly *Rytidosperma* spp. (wallaby grasses), *Austrostipa* spp. (spear grasses), and *Nassella neesiana* (Chilean needle grass)).

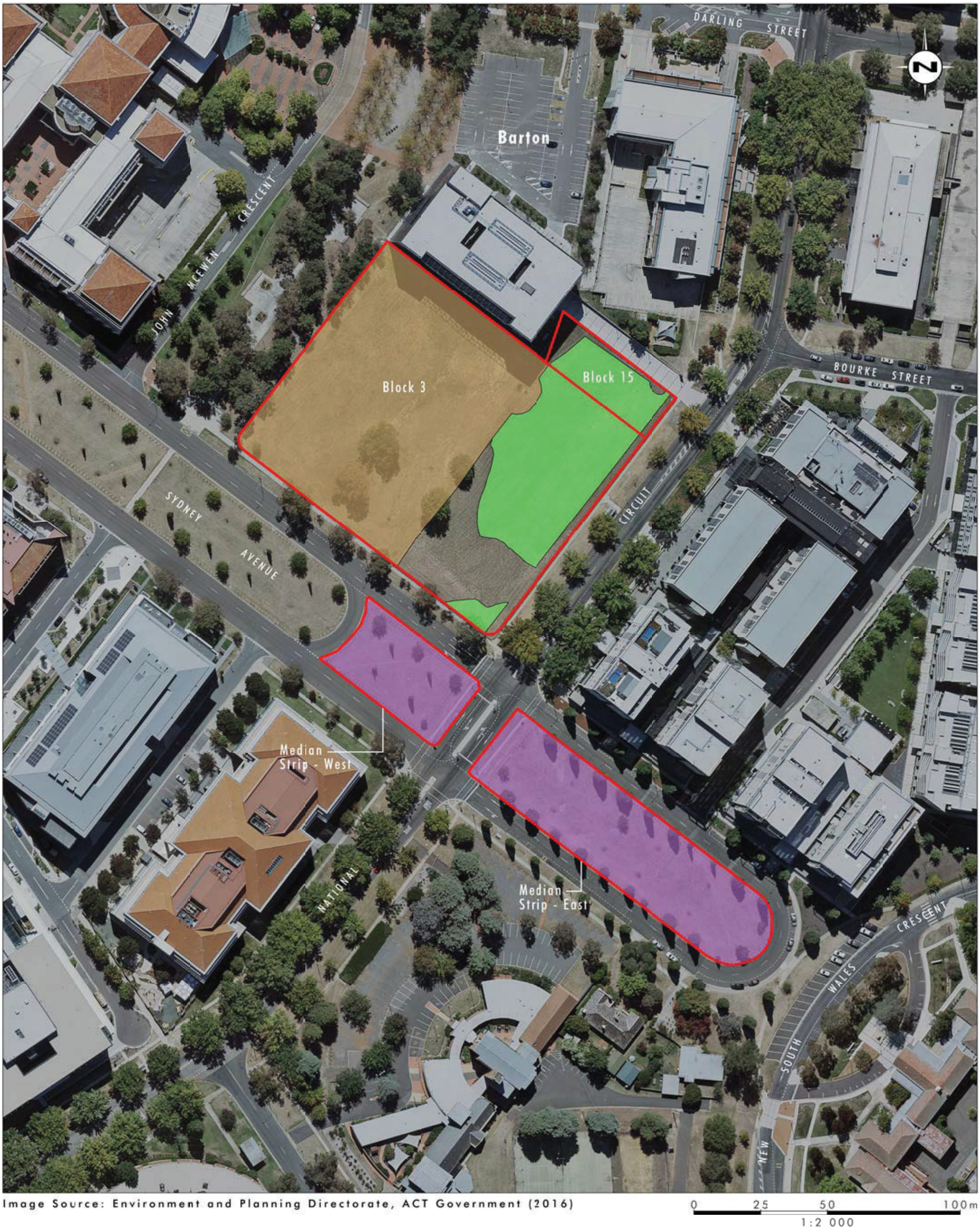
GSM habitat quality was also determined by Umwelt (2018a). The following definitions (adapted from Rowell, 2013) were used to define the quality of the GSM habitat identified above:

- Low quality habitat:
  - exotic grasslands with a moderate amount of GSM feed species (including Chilean needle grass);
  - native grasslands dominated by kangaroo grass, with a moderate component of native GSM feed species on shallow, eroded soils; or
  - moderately dense mixed grassland, with a moderate component of GSM feed species.
- Moderate (Disturbed) quality habitat: exotic grassland dominated by Chilean needle grass.
- Moderate quality habitat: native grassland with low to moderate weed cover and a moderate cover of native GSM feed species.
- High quality habitat: dominated by native grasses, including a moderate component of wallaby grasses, moderate diversity of native forbs, and moderate bare ground (excluding rocky outcrops with shallow soil).

Umwelt (2018a) identified 1.46 hectares of GSM habitat within the proposed Impact Area. These results are summarised in **Table 2.2** and shown in **Figure 2.2**.

Table 2.2 2017 Survey GSM Survey Results (Umwelt, 2018a)

Location	Vegetation Type	Quality	Area (ha)
York Park Conservation Area	natural temperate grassland	high	0.32
Remaining area of Block 3	exotic grassland dominated by Chilean needlegrass	moderate (disturbed)	0.74
Sydney Avenue median strips	exotic grassland	low	0.40
TOTAL			1.46



Legend

- Proposed Action Area
- High Quality GSM Habitat
- Moderate - Disturbed Quality GSM Habitat
- Low Quality GSM Habitat

FIGURE 2.2

GSM Habitat Extent and Quality within the Proposed Action Area

Details of the survey, including discussion of the results may be found in Umwelt (2018a), attached as **Appendix 4**.

Following further survey in later 2017, Umwelt (2018a) confirmed the presence of 0.32 hectares of GSM habitat within the York Park Conservation Area and 0.4 hectares within the Sydney Avenue median strips. An additional 0.74 hectares of GSM habitat within the proposed action area was also identified within the portion of Block 3 outside of the York Park Conservation Area.

As the extent of GSM habitat within the proposed Impact Area has increased from what was described in the Referral (**Appendix 1**), an updated impact assessment has been prepared (see **Section 3.2**).

2.1.3 Striped Legless Lizard

The impact assessment completed by Umwelt (2017) to accompany the original Referral determined that SLL were unlikely to occur within the proposed Impact Area. Despite SLL being known to occur within NTG; Umwelt (2017) made this assessment based on the size and isolation of the NTG patch present within the proposed Impact Area, the intensity of the surrounding development, historic disturbance, and lack of any records of the species.

The RAI sought confirmation of whether SLL had been recorded within the proposed action area. To provide this information, Umwelt (2018b) undertook targeted SLL survey that included the following steps:

1. Desktop review to determine if SLL had been recorded at the proposed Impact Area.
2. Targeted SLL survey at Blocks 3 and 15 using active search methodology in accordance with SLL survey guidelines (DSEWPaC, 2011a; 2011b).
3. Detailed habitat assessment using a combination of 50 metre step-point transects and meandering survey methodology.

In addition to the above, it was also initially proposed that the targeted SLL surveys would include artificial shelter survey in addition to the active searches. Two arrays of 50 artificial shelters (concrete roofing tiles) were deployed within Block 3 in November 2017, in the same area that active searches were undertaken. Given the seasonal limitations of reptile surveys and the timing of the tile deployment; it was agreed to discontinue this survey technique and concentrate on the alternative active searches and habitat assessment.

The results of Umwelt's (2018b) SLL survey are summarised in the following sections; the full report is provided as **Appendix 5**.

2.1.3.1 Previous SLL Records

During the public consultation period for the Referral in September 2017, DoEE was made aware of a recent SLL record at the proposed action area that was not identified during the previous desktop assessment. To identify the source of this SLL record, Umwelt (2018b) undertook further desktop assessment, including consultation with the ACT Government, and gathered relevant details.

A search of Canberra Nature Map (2017) identified a SLL record and the relevant report by SMEC, (2017) was sourced from 22 Barton Pty Ltd. No other SLL records were identified during the desktop assessment.

SMEC (2017) opportunistically identified one SLL individual while undertaking annual GSM monitoring within the York Park Conservation Area. The SLL was recorded towards the eastern boundary of the proposed action area, within the NTG. Due to the opportunistic nature of the species' record (SMEC, 2017); a targeted survey of the proposed action area was undertaken in November and December 2017 by Umwelt so that greater detail regarding the species' extent could be gathered (Umwelt, 2018b).

2.1.3.2 Umwelt (2018b) Survey Results

Umwelt (2018b) recorded one SLL individual within NTG on Block 3 on 15 December 2017 (**Figure 2.3**). This result is consistent with the opportunistic sighting from SMEC (2017) and confirms the presence of SLL within the NTG in the proposed action area.

In addition, while the artificial shelters were being removed in February 2018, a number of reptile skins (approximately eight) were found under both arrays. These skins could not be identified down to species level; however they are consistent with SLL in terms of size and shape. A precautionary approach has been taken and these skins have been assumed to be from SLL. These observations indicate that the entire Project Area (i.e. not just York Park Conservation Area) provides habitat for SLL.

Two step-point transects were surveyed within the Project Area; one in the NTG and the other in the exotic grassland. This was supported by meandering survey to determine the extent of habitat types throughout the proposed action area. A total of 1.25 hectares of SLL habitat was recorded; including 0.36 hectares of high quality habitat within the NTG and planted native grassland; and 0.89 hectares of low quality habitat within exotic grassland (**Figure 2.3**).

Based on the results, the NTG is considered to constitute the core habitat for the species. The exotic grassland supplements the core habitat by providing shelter and additional foraging habitat; however is considered unlikely to support the species if the native grassland was not present.

Details of the survey, including discussion of the results may be found in Umwelt (2018b), attached as **Appendix 5**.

Given that SLL has been confirmed to occur within the proposed action area (Umwelt, 2018b; SMEC, 2017), the impact assessment has been updated in **Section 3.3**; this includes an assessment of the importance of the population, as requested in the RAI.

Image Source: Environment and Planning Directorate, ACT Government (2016)

0 25 50 100m
1:2 000

Legend
- Proposed Action Area
- Umwelt (2018b) SLL Record
- High Quality SLL Habitat
- Low Quality SLL Habitat

FIGURE 2.3

SLL Habitat Extent and Quality within the Proposed Action Area

2.2 Whole of Environment Considerations

In addition to requiring a proponent to consider the potential impacts to MNES (see **Section 2.1**); if the proponent is a Commonwealth Agency then the EPBC Act requires that significant impacts to the 'environment' are also considered. Section 528 of the EPBC Act defines the 'environment' as including:

(a) ecosystems and their constituent parts, including people and communities; and

(b) natural and physical resources; and

(c) the qualities and characteristics of locations, places and areas; and

(d) heritage values of places; and

(e) the social, economic and cultural aspects of a thing mentioned in paragraph (a), (b), (c), or (d).

The original Referral documentation (**Appendix 1**) includes a description of the environment of the proposed action area and its surrounds. Based on this information and consideration of the relevant Commonwealth guidelines (DSEWPaC, 2013); the impact assessment (Umwelt, 2017) determined that a significant impact to the 'environment' was unlikely to occur.

The RAI provided by DoEE stated that the original Referral documentation (including the impact assessment (Umwelt, 2017)) may have underestimated the scientific heritage values of the York Park Conservation Area; due to the apparently limited consultation with the scientific community regarding these values. In particular, DoEE believed there may be scientific heritage values associated with the longitudinal survey data collected for GSM at the York Park Conservation Area and that these were not adequately addressed in the original Referral documentation.

In accordance with the RAI, the following sections outline the consultation undertaken as a part of the Referral, including any additional consultation undertaken since the Referral's submission; and define the scientific heritage values present within the proposed action area. A detailed report on the scientific heritage values and associated consultation undertaken is provided in **Appendix 6**.

No other aspects of the 'environment' are considered again in this PD.

2.2.1 Scientific Community Consultation

No specific consultation was undertaken with the scientific community as part of the preparation of the initial Referral. The impact assessment (Umwelt, 2017) determined that a significant impact to the 'environment' was unlikely to occur. This was based on consideration of the results of the heritage assessment prepared by Environmental Resources Management Australia (ERM) for the Referral (ERM, 2016), the location, surrounding land uses, land-use history of Blocks 3 and 15, mitigation measures proposed, scale, and NCA planning and approval processes.

As requested in the RAI (**Section 1.4**), Umwelt has undertaken targeted consultation on behalf of Finance with representatives of the local scientific community (Umwelt, 2018d). To inform the consultation process, the following steps were undertaken:

1. Confirm the meaning of scientific heritage value and the criteria to be applied to the significance assessment.

2. Undertake a literature review of information about the scientific heritage value of the site.

3. Based on the results of the first two steps, identify the scientific stakeholders to be consulted about the scientific heritage values of the York Park Conservation Area.

4. Provide information to the identified stakeholders to set the context and framework of the discussions, including a copy of the questions to be asked and specific issues to be considered.

5. Conduct the stakeholder consultation.

6. Document the input provided by the stakeholders and identify the criteria to which it is relevant.

2.2.1.1 Research Themes

The literature review (Umwelt, 2018d) determined that much of the scientific work that has been carried out at Block 3 and Block 15 relates to GSM. In particular, the background and introductory work undertaken to inform the consultation process (steps 1 and 2 above) identified the following research categories applicable to the work that has occurred at Block 3 and 15:

- Specialist scientific research, including research conducted by academic staff and students at the major research institutes in the city. The research is generally specific and technical in nature and often peer-reviewed. The consideration of these reports together may contribute to the scientific evidence underpinning planning and land management relating to GSM habitat.

- Studies required for development assessment purposes due to the presence of protected species or communities. Many of these surveys are conducted by consultants, but some are conducted by academic researchers who also operate in a consultancy context. Peer-reviewed studies may also be required, but are less common than within the specialist scientific research category.

- Monitoring, required to be carried out by land owners or managers because of the known presence of protected species. This work is primarily conducted by consultants on behalf of ACT or Commonwealth land owners, but as above, may be conducted by academic researchers.

- Baseline survey, monitoring, or targeted management research conducted by public authorities as part of regional scale conservation planning and priority setting. This work is generally carried out by government authorities, either in-house or by consultants acting on their behalf.

A majority of the work undertaken at Block 3 and Block 15 has been monitoring required of the land managers (i.e. Finance) or for development assessment purposes (Umwelt, 2018d).

2.2.1.2 Consultation Process

From a scientific heritage perspective, the primary stakeholders are people who have conducted scientific research at the site or who have used the available data to develop conservation and management proposals for GSM and NTG.

Finance considered a number of potential stakeholders and identified three institutions with an association with the Blocks and/or with research on the grassland habitats or GSM ecology in the ACT. These institutions are Australian National University (Fenner School of Environment and Society) (ANU), University of Canberra (UC), and Commonwealth Scientific and Industrial Research Organisation (CSIRO). These institutions were considered appropriate stakeholders for the purposes of this PD.

Representatives to participate in the consultation process were nominated by each institution and confirmed via phone and email correspondence in February and March 2018. Each representative was provided with a brief document that provided contextual information regarding the proposed action, the purpose of the consultation, and the specific matters to consider when evaluating scientific heritage significance under the EPBC Act; and the questions to be discussed for the consultation.

Feedback was received from the representatives of all three institutions. Details of the representatives and a summary of the type of consultation conducted with them are described below:

- Doctor David Yeates, Director Australian National Insect Collection, Senior Principal Research Scientist, CSIRO. Dr Yeates participated in a face to face interview on 14 March 2018 and also provided some follow up suggestions, references, and contacts via email.

- Associate Professor Will Osborne, Institute for Applied Ecology, UC. Dr Osborne provided a preliminary email response and more detailed follow up email response to specific questions on 28 February and 22 March 2018.

- Doctor Philip Gibbons, Fenner School of Environment and Society, ANU. Dr Gibbons provided a brief email response on 8 March 2018.

Stakeholders were asked specifically about the research value of Blocks 3 and 15, based on how the previous studies at these Blocks have contributed to the understanding of the GSM and NTG in Australia; and how the site could continue to contribute new knowledge and understanding in the future. They were also asked to comment on potential mitigation or offset measures that could be incorporated into the proposed action (Umwelt, 2018d).

In correspondence and discussion, these key stakeholders also referred to the research work of colleagues either at Bocks 3 and 15 or more broadly on related biodiversity and conservation issues in the ACT and beyond.

A detailed summary of the stakeholder responses is provided by Umwelt (2018d) in **Appendix 6**.

2.2.2 Scientific Heritage Values

Section 528 of the EBPC Act defines heritage value of a place as '*the place's natural and cultural environment having aesthetic, historic, scientific or social significance, or other significance, for current and future generations of Australians*'. Australia International Council on Monuments and Sites (AICOMOS, 2013) defines scientific heritage value as:

> *…the information content of a place and its ability to reveal more about an aspect of the past through examination or investigation of the place, including the use of archaeological techniques. The relative scientific value of a place is likely to depend on the importance of the information or data involved, on its rarity, quality or representativeness, and its potential to contribute further important information about the place itself or a type or class of place or to address important research questions... To appreciate scientific value, ask:*
>
> - *would further investigation of the place have the potential to reveal substantial new information and new understanding about people, places, processes or practices which are not available from other sources?* (p. 3, AICOMOS, 2013).

2.2.2.1 Previous Reports

Environmental Resources Management (ERM, 2016) completed a heritage assessment of potential Indigenous, natural, and historic values at Block 3 in April 2016. The assessment was undertaken to meet Finance's obligations under the EPBC Act and noted that Block 3 is not included in any Commonwealth or ACT heritage lists for its Indigenous, natural, or historic heritage values.

ERM (2016) evaluated the natural heritage values of Block 3 against the ACT and Commonwealth heritage criteria. The assessment includes a comparative analysis of the natural heritage values of the place with other places in the ACT. This assessment primarily considers the size, habitat quality, and level of protection available at other GSM and NTG sites and the implications of alternative sites for research that would add valuable knowledge of the ACT's natural history. No consultation with the scientific community was undertaken by ERM (2016).

ERM (2016) found that none of the Commonwealth or ACT heritage criteria are met as other places can provide the same information relating to GSM life cycles and habitat requirements.

In particular, ERM (2016) noted that Block 3 likely holds social values for the ecologists involved in the studies that have occurred at the Block; however, an ordinary person would not be able to recognise that association. Furthermore, ecologists (as a professional or special interest group) do not meet the definition of a 'community' in the ACT Heritage Assessment Policy (ACT Heritage Council, 2015).

2.2.2.2 2018 Results

To meet the requirements of the RAI, Umwelt (2018d) reassessed the scientific heritage values of the proposed Impact Area. As described above, the methodology included a literature review and consultation with representatives of the ACT scientific community. The research themes identified by Umwelt (2018d), the views expressed by the consulted stakeholders, and relevant heritage significance criteria and guidelines (AICOMOS, 2013; and AHC, 2010) were used to define the scientific heritage values of the proposed Impact Area (Umwelt, 2018d).

Details of the responses received during consultation are provided in Umwelt (2018d, **Appendix 6**). A summary of the scientific values of the proposed action area, as identified by the consulted parties, is as follows:

- Previous research has led to a greater understanding of the genetic diversity of GSM throughout Australia, has informed the conservation management of the species within the ACT, allowed for testing of methodologies for population analysis, and contributed to our ability to calculate GSM extinction probabilities and population viability analysis across a range of different sized sites.
- It is unique in the ACT (and possibly nationally) as a site with a monitoring record that spans approximately 10 generations of GSM.
- It is useful as a research site as it is stable and easily accessible to researchers. This stability combined with its monitoring record and isolation, allows greater potential for future research to be valuable and provide rigorous results.
- The research and the site are a part of the scientific culture of Canberra. As a small city with major research institutions, convenient and accessible in-town sites are valued for local research and teaching opportunities. While the proposed action area is not unique in this contribution in the ACT, it is certainly a '*distinctive Canberra cultural heritage feature*' (Dr Yeates, 2018, pers. comm. 14 March).

- If further research were to occur within the proposed Impact Area (noting that none is currently scheduled by the consulted parties), it could inform potential future research in topics such as:
  - understanding the effect of Chilean needle grass on GSM populations and native grassland management;
  - better understanding the resilience of GSM in small and isolated habitat patches;
  - the effect of invasive invertebrates or predator species on the mortality rates of GSM, particularly given changes to native grassland habitats as a result of climate change;
  - habitat restoration activities in areas of both native grassland and dominated by Chilean needle grass; and
  - population persistence, adaptation and management within an urban matrix.
- ACT organisations that have contributed to GSM research have benefitted from the 'flagship' profile of the species.

These research values sit within the broader context of research into the vulnerability, adaptation, and resilience of threatened species within isolated urban habitat. The value of the proposed Impact Area to these broader themes is in part dependent upon the relative significance of the habitat to the species across its broader range. Furthermore, as a site that contains a 'flagship' species it also contributes to the value of community ecological awareness for habitat rehabilitation and citizen science in urban areas.

The EPBC Act identifies heritage criteria and thresholds for determining the level of significance of a heritage place. When assessing the heritage significance of a place, AHC (2010) requires assessors to identify whether a place has significance against each heritage criterion at local, regional, state, national, or international scales. For example, to be eligible for recognition on the National Heritage List a place must contribute to Australia's natural or cultural history. However, to be placed on the Commonwealth Heritage List, a place may qualify when it is assessed as valuable at a local (i.e. ACT) scale.

Umwelt (2018d) evaluated the information summarised above against the relevant Commonwealth and ACT Heritage criteria. The analysis indicated that the proposed Impact Area currently meets the following ACT heritage criteria:

(a) important to the course of the ACT's cultural or natural history; and

(b) has uncommon, rare or endangered aspects of the ACT's cultural or natural history.

The heritage values of the proposed action area are not considered to meet any Commonwealth heritage criteria (Umwelt, 2018d).

The proposed action area has scientific heritage values associated with the natural heritage of the site at the ACT (i.e. local) scale.

These values are partly embodied in the fabric of the place as an isolated fragment of habitat which illustrates the resilience of a critically endangered species. More importantly, the values also derive from the documentary evidence of the persistence of the GSM, obtained from the Impact Area from 20 years of observations by scientists and citizen scientists. This interest has made the scientific work at the Project Area rare and influential in the development of research themes for GSM.

An impact assessment of the proposed action on these heritage values is provided in **Section 3.4**.

3.0 Relevant Impacts

This section summarises the impacts of the proposed action on MNES and the 'environment', including an assessment of whether these impacts area considered significant under the EPBC Act.

The detail of this section is provided in the relevant reports, which are attached.

3.1 Natural Temperate Grassland

The proposed action will directly impact upon 0.32 hectares of NTG, as described in the original Referral and associated attachments. There is no other NTG in the surrounding landscape.

As described in **Section 2.1.1**, the quality of the NTG has been updated to reflect the new Commonwealth Conservation Advice (TSSC, 2016b). All NTG within the proposed action area is considered to be very-high to high quality (Umwelt, 2018c).

The NTG Conservation Advice (TSSC, 2016b) identifies all remaining patches of NTG as critical to the survival of the ecological community. As such, the removal of the entire NTG present within the landscape as a result of the proposed action is considered to be a significant impact.

No further information was requested by DoEE in the RAI. An offset strategy to compensate for these significant impacts has been prepared. This is described in further detail in **Section 5.1**.

3.2 Golden Sun Moth

The Referral assessed impacts to GSM based on the direct loss of 0.32 hectares of high quality NTG habitat within the York Park Conservation Area and indirect impacts to a maximum of 0.4 hectares of unknown quality habitat on the Sydney Avenue median strips. The impact assessment submitted with the Referral determined that this impact (i.e. total loss of 0.72 hectares) is considered significant as the area is small (less than 10 hectares) and fragmented; and the Commonwealth impact guidelines for GSM (DEWHA, 2009) stipulated that any loss of habitat in such circumstances is significant.

The updated survey information collected as part of this PD package (Umwelt, 2018a) determined that 1.46 hectares of GSM habitat occurs within the proposed action area (see **Section 2.1.2** and **Appendix 4**). Of this habitat, 1.06 hectares will be directly impacted by the proposed action and 0.4 hectares will be indirectly impacted.

For the same reasons applied in the original Referral, this impact is considered to be a significant impact (discussed in further detail in **Appendix 4**). An offset strategy to compensate for these significant impacts has been prepared. This is described in further detail in **Section 5.2**.

3.3 Striped Legless Lizard

The proposed action will directly impact upon 1.25 hectares of SLL habitat.

As a vulnerable species, many of the significant impact criteria for SLL rely on a determination of whether the impacted population constitutes an 'important population'. The following sections discuss the importance of the population and the significance of the impact based on this.

3.3.1 Identification of an Important Population

An important population is defined as "*a population that is necessary for a species' long term survival and recovery. It may include populations identified as such in recovery plans, and/or that are:*

- key source populations, either for breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and/or
- populations that are near the limit of the species range. (DoE, 2013)"

Important populations known from the Canberra region include Gungahlin, Majura Valley, Jerrabomberra Valley, Yarramundi Reach, and Sutton (EPSDD, 2017; TSSC, 2016a). Furthermore, in the ACT, SLL are known to occur in four discrete areas (Gungahlin/Belconnen, Majura Valley, Jerrabomberra Valley, and Central Canberra). These areas are considered to represent genetically distinct sub-populations and to represent the genetic variability across Canberra (EPSDD, 2017). The population within the proposed action area does not occur within any of these areas; therefore it is not considered necessary for maintaining SLL genetic diversity within the ACT.

The population within the proposed Impact Area is not identified as a key population within the ACT (EPSDD, 2017) and due to its isolation is unlikely to be considered a key population in the future as it cannot contribute to breeding or dispersal of the species within the ACT.

The proposed Impact Area does not occur near the limit of the species' range.

The population present within the proposed Impact Area does not meet any of the above important population criteria.

In addition to the above definition of an important population, the Commonwealth SLL referral guidelines (DSEWPaC, 2011a) defines that a population is not likely to meet the above definition of an important population if it meets any of the following criteria:

- occurs in less than 0.5 hectares of habitat, as it is unlikely to be viable in the medium to long term;
- is considered small, isolated, under pressure; or
- the habitat is of marginal to low quality, especially if it contains high threat weeds.

While more than 0.50 hectares of habitat occurs within the proposed action are, the medium to long term viability of the population is doubtful given its urban location, which isolates it from other habitat, and the presence of high threat weeds (especially Chilean needle grass). Furthermore, a majority (0.89ha or 71%) of the habitat present is considered low quality due to the dominance of high threat weeds.

For these reasons, the SLL population within the proposed Impact Area is not considered to be an important population under the EPBC Act.

3.3.2 Significant Impact Criteria

Umwelt (2018b) completed an impact assessment for the proposed action against the Significant Impact Guidelines 1.1 (DoE, 2013), as shown in **Table 3.1**.

Table 3.1 Significant Impact Assessment for SLL (Umwelt, 2018b)

Significant Impact Criteria	Rationale
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
Lead to a long-term decrease in the size of an important population of a species	While clearance of the Project Area would impact on SLL individuals, the population is not considered to be an important population. The proposed action would therefore not lead to a long-term decrease in the size of an important population of a species. **Unlikely to be significant.**
Reduce the area of occupancy of an important population	The proposed action would remove all potential habitat for SLL within the Project Area. The impacted population is not considered to be an important population. The proposed action would therefore not reduce the area of occupancy of an important population. **Unlikely to be significant.**
Fragment an existing important population into two or more populations	The population is entirely isolated from other patches of grassland and other known SLL populations, and has been since the 1970s when Barton was first developed. The Project Area is approximately equidistant between the known populations at Yarramundi Reach and Amtech Estate (Symonston); both approximately five kilometres away. As current isolation is already absolute, the project will not increase fragmentation. The impacted population is also not considered to be an important population. Therefore, the proposed action will not fragment an existing important population. **Unlikely to be significant.**

Significant Impact Criteria	Rationale
Adversely affect habitat critical to the survival of a species	The Conservation Advice for SLL (TSSC, 2016) identifies the following features of habitat critical to the survival of SLL: • provides breeding habitat; • provides foraging habitat; • provides refuge from disturbance events; • provides for long-term protection from development; and • has connectivity value and contributes to the evolutionary potential of the specie sin the wild. As noted in **Section 1.3**, the Project Area was part of a grazing land grant from 1824 through to the mid-1900s and while the area around the Project Area was developed as part of the Parliamentary Triangle and the more recent urban renewal of Barton, the Project Area has remained undeveloped managed grassland, progressively isolated from any other remnant potential habitat (ERM 2016). Given the length of time that the Project Area has been isolated the Project Area must be assumed to be breeding habitat for SLL; however as discussed in **Section 4.1**, this population is not considered an important population and is therefore unlikely to be considered critical habitat solely for this reason. Furthermore, whilst the NTG provides high quality foraging habitat and arthropod burrows are present; the patch is isolated, small, and currently under threat from Weeds of National Significance and surrounding development pressures and the existing population is unlikely to survive a catastrophic disturbance event. Its location within suburban Canberra also limits the long-term protection and eliminates the possibility of the site ever being connected to other grasslands. At a local scale, the ACT SLL Action Plan (EPSDD, 2017) identifies key habitat for striped legless lizard in the ACT. The Project Area is not listed as key habitat, nor is likely to be considered key habitat in the future due to its small size and isolation. For these reasons, the impacted habitat is not considered critical to the survival of SLL. The proposed action will not adversely affect habitat critical to the survival of a species. **Unlikely to be significant.**
Disrupt the breeding cycle of an important population	The proposed action will disrupt the breeding cycle of the population present within the Project Area as the entire population will be impacted. The impacted population is not considered to be an important population. Therefore, the proposed action would therefore not disrupt the breeding cycle of an important population. **Unlikely to be significant.**
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The proposed action will remove all SLL habitat present within the Project Area. As the impacted population is not considered to be an important population, nor is the habitat considered critical to the survival of the species; the proposed action is unlikely to result in the decline of the species overall. **Unlikely to be significant.**

Significant Impact Criteria	Rationale
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	All vegetation present within the Project Area is proposed to be removed, including the SLL habitat. There is no other nearby habitat areas for a vulnerable species, as such; the proposed action will not result in invasive species being established in the vulnerable species' habitat. **Unlikely to be significant.**
Introduce disease that may cause the species to decline	All vegetation present within the Project Area is proposed to be removed, including the SLL habitat and there is no connectivity between the Project Area and other habitat. The proposed action will not introduce a disease that could result in the decline of the species. **Unlikely to be significant.**
Interfere substantially with the recovery of the species.	There is no current Commonwealth Action Plan for SLL. The ACT SLL Action Plan (EPSDD, 2017) describes the following major conservation objectives for SLL: • conserve large and medium sized populations in the ACT; • manage the species and its habitat to maintain the potential for evolutionary development in the wild; and • enhance the long-term viability of populations through management of adjacent grassland to increase habitat area and connect populations . For the reasons discussed above in relation to important populations and critical habitat; the proposed development will not interfere with the ACT SLL Action Plan (which operates as the ACT recovery plan) conservation objectives. **Unlikely to be significant.**

Noting that the population is not considered to be important under the EPBC Act and relevant guidelines (see **Section 3.3.1**), the proposed action is not considered likely to result in a significant impact to SLL. A detailed impact assessment is provided in **Appendix 5**.

3.4 Scientific Heritage

Umwelt (2018d) determined that the proposed Impact Area contains scientific heritage value at the local scale (i.e. it meets ACT heritage criteria but not Commonwealth). The scientific values are partly embodied in the fabric of the place as an isolated fragment of habitat that illustrates the resilience of a critically endangered species. More importantly, the value also derives from the documentary evidence of the persistence of the GSM, obtained from the site from 20 years of observations.

The proposed action will result in a permanent and complete impact to the fabric of the place and prevent further documentary evidence being collected at the site in the future. The proposed action will not impact the existing scientific record. To determine whether this impact is significant, the criteria 'Significant Impact Guidelines 1.2' (DSEWPaC, 2013) have been considered in the context of the EPBC Act definition of a significant impact and in conjunction with the significance of the scientific heritage value.

Table 3.2 applies the criteria set out in the 'Significant Impact Guidelines 1.2' for impacts on heritage values, taking into account the sensitivity, quality, and value of the place.

Table 3.2 Significance of the Impact of the Action on Heritage Values

Consideration/Criterion	Response
Is there a real chance or possibility that the action will:	
Permanently destroy, remove or substantially alter the fabric (physical material including structural elements and other components, fixtures, contents, and objects) of a heritage place	The local scientific heritage value of the place relates to the contribution, rarity, and influence of the past research and monitoring that has taken place there, not to its future research potential, which is declining. The proposal will remove the fabric of the place (i.e. what would enable it to be used for future field based research). The existing monitoring record of past change will not be impacted. The significance of this impact must be considered in the context of the existing trends in integrity and the future quality of the environment of the place, which are already diminishing its future research value and influence. Overall, in relation to the heritage criteria that apply to the place, the impact of clearing and disposal is not significant, provided the records of past influential work are maintained. **A significant impact of value associated with criteria (a) and (b) is not likely.**
Involve extension, renovation, or substantial alteration of a heritage place in a manner which is inconsistent with the heritage values of the place	Not applicable
Involve the erection of buildings or other structures adjacent to, or within important sight lines of, a heritage place which are inconsistent with the heritage values of the place	Not applicable
Substantially diminish the heritage value of a heritage place for a community or group for which it is significant	The local scientific heritage value of the place relates to the contribution, rarity, and influence of the past research and monitoring that has taken place there, not to its future research potential, which is declining. The proposal will remove the fabric of the place (i.e. what would enable it to be used for future field based research). The existing monitoring record of past change will not be impacted. The significance of this impact must be considered in the context of the existing trends in integrity and the future quality of the environment of the place, which are already diminishing its future research value and influence. Overall, in relation to the heritage criteria that apply to the place, the impact of clearing and disposal is not significant, provided the records of past influential work are maintained. **A significant impact of value associated with criteria (a) and (b) is not likely.**

Consideration/Criterion	Response
Substantially alter the setting of a heritage place in a manner which is inconsistent with the heritage values of the place, or	The proposed action is not considered likely to substantially alter the setting of a heritage place as the setting has been previously modified by urban development
Substantially restrict or inhibit the existing use of a heritage place as a cultural or ceremonial site?	Not applicable

As shown in **Table 3.2**, the significance of the impact of the proposed action on scientific heritage values is not as great as could be initially concluded from the extent, duration, and magnitude of the proposal.

The proposed clearing and disposal of the Impact Area will clearly impact on its fabric. However, its local heritage significance does not relate specifically to the future research potential of the fabric of the place (heritage criterion (c)); rather it relates to the rarity and influence of past work. The proposed clearing and disposal will prevent future studies occurring in the Impact Area, however this is not considered to be a significant impact as this past value is not affected by the proposed action.

Umwelt identified a number of additional factors that influence the likelihood of a significant impact occurring. These include the following:

- The records of past monitoring exist. The disposal of the Impact Area will not affect these records and they will continue to be available for further analysis where there are relevant research or management questions.
- The local heritage value of the Impact Area is linked to the scientific culture of Canberra as a city which holds several nationally important research and environmental management institutions. This institutional context has influenced the research and community interest in Block 3 and Block 15, which are centrally located and accessible.
- The accessibility of the Impact Area appears to be an important reason for the early recognition and extensive research in relation to GSM being undertaken on site. This accessibility has led to the previous research and extensive monitoring record, linked to obligations under the EPBC Act and/or approval conditions for adjacent development. The early commencement of scientific work on the Impact Area is an important factor in its local scientific heritage value, positioning the scientific work at the Impact Area as influential on GSM research themes.

  Now that a large number of other GSM sites are known in and around the ACT, and broad based monitoring and conservation programs are being implemented at diverse habitat sites, the significance of the record from Blocks 3 and 15 will decline over time. It is one snapshot of the population dynamics of the species, from a site that is not representative of the range of sites on which the GSM and its grassland habitat occur. This suggests that the relative significance of the Impact Area will decline over time and therefore the significance of the impact of development would also decline.
- Beyond the requirements of the EPBC Act for the land owner, monitoring and research conducted at the Impact Area by CSIRO, ANU or UC scientists has been somewhat opportunistic and patchy, with the key studies having taken place in the mid to late 1990s and then in 2006 and 2010. Other publications refer to these earlier studies. Although there is recognition and interest in the site, there is no commitment from these institutions to continue new research into the GSM at this site.

The Impact Area has provided valuable information about some key conservation issues which continue to attract research interest in Australia – but now with research opportunities across a wide range of grassland habitat sites in the ACT, NSW and Victoria.

- The Impact Area has been used intermittently for student coursework for ANU and UC courses, benefiting from its central location and long recognition. There are other grassland sites throughout the valleys of the ACT which could be used for such tutorial/excursions. These other sites are also generally accessible.

- The culture of Canberra, and the central location and accessibility of the Impact Area have also influenced its value for citizen science, with intermittent community monitoring adding to the overall body of monitoring work and to the recognition of the site by the broader community as a place of scientific interest. However, these community scientists also monitor other GSM sites, and the value of their contribution at Blocks 3 and 15 must be considered in the context of the annual monitoring required under the EPBC Act. In this context, occasional community monitoring (whether recorded or not recorded) demonstrates interest and commitment but is not scientifically significant.

- The integrity of the fabric of the place is vulnerable to a range of urban and isolation threats, and to invasive species. In the short term, this provides a further research opportunity to study how the population responds to isolation and local threats over time. In the medium term, the value of the place in relation to criteria (a) and (b) is expected to decline as the quality of the fabric of the place declines, even if relatively intensive conservation management is maintained. Intensive management to date has not prevented substantial changes to the habitat (including invasion by Chilean needle grass and shading from adjacent buildings). In comparison to other sites, the value of the fabric of the place has a limited lifespan.

- With the changes to the condition of the fabric of the place, the research opportunities at the Impact Area will not necessarily make a major contribution to knowledge that will support the conservation of the GSM across its range, which includes large and contiguous areas of grassland – in the ACT, southern NSW and Victoria.

- There are opportunities to continue to build knowledge of the survival of the GSM on isolated urban sites (and other sites) from continuing structured monitoring programs across land owned by ACT Government and the Commonwealth Government.

In consideration of the above factors, the proposed action is not considered likely to result in a significant impact to heritage elements of the environment. A detailed impact assessment is provided in **Appendix 6**.

3.5 Social and Economic Impacts of the Action

Purdon Planning (2018) undertook a high-level analysis of the potential social and economic impacts of the proposed action in response to the RAI. The results of the analysis are provided below, and the full report is provided in **Appendix 7**.

As the actual development outcome for the Project Area is unknown, numeric values cannot be provided for the economic impacts. As such, the economic impact has been measured in terms of negative and positive outcomes. The proposed action is considered to have a positive economic impact through reduced maintenance costs associated with Block 3 and the sale of the land. The community will also see an economic benefit through provision of additional services and investment in the area. There are no perceived negative economic impacts associated with the proposed action (Purdon Planning, 2018).

The future development of Blocks 3 and 15 that is a facilitated impact of the proposed action will result in increased urban density, promotion of active transport modes, and improved activity and vibrancy of the area; resulting in a positive outcome for healthy lifestyles. This can be achieved with minimal adverse impacts to traffic (Purdon Planning, 2018). The loss of public open space as a result of future development is compensated by the high proportion of community open space areas available throughout Barton (32 per cent of the total area) (Purdon Planning, 2018).

The loss of biodiversity on the site has been identified as a key social impact as it generally affects the community's interest in environmental protection. However, this impact is reduced somewhat given that the long-term viability of the population is uncertain and the proposed action includes a biodiversity offset strategy (Purdon Planning, 2018).

Purdon-Planning in consultation with Umwelt and Finance have concluded that positive social impacts of the proposed action will outweigh the negative impacts associated with minimal traffic impacts, loss of public open space, and the loss of biodiversity values (Purdon Planning, 2018).

4.0 Avoidance, Mitigation and Management Measures

4.1 MNES

Options to avoid the patch of native grassland within Blocks 3 and 15 have been considered as part of the proposed action, including the option of not divesting the land.

Block 3 is currently included in the Commonwealth divestment strategy as it has been determined to be surplus to Commonwealth requirements. Purdon Planning (2018) noted that if divestment was not pursued, the site would likely remain in its present state and maintenance would be ongoing. However, as the key area of ecological value is the 0.32 hectare patch of native grassland within York Park Conservation Area and is located in a highly developed area with no connectivity to conservation areas, it is difficult to manage the site for conservation. A small patch such as this is susceptible to threats and degradation, or even loss as a result of a catastrophic event. Therefore a 'business-as-usual' approach is not considered viable from either an ecological or economic perspective.

The option of avoiding the core native grassland patch within the York Park Conservation Area and clearing the remainder of Block 3 for sale and development was considered by Purdon Planning (2018). Options to partially divest or divest with constraints on potential future development (e.g. only develop the north-western exotic grassland portion) have been deemed unfeasible (Purdon Planning, 2018). In addition to the loss of revenue associated with selling only a portion of Block 3 or by placing constraints on the purchaser; it would likely result in further accelerated degradation of the small remaining area of native vegetation (0.32 hectares). The increased pressure of partial development of the site on the avoided York Park Conservation Area habitat, reduces the likelihood of success that any proposed mitigation and management measures would achieve. Given the current difficulties in maintaining such a small site, there is little confidence that any mitigation or management measures could be successfully implemented to ensure the ongoing viability of the core native grassland habitat. Furthermore, unconstrained partial development of the block would significantly impact on habitat for GSM due to overshadowing and effects on soil temperature. This would likely result in a significant impact to GSM under the EPBC Act, and may additionally impact the quality of the NTG.

The proposed action has also taken a conservative approach by including all known NTG and GSM habitat within the immediate surrounds in the impact footprint. Given the small size of the impact area and the adjacent habitat, all areas have been assumed to be affected by the proposed action and other alternatives are not considered feasible for the protection of MNES.

An offset strategy to compensate for the loss at the proposed action area has been developed at a more appropriate location for the conservation and enhancement of these habitats.

4.2 Whole of Environment

Potential impacts to the 'environment' as a result of the proposed action are linked to possible erosion, sedimentation, air pollution from dust, and water quality degradation following vegetation removal. There may also be community impacts if subsequent development is not considerate of the surrounding land uses and users. The initial Referral documentation (**Appendix 1**) included the following measures to mitigate these potential impacts:

- Following the clearing of vegetation and up to the finalisation of the divestment of land, the Proponent will be responsible for maintaining the Blocks to minimise erosion, sedimentation, and dust.

- It will be a condition of sale that the purchaser continues to maintain the Blocks to minimise erosion, sedimentation, and dust until the time construction is completed. This will be enforced through the contact for sale.

- The consequential development will be subject to approval from the NCA. At this stage, consideration of land-use and impacts to the community will occur. Given the current provisions of the NCP, it is unlikely that any future development will have impacts to the local community if approved by the NCA.

4.3 Additional Measures for Scientific Heritage Values.

Finance may permit local scientists and citizen science groups to implement a number of management options designed to hold and preserve records of the evidence that underpins the local scientific heritage value of the Impact Area. Options that Finance may consider include:

- Continue with existing obligations to manage the Impact Area to minimise impacts on MNES, until the property is cleared.

- Prior to clearance, facilitate research opportunities including collection of specimens from Block 3 and Block 15 that can be used for genetic profiling using modern techniques and can also be stored using modern techniques to improve longevity and future usefulness for research.

- Work with scientists and/or scientific libraries at CSIRO or universities in Canberra to make sure copies of past research and monitoring data and reports are maintained and are accessible for future researchers.

In addition to these measures that relate to the scientific heritage value of the Project Area, Finance could permit scientists and citizen scientists to facilitate future scientific research on the GSM on land that it owns where quality GSM habitat can be maintained. This could include the proposed offset site at Block 48 at Hall. Finance could:

- outline the location of other GSM sites available throughout the ACT, including the proposed offset site;

- invite relevant scientific stakeholders to participate in the management of the offset property;

- arrange access to the site for research and teaching purposes, which could help build up a record of change over time; and

- make any previous and future survey results of this site readily available.

5.0 Proposed Offset Strategy

As the proposed action will result in significant impacts to NTG and GSM an Offset Strategy has been developed to compensate for these impacts. Umwelt (2018c) outlined the key measures included in the proposed Offset Strategy and assessed these against the Commonwealth Offsets Policy (DSEWPaC, 2012).

The Offset Strategy is proposed to be based on the use of direct offsets, located within a 12.79 hectare portion of Rural Registered Block 48, Hall, ACT (Block 48). The direct offset will be managed under an Offset Management Plan (OMP), which will include specific management measures required to meet the commitments of the proposed Offset Strategy.

Umwelt (2018c) determined that the proposed Offset Strategy meets the principles and requirements of the Commonwealth Offsets Policy. This conclusion was based on the 'offset assessment guide; (DSEWPaC, 2012) and in consideration of the principles set out in the Commonwealth Offset Policy (DSEWPaC, 2012).

Sections 5.1 and **5.2** describe the Offset Strategy details relevant to NTG and GSM respectively. The full Offset Strategy, including a description of all values used in the assessment of the Offset Strategy, has been provided in **Appendix 8**.

5.1 Natural Temperate Grassland

Block 48 contains 2.3 hectares of NTG with an overall starting habitat quality of '5'. This NTG will be used to directly compensate for impacts to 0.32 hectares of NTG within the Impact Area, which is of a quality of '6'. The calculations used in the Offset Strategy (Umwelt, 2018c) show that this proposed NTG offset, including the management measures described below, exceeds the 100 per cent threshold for direct offsets at 106.76 per cent.

To achieve the 100 per cent threshold, the following management measures will be incorporated into the OMP to ensure the ongoing persistence and improvement of the NTG community within Block 48:

- Weed management: targeting areas where introduction and persistence of native species subsequent to weed management actions would be most likely. Initially this is expected to be in locations directly adjacent to, or within, the NTG patches. The specific locations of any weed management activities will be guided by the OMP as amended over time.

- Biomass control: targeting the introduction and persistence of native species integral to the NTG community. The OMP will consider the effects of cattle grazing as well as from grazing of other herbivores (e.g. kangaroos) and manage these as appropriate based on best practice principles and the results of the monitoring.

- A commitment to increase the average number of native species (i.e. richness) to more than 20 throughout the NTG.

It is proposed that the NTG offset outcomes will be achieved within 10 years of offset establishment.

5.2 Golden Sun Moth

Block 48 contains 6.2 hectares of GSM habitat, which has been determined to be a quality of '7'. It is proposed that this will be used to compensate for impacts to 1.46 hectares of '5' quality GSM habitat impacted by the proposed action (Umwelt, 2018a and 2018c). The calculations used in the Offset Strategy (Umwelt, 2018c) show that this proposed GSM offset exceeds the 100 per cent threshold for direct offsets at 106.13 per cent.

The commitments relating to the improvement of existing GSM habitat will be achieved by a number of actions that will include, but not be limited to the following:

- Biomass control across the Proposed Offset Area. This will target achieving one of the following two outcomes:
    - improving inter-tussock space within GSM habitat area; or
    - limiting the height of grasses between and surrounding GSM habitat, to improve the ability for flying males to disperse throughout the Proposed Offset Area.
- Manage agricultural practices so that they align with the ecological and biological requirements of GSM. This includes:
    - consideration of the soil nutrient levels that are required for the promotion of native 'C3' grass growth; and
    - management of stock grazing levels, considering the combined effect of stock, native herbivores (e.g. kangaroos), and introduced herbivores (e.g. rabbits), especially in areas currently affected by erosion.
- Undertaking weed management throughout the Proposed Offset Area, targeting the 'habitat matrix' between patches of GSM habitat to promote the growth of native 'C3' grasses to improve connectivity for GSM.
- Remediate the erosion present on the ridge-top within the major patch of GSM habitat by re-seeding with appropriate GSM feed species. Over time, this is expected to result in improved soil conditions for GSM pupae and larvae.

The measures described above will be implemented by through the OMP, as amended based on an adaptive management framework. It is proposed that the GSM offset outcomes will be achieved within 10 years of offset establishment.

6.0 Other Approvals and Conditions

Both Blocks 3 and 15 are ‘Designated Land’ under the *National Capital Plan 1990* (as amended), being land having ‘special characteristics of the National Capital’ (s. 1.2, *National Capital Plan 1990*).

As designated land within the ACT, the Project Area is not subject to Territory planning and land use legislation.

In order to facilitate development of the Project Area, the Proponent submitted a proposed amendment to the *National Capital Plan 1990*, which is expected to be finalised in June 2018. Any development of the Project Area is subject to an approved EPBC referral, the *National Capital Plan 1990* and approval from the National Capital Authority (NCA).

7.0 Environmental Record of the Proponent

7.1 Does the Person taking the Action have a Satisfactory Record of Responsible Environmental Management? Please explain in Further Detail.

The Proponent is the custodian of a Commonwealth property portfolio. A number of the properties that the Proponent manages have threatened ecological communities, or species that require management and protection. The Proponent operates under all Commonwealth legislation and policy, including the EPBC Act, to ensure it remains compliant and meets its obligations with respect to environmental protection on its properties.

The Proponent has a history of managing properties in accordance with environmental management plans, which ensure the appropriate outcomes are met. This has included undertaking weed and pest management strategies to ensure its properties are maintained to a high standard that is consistent with key environmental objectives.

7.2 Provide Details of any Past or Present Proceedings under a Commonwealth, State, or Territory Law for the Protection of the Environment or the Conservation and Sustainable Use of Natural Resources Against either (a) the person proposing to take the action or, (b) if a Permit has been applied for in Relation to the Action – the person making the Application.

The Proponent does not and has not had proceedings against it under a Commonwealth, State, or Territory law for the protection of the environment, or the conservation and sustainable use of natural resources.

7.3 Will the Action be taken in Accordance with the Corporations' Environmental Policy and Planning Framework?

As a Commonwealth Agency, the Proponent operates under all Commonwealth legislation and policy, including the EPBC Act, to ensure it remains compliant and meets its obligations with respect to environmental protection on its properties.

7.4 Has the Person Taking the Action Previously Referred an Action under the EPBC Act, or been Responsible for Undertaking an Action Referred under the EPBC Act?

Yes.

7.4.1 EPBC Act No and/or Name of Proposal

In the last five years, the Proponent has submitted the following EPBC referrals: 2016/7766; 2015/7587; 2015/7499; 2013/7017; 2013/6903; 2012/6586; 2012/6504; 2012/6437; and 2008/4158.

8.0 Consultation Parties

The following parties were consulted during the preparation of the Preliminary Documentation:

- Doctor David Yeates, Director Australian National Insect Collection, Senior Principal Research Scientist, CSIRO. Dr Yeates participated in a face to face interview on 14 March 2018 and also provided some follow up suggestions, references, and contacts via email.

- Associate Professor Will Osborne, Institute for Applied Ecology, UC. Dr Osborne provided a preliminary email response and more detailed follow up email response to specific questions on 28 February and 22 March 2018.

- Doctor Philip Gibbons, Fenner School of Environment and Society, ANU. Dr Gibbons provided a brief email response on 8 March 2018.

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Umwelt (2018b) *Striped Legless Lizard Impact Assessment Report: Blocks 3 and 15, Section 22, Barton ACT*, unpublished report prepared for the Department of Finance, Canberra.

Umwelt (2018c) *Offset Strategy: Blocks 3 and 15, Section 22 Barton and Block 48 Wallaroo Road Hall*, unpublished report prepared for the Department of Finance, Canberra.

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APPENDIX 1

Referral Documentation

Title of Proposal - Blocks 3 and 15, Section 22, Barton, ACT Divestment

Section 1 - Summary of your proposed action

Provide a summary of your proposed action, including any consultations undertaken.

1.1 Project Industry Type

Commonwealth

1.2 Provide a detailed description of the proposed action, including all proposed activities.

This referral, made under Part 9 of the Commonwealth's Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act), is seeking approval to clear Blocks 3 and 15, Section 22, Barton, Australian Capital Territory (ACT) 2600 (the Project Area). The proposed action includes divestment of the Project Area in a single, open market sale to a private purchaser for the purpose of development.

To prepare the land for sale, the Proponent will clear all of the vegetation present and subsequently maintain the Project Area. Clearing will occur between exchange and completion of contracts for sale, prior to transfer.

The overall Project Area is 1.25 hectares. A section of the Project Area contains 0.32 hectares of natural temperate grassland of the South Eastern Highlands (NTG) and golden sun moth (Synemon plana) (GSM) habitat. The median strips adjacent to the Project Area contain 0.4 hectares of low quality GSM habitat. The Proposed Action will directly impact the NTG and GSM habitat on the Project Area and indirectly impact the GSM population on the median strips.

An offset strategy, consistent with the EPBC Act Environmental Offsets Policy has been developed to compensate for the impact at the Project Area. Block 48, Wallaroo Road, Hall, ACT (Block 48) exceeds offset value requirements and adequately compensates for the loss of NTG and GSM habitat. Block 48 is in a rural location, and is more suitable to ensure the conservation and long-term viability of GSM and NTG habitats. A conservation agreement will be developed to ensure the protection and continued growth of NTG and GSM habitat at Block 48.

Block 3 is National Land, managed by the Proponent. Block 15 is Territory Land, managed by the ACT Government. Accordingly, the proposed action will be undertaken by the Proponent with agreement from the ACT Government to include Block 15. If the transfer of Block 15 is not agreed to by the ACT Government, the Proponent will proceed to divest only Block 3 in a single, open market sale.

1.3 What is the extent and location of your proposed action? Use the polygon tool on the map below to mark the location of your proposed action.

Area	Point	Latitude	Longitude
Block 3, Section 22, Barton ACT	1	-35.312318605332	149.13192622325
Block 3, Section 22, Barton ACT	2	-35.311675119588	149.13082115314
Block 3, Section 22, Barton ACT	3	-35.311014118698	149.13145951888
Block 3, Section 22, Barton ACT	4	-35.311675119588	149.13251094482
Block 3, Section 22, Barton ACT	5	-35.312314227895	149.13192085884
Block 3, Section 22, Barton ACT	6	-35.312318605332	149.13192622325
Block 15, Section 22, Barton ACT	1	-35.311416479052	149.13210206462
Block 15, Section 22, Barton ACT	2	-35.311317985569	149.13223349286
Block 15, Section 22, Barton ACT	3	-35.311547803509	149.13261973096
Block 15, Section 22, Barton ACT	4	-35.311674750281	149.1325124426
Block 15, Section 22, Barton ACT	5	-35.311420856537	149.13210474683
Block 15, Section 22, Barton ACT	6	-35.311416479052	149.13210206462

1.5 Provide a brief physical description of the property on which the proposed action will take place and the location of the proposed action (e.g. proximity to major towns, or for off-shore actions, shortest distance to mainland).

The Project Area is currently vacant land, located on the corner of Sydney Avenue and National Circuit within the highly developed suburb of Barton in Canberra, ACT. Surrounding land uses include accommodation (hotels), office space, residential (apartments), and major roads. The proposed action will be located across the entire Project Area.

The south-east portion of the Project Area currently contains two Matters of National Environmental Significance (MNES) protected under the EPBC Act. They are the critically endangered ecological community natural temperate grassland of the South Eastern Highlands (NTG) and the critically endangered golden sun moth (*Synemon plana*) (GSM).

The remaining portion of the Project Area contains exotic vegetation, predominantly in the form of grassland, with four planted exotic trees (Umwelt, 2016a and Rowell, 2007). The north-west of Block 3 is also reported to contain fill from other, historic, off-site developments (Parsons Brinckerhoff, 2008). This area is considered highly disturbed and does not support any other environmental values.

1.6 What is the size of the proposed action area development footprint (or work area) including disturbance footprint and avoidance footprint (if relevant)?

1.25 hectares.

1.7 Is the proposed action a street address or lot?

Lot

1.7.2 Describe the lot number and title. Blocks 3 and 15, Section 22, Barton, ACT 2600

1.8 Primary Jurisdiction.

Other Australian Land/Water

1.9 Has the person proposing to take the action received any Australian Government grant funding to undertake this project?

No

1.10 Is the proposed action subject to local government planning approval?

Yes

1.10.1 Is there a local government area and council contact for the proposal?

No

1.11 Provide an estimated start and estimated end date for the proposed action.

Start date 09/2017

End date 06/2018

1.12 Provide details of the context, planning framework and State and/or Local government requirements.

Both Blocks 3 and 15 are ‘designated land’ under the *National Capital Plan 1990* (as amended), being land having ‘special characteristics of the National Capital' (s. 1.2, *National Capital Plan 1990*).

As designated land within the ACT, the Project Area is not subject to Territory planning legislation.

Any development of the Project Area following divestment will be subject to the *National Capital Plan 1990* and approval from the National Capital Authority (NCA). In order to facilitate development of the Project Area, the Proponent has submitted a proposed amendment to the *National Capital Plan 1990*. The NCA is currently considering the proposed amendment; and NCA approval will be subject to an approved EPBC referral.

1.13 Describe any public consultation that has been, is being or will be undertaken, including with Indigenous stakeholders.

The Proponent has undertaken significant communication between relevant government agencies and personnel, and approving authorities. This includes the Minister for Finance, the Department of Finance, the Department of the Environment and Energy, the NCA, and the ACT Government. This consultation includes meetings, written and telephone liaison, and feedback on documents proposed for submission with this referral.

Communication with nearby land owners and key stakeholders has occurred as part of the NCA public consultation process for the proposed amendment to the *National Capital Plan 1990* for the Project Area. Further consultation will occur as part of the NCA approvals process for any future development following divestment of the Project Area.

Indigenous stakeholders identified as ACT Representative Aboriginal Organisations (RAOs), have been consulted as part of a heritage assessment completed for Block 3 (ERM, 2016). Block 15 was not included as part of this survey. Representatives of two RAOs attended a site visit with ERM and all RAOs were provided with the draft heritage assessment report (ERM, 2016) for comment on 1 March 2015 - no comments were received. The heritage assessment concluded that no known Indigenous heritage objects, or places, occur and there is a low potential for unknown Indigenous heritage sites to occur.

1.14 Describe any environmental impact assessments that have been or will be carried out under Commonwealth, State or Territory legislation including relevant impacts of the project.

A large number of ecological surveys have been conducted across the Project Area. The monitoring provides assessment of the extent and condition of NTG, and GSM population trends.

The most recent monitoring occurred in 2015 (Umwelt, 2016a). These surveys identified 0.32 hectares of NTG and GSM habitat, which occur concurrently within the south-east of the Project Area. No other MNES have been recorded within the Project Area. In addition, a further 0.4 hectares of low quality GSM habitat has been identified along the median strips of Sydney Avenue to the south and south-east of the Project Area (ACT Government, 2015).

The attached impact assessment (Umwelt, 2017) to this referral confirms the proposed action will result in the loss of 0.32 hectares of NTG and 0.72 hectares of GSM habitat.

Other indirect impacts that would occur if no mitigation measures are undertaken include erosion, sedimentation, changes to water surface run off, water flow and quality, and air pollution from dust. Dust, erosion, and sedimentation controls will be appropriately implemented following clearing of the vegetation on the Project Area.

Given the current provisions of the *National Capital Plan 1990*, it is unlikely that future development approved under these provisions, would cause significant impact to the community, as it would be consistent with surrounding land uses. If the *National Capital Plan 1990* is amended as part of the NCA approvals process to allow alternate types of development, impacts to the community and surrounding land users would be assessed. Given the importance of the Barton Precinct to the National Capital, it is unlikely that the NCA would approve development that is inconsistent with current surrounding land uses.

1.15 Is this action part of a staged development (or a component of a larger project)?

No

1.16 Is the proposed action related to other actions or proposals in the region?

No

Section 2 - Matters of National Environmental Significance

Describe the affected area and the likely impacts of the proposal, emphasising the relevant matters protected by the EPBC Act. Refer to relevant maps as appropriate. The interactive map tool can help determine whether matters of national environmental significance or other matters protected by the EPBC Act are likely to occur in your area of interest. Consideration of likely impacts should include both direct and indirect impacts.

Your assessment of likely impacts should consider whether a bioregional plan is relevant to your proposal. The following resources can assist you in your assessment of likely impacts:

• Profiles of relevant species/communities (where available), that will assist in the identification of whether there is likely to be a significant impact on them if the proposal proceeds;

• Significant Impact Guidelines 1.1 – Matters of National Environmental Significance;

• Significant Impact Guideline 1.2 – Actions on, or impacting upon, Commonwealth land and Actions by Commonwealth Agencies.

2.1 Is the proposed action likely to have ANY direct or indirect impact on the values of any World Heritage properties?

No

2.2 Is the proposed action likely to have ANY direct or indirect impact on the values of any National Heritage places?

No

2.3 Is the proposed action likely to have ANY direct or indirect impact on the ecological character of a Ramsar wetland?

No

2.4 Is the proposed action likely to have ANY direct or indirect impact on the members of any listed species or any threatened ecological community, or their habitat?

Yes

2.4.1 Impact table

Species	Impact
Synemon plana (golden sun moth)	The GSM habitat at the Project Area is

Species	Impact
	considered to be small (less than ten hectares) and fragmented, and any impact that results in the loss or degradation of this habitat is considered significant (DEWHA, 2009). The proposed action will remove the entire 0.32 hectares of GSM habitat that occurs within the Project Area and indirectly impact 0.4 hectares of habitat occurring on two median strips of Sydney Avenue (a total maximum of 0.72 hectares). The Sydney Avenue median strips are located directly across from the Project Area, east and west of National Circuit (ACT Government, 2015). Subsequent to the 2009 survey identifying the median strips as low quality GSM habitat, significant disturbance has occurred as a result of construction activities and weed incursion. It is considered likely that all three areas of habitat (i.e. the Project Area and the two median strips) are occupied by a single population of GSM. The loss of primary habitat within the Project Area will subsequently impact the population on the median strips.
natural temperate grassland of the south eastern highlands	The Approved Conservation Advice (TSSC, 2016) identifies all remaining patches of NTG as critical to the survival of the ecological community. The proposed action is therefore considered to be a significant impact, as it will remove the entire 0.32 hectares of NTG that occurs within the Project Area. The NTG community at the Project Area has reduced over time due to weed incursion and surrounding development. The Offset site (Block 48) identified by the Proponent will adequately offset the impacts to the Project Area and is in an ideal location for the ongoing conservation of NTG community. There is no other NTG in the surrounding landscape.

2.4.2 Do you consider this impact to be significant?

Yes

2.5 Is the proposed action likely to have ANY direct or indirect impact on the members of

any listed migratory species, or their habitat?

No

2.6 Is the proposed action to be undertaken in a marine environment (outside Commonwealth marine areas)?

No

2.7 Is the proposed action to be taken on or near Commonwealth land?

No

2.8 Is the proposed action taking place in the Great Barrier Reef Marine Park?

No

2.9 Is the proposed action likely to have ANY direct or indirect impact on a water resource related to coal/gas/mining?

No

2.10 Is the proposed action a nuclear action?

No

2.11 Is the proposed action to be taken by the Commonwealth agency?

Yes

2.11.1 Describe the nature and extent of the likely impact on the whole of the environment.

The proposed action is unlikely to significantly impact on the whole of the environment as required to be considered under Section 28 of the EPBC Act.

The proposed action will result in the removal of a maximum of four trees and a maximum of 1.25 hectares of vegetation. As the proposed action will not involve medium, or large-scale excavation of soil or minerals, the proposed action is unlikely to result in a significant impact to soils and landscapes.

Clearing activities are likely to result in localised erosion, which may pose a sedimentation and pollution risk to local waterways. However, due to the urban setting, small scale of the clearing and highly altered hydrology of the surrounding landscape, it is not expected to measurably alter water table levels, or channelise, divert, or impound rivers or creeks.

The proposed action may generate dust and sediment that may cause local air or water pollution. As dust, erosion, and sedimentation controls will be implemented in accordance with best practice, the proposed action is considered unlikely to reduce air quality or quantity, or availability of surface or ground water.

It is unlikely the proposed action will have a significant impact on native plants due to the urban context of the surrounding landscape and small-scale of native vegetation impacted. Similarly, the proposed action is not expected to displace or substantially limit movement or dispersal of native animal populations, or substantially reduce or fragment habitat for native animal species.

The meta-population of GSM is not likely to be impacted by the proposed action. Genetic analysis of GSM populations in the ACT, including the Project Area, has identified at least five distinct regional populations comprised of smaller, generally isolated local populations (Clarke and O'Dwyer, 1998). The regional population, which the local Project Area population is a part of, includes larger and more viable populations in Majura Valley East, Mulanggari Grassland Reserve, and Jerrabomberra Reserve. These populations are considered well protected and more important for the viability of the meta-population.

No other native plant or animal species are expected to suffer long-term detrimental effects as a result of the proposed action. Nor is it going to reduce, or fragment, available habitat for listed threatened species resulting in a long-term decline in a population.

The proposed action will be undertaken in accordance with all relevant work health and safety standards, and noise restrictions to protect the welfare of the local community. Any residual impacts as a result of clearing are to be temporary and localised.

The Project Area is not associated with social organisation, or community resources and is not considered likely to substantially change or diminish cultural identity, social organisation, or community resources. The Project Area has played a small role in the promotion of conservation efforts for GSM in the local community, and the scientific knowledge associated with the species.

There are no known heritage items, or places within or adjacent to the Project Area.

2.11.2 Do you consider this impact to be significant?

No

2.12 Is the proposed action to be undertaken in a Commonwealth Heritage Place Overseas?

No

2.13 Is the proposed action likely to have ANY direct or indirect impact on a water resource related to coal/gas/mining?

No

Section 3 - Description of the project area

Provide a description of the project area and the affected area, including information about the following features (where relevant to the project area and/or affected area, and to the extent not otherwise addressed in Section 2).

3.1 Describe the flora and fauna relevant to the project area.

The Project Area has been subject to a large number of ecological surveys, including ongoing monitoring. The latest of these monitoring events occurred in 2015 (Umwelt, 2016a). These surveys identified 0.32 hectares of NTG and 0.32 GSM habitat within the Project Area. The remainder of the Project Area is exotic vegetation, with some native grass species present. A full flora list, as collected over all surveys since the 1990s, is included as an appendix to the Umwelt (2016a) report.

Given the changes to the description of NTG that came into effect in 2016, Umwelt re-visited the Project Area to confirm that all areas mapped as NTG meet the new description of the community. The mapping previously provided was determined to still be accurate.

In addition to the critically endangered GSM, fauna species noted to utilise the Project Area are consistent with common species in an urban environment in the ACT, such as common starlings (*Sturnus vulgaris*) and Australian magpies (*Cracticus tibicen*).

The area of GSM habitat at the Project Area has reduced over time. The NTG component of the Project Area (in this case, NTG cover is equivalent to the GSM habitat area) was first recorded at 0.4 hectares, then 0.56 hectares in 2008 and 0.5 hectares in 2013. In 2014 a portion of the habitat in Block 15 was removed to make an access road as part of the adjacent private development of Block 14, Section 22 Barton, reducing the area of GSM to 0.34 hectares. By 2015, habitat had further reduced to 0.32 hectares, as a result of weed incursion.

The two adjacent Sydney Avenue median strips contain occupied GSM habitat (ACT Government, 2015). These areas have not been surveyed in detail since 2009, when they were confirmed as occupied, low quality habitat. Since this time, significant disturbance has occurred in these areas as a result of construction activities (including gravel fill for vehicle parking and material dumping) and weed incursion. Overall, the NTG and GSM habitat of the Project Area is decreasing. The offset strategy is considered to adequately compensate for impacts to the median strip habitat as well as the Project Area.

3.2 Describe the hydrology relevant to the project area (including water flows).

The hydrology of the Project Area is highly modified due to the intensity of surrounding urban development. There are no drainage lines present and any surface water flows run into the urban storm water system.

3.3 Describe the soil and vegetation characteristics relevant to the project area.

The Project Area is located within the Williamsdale Soil Landscape, overlaying Silurian volcanic geology. Soils in this landscape are generally complex and transition from lithosols, red and yellow earths, red and yellow podzolic soils into soldoic and solodized solonetz soils. They are hard setting, erodible, and potentially dispersive (ACT Government, 2015). The north-west of Block 3 is also reported to contain fill from historic, off-site developments, with unknown soil characteristics (Parsons Brinckerhoff, 2008).

The Australian Soil Resource Information System (ASRIS) (CSIRO, 2017) online database indicates there is no known occurrence of acid sulphate soils within the Project Area. Furthermore there is an extremely low probability of them occurring.

Currently a majority of the Project Area has been assessed as exotic vegetation, predominantly in the form of grassland. These areas are dominated by Phalaris (*Phalaris aquatica*), hoary mustard (*Hirschfeldia incana*), and wild oats (*Avena* spp.) with some scattered native wallaby grasses (*Rytidosperma laevis* and *R. bipartitum*) (Rowell, 2007). This exotic grassland extends into the higher quality south-east portion of the Project Area, where it also includes cocksfoot (*Dactylis glomerata*), fescue species (*Festuca* spp.), and paspalum (*Paspalum dilatatum*) (Umwelt, 2016a).

The south-east of the Project Area contains 0.32 hectares of NTG. This area is dominated by spear grass (*Austrostipa bigeniculata*), red-leg grass (*Bothriochloa macra*), various wallaby grasses, and native forbs (including *Chrysocephalum apiculatum*, *Goodenia pinnatifida*, *Calocephalus citreus*, and *Tricoryne elatior*).

A strip of planted kangaroo grass (*Themeda triandra*) occurs along the south-eastern border of the grassland. This native grass was planted following disturbance as a result of footpath upgrades. Despite being a native, it is considered invasive in this context as it is encroaching on the NTG (Umwelt, 2016a).

Exotic grass species, African love-grass (*Eragrostis curvula*) and Chilean needlegrass (*Nassella neesiana*) have previously been mapped between the footpath and road along National Circuit. These values have since been replaced by gravel; as confirmed by an Umwelt site inspection on 6 February 2017.

The NTG values present at the Project Area have been monitored on a semi regular basis since the early 1990s. Since 1992, the NTG within the Project Area has been part of a long-term monitoring program being undertaken by the ACT Government and surveys commissioned by the Proponent.

Overall trends to the Project Area, such as the apparent loss of some native species, the arrival and persistence of undesirable exotic species, and the increase of weed cover overall, indicate the NTG values of the site are decreasing.

Vegetation associations were previously mapped by Parsons Brinckerhoff (2008), Alison Rowell

(2012), and Umwelt (2014 and 2015) and have changed little in type. The extent of NTG has changed over this time. Between 2008 and 2014, the NTG varied between 0.56 and 0.5 hectares. During 2015, Block 15 was split, with an access road being built through the northern half, servicing the private development at Block 14, Section 22, Barton.

In addition to the loss of NTG in this portion of Block 15, the site was affected by a significant weed incursion, recorded in the 2015 surveys (Umwelt, 2016a). This has resulted in the current extent of NTG being recorded at 0.32 hectares.

3.4 Describe any outstanding natural features and/or any other important or unique values relevant to the project area.

Aside from the presence of NTG and GSM habitat, there are no outstanding natural features, or other important, or unique values present within the Project Area.

3.5 Describe the status of native vegetation relevant to the project area.

The only native vegetation present at the Project Area is the 0.32 hectares of NTG in the south-east.

3.6 Describe the gradient (or depth range if action is to be taken in a marine area) relevant to the project area.

The Project Area is relatively flat, varying between 567 and 570 metres above sea level (ACT Government, 2015; as mapped in May 2004).

The proposed action would remove topsoil from the Project Area but would not significantly vary the gradient present at the Project Area.

3.7 Describe the current condition of the environment relevant to the project area.

As stated in **Section 3.3**, a large portion of the Project Area is dominated by exotic grassland flora species, with some planted exotic tree species also occurring. The most recent monitoring report completed by Umwelt (2016a) for the south-east area, assessed a notable increase in some weed species, namely St. John’s wort (*Hypercium perforatum*), cocksfoot (*Dactylis glomeratoa*), and ribbed plantain (*Plantago lanceolata*). In addition, the planted kangaroo grass (*Themeda triandra*) along the south-eastern boundary was noted as having expanded into the NTG area.

Monitoring for GSM habitat has demonstrated that wallaby grasses, important feed species in the ACT region, are at levels considered low for population maintenance. GSM population size and trends cannot be identified due to limitations of the survey techniques (i.e. only observing flying males) and understanding of the moth’s population traits. This is a limitation inherent in the Commonwealth approved survey technique for the species. A capture-mark-recapture survey has not been repeated since 2012, in accordance with the maintenance plan for the Project Area.

There is no evidence of erosion at the Project Area. However, the central and north-west portion of Block 3 is highly disturbed and there is evidence of previous ground disturbance.

Overall, the NTG and GSM values of the Project Area are decreasing. The long term viability of the GSM population at the Project Area is considered low.

3.8 Describe any Commonwealth Heritage Places or other places recognised as having heritage values relevant to the project area.

There are no known heritage values present within the Project Area (ERM, 2016). The interactive map tool (DoEE, 2015) identified 70 Commonwealth Heritage Places within five kilometres of the Project Area. However, none of these are within the immediate vicinity of the Project Area.

3.9 Describe any Indigenous heritage values relevant to the project area.

The heritage assessment completed for the Project Area (ERM, 2016) did not identify any Indigenous heritage values. Furthermore, it was assessed as having a low potential for unknown Indigenous heritage sites.

3.10 Describe the tenure of the action area (e.g. freehold, leasehold) relevant to the project area.

Block 3 is National Land, managed by The Proponent. Block 15 is Territory Land managed by the ACT Government. Neither block is leased to a third party. It is the intent of the proposed action to prepare Blocks 3 and 15 for sale to a private entity.

3.11 Describe any existing or any proposed uses relevant to the project area.

The Project Area is currently vacant land and this is proposed to continue until the sale.

It is the intent of the proposed action to prepare the Project Area for sale to a private, third party. Any future development would be subject to NCA approval and would be consistent with the surrounding land uses as befits the Barton Precinct Code under the *National Capital Plan 1990*. This referral has considered the potential effects of such future development on the surrounding landscape and land users, including the GSM habitat present on the Sydney Avenue median strips.

As described in **Section 2.4.1**, the full extent of known GSM habitat present within the surrounding landscape has been included in the impact footprint and will be compensated for appropriately in the offset strategy at Block 48. Potential impacts to surrounding land users and the local community are considered during the NCA assessment and approvals process.

Section 4 - Measures to avoid or reduce impacts

Provide a description of measures that will be implemented to avoid, reduce, manage or offset any relevant impacts of the action. Include, if appropriate, any relevant reports or technical advice relating to the feasibility and effectiveness of the proposed measures.

Examples of relevant measures to avoid or reduce impacts may include the timing of works, avoidance of important habitat, specific design measures, or adoption of specific work practices.

4.1 Describe the measures you will undertake to avoid or reduce impact from your proposed action.

Options to sell the Project Area with constraints on potential future development (e.g. only develop the north-western exotic grassland portion) have been deemed unfeasible and would likely result in further accelerated degradation of the small remaining area of native vegetation (0.32 hectares).

In addition, the small size (0.32 hectares) of native grassland has low resilience to impacts. It would be difficult to mitigate indirect impacts as a result of adjacent development with any confidence. This is also true for the 0.4 hectares of the Sydney Avenue median strips. Therefore, this referral considers the entire local population of NTG and GSM will be impacted. An offset strategy to compensate for the loss at the Project Area has been developed at a more appropriate location for the conservation and enhancement of these habitats.

Potential impacts to the ‘whole of the environment’ as a result of the proposed action are linked to possible erosion, sedimentation, air pollution from dust, and water quality degradation following vegetation removal. There may also be community impacts if subsequent development is not considerate of the surrounding land uses and users. To mitigate these potential impacts, the following will occur:

-Following the clearing of vegetation and up to the finalisation of the divestment of land, the Proponent will be responsible for maintaining the Project Area to minimise erosion, sedimentation and dust.

-It will be a condition of sale that the purchaser continues to maintain the Project Area to minimise erosion, sedimentation, and dust until the time construction is completed. This will be enforced through the contact for sale, or Crown lease.

-The consequential development will be subject to approval from the NCA. At this stage, consideration of land-use and impacts to the community will occur. Given the current provisions of the *National Capital Plan 1990*, it is unlikely that any future development will have impacts to the local community if approved by the NCA.

4.2 For matters protected by the EPBC Act that may be affected by the proposed action, describe the proposed environmental outcomes to be achieved.

An offset site has been identified to mitigate the loss of 0.32 hectares of NTG and 0.72 hectares of GSM at the Project Area. Umwelt (2016b) completed an assessment of two proposed offset sites, both of which are currently owned by the Commonwealth and managed by the Proponent. This report found that Block 48, Wallaroo Road, Hall, ACT (Block 48) is the most suitable for offsetting the impact to NTG and GSM habitat on the Project Area. This conclusion was made with consideration of the Commonwealth's environmental offset policy and guidelines.

Details of the values present at Block 48 are described in Umwelt's (2016b) report. The additional 0.4 hectares of low quality GSM habitat present on the Sydney Avenue median strips was not considered in detail, however it is considered that sufficient habitat occurs on Block 48 to fully offset the impact.

A Vegetation Management Plan (VMP) has been prepared for Block 48 (Umwelt 2016c) to protect and enhance ecological communities and habitats for conservation significance, particularly GSM and NTG habitat values, through a Priority Vegetation Management Action Plan with monitoring and review. The VMP itemises on site management issues and details management strategies and control measures specified according to priority setting and for each area of habitat. Management strategies/control measures include:

-Ecological condition monitoring, e.g. GSM habitat and vegetation condition monitoring every 3 years.

-Reconfiguration of fencing according to habitat management units; and assessment and monitoring of boundary fencing to ensure security and containment.

-Weed control: certification of weed contractor, site induction and identification of native species; baseline survey and ongoing monitoring of weed density and presence; vehicle hygiene identification, inspection and cleaning to minimise weed transmission, and inclusion of requirements in contracts/work orders; use of herbicides in a controlled manner; and schedule of application.

-Grazing for biomass control for enhancement of NTG and managing potential fuel loads; to be conducted seasonally as restricted conservation grazing, with weekly inspections/regular monitoring.

-Bushfire mitigation to be assessed and conducted prior to the fire danger season with possible measures to be considered to reduce biomass loads, only if required, through slashing and establishment of a 5-10 metre firebreak.

-Erosion control by grazing as well as management of the riparian corridor.

-Rabbit control through fumigating warrens, or poisoning/culling in a controlled manner.

-Adaptive management planning to address any unplanned events and provide contingencies that are responsive and flexible. This provides a risk based flexible approach to management to ensure any issues are addressed expediently relating to the threats such as new weed presence, additional erosion, or bushfire event.

Section 5 – Conclusion on the likelihood of significant impacts

A checkbox tick identifies each of the matters of National Environmental Significance you identified in section 2 of this application as likely to be a significant impact.

Review the matters you have identified below. If a matter ticked below has been incorrectly identified you will need to return to Section 2 to edit.

5.1.1 World Heritage Properties

No

5.1.2 National Heritage Places

No

5.1.3 Wetlands of International Importance (declared Ramsar Wetlands)

No

5.1.4 Listed threatened species or any threatened ecological community

Listed threatened species and communities - Yes

5.1.5 Listed migratory species

No

5.1.6 Commonwealth marine environment

No

5.1.7 Protection of the environment from actions involving Commonwealth land

No

5.1.8 Great Barrier Reef Marine Park

No

5.1.9 A water resource, in relation to coal/gas/mining

No

5.1.10 Protection of the environment from nuclear actions

No

5.1.11 Protection of the environment from Commonwealth actions

No

5.1.12 Commonwealth Heritage places overseas

No

5.2 If no significant matters are identified, provide the key reasons why you think the proposed action is not likely to have a significant impact on a matter protected under the EPBC Act and therefore not a controlled action.

Not applicable.

Section 6 – Environmental record of the person proposing to take the action

Provide details of any proceedings under Commonwealth, State or Territory law against the person proposing to take the action that pertain to the protection of the environment or the conservation and sustainable use of natural resources.

6.1 Does the person taking the action have a satisfactory record of responsible environmental management? Please explain in further detail.

The Proponent is the custodian of the Commonwealth's non-Defence property portfolio. A number of the properties that the Proponent manages have threatened ecological communities, or species that require management and protection. The Proponent operates under all Commonwealth legislation and policy, including the EPBC Act, to ensure it remains compliant and meets its obligations with respect to environmental protection on its properties.

The Proponent has a history of managing properties in accordance with environmental management plans, which ensure the appropriate outcomes are met. This has included undertaking weed and pest management strategies to ensure its properties are maintained to a high standard that is consistent with key environmental objectives.

6.2 Provide details of any past or present proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against either (a) the person proposing to take the action or, (b) if a permit has been applied for in relation to the action – the person making the application.

The Proponent does not and has not had proceedings against it under a Commonwealth, State, or Territory law for the protection of the environment, or the conservation and sustainable use of natural resources.

6.3 If it is a corporation undertaking the action will the action be taken in accordance with the corporation's environmental policy and framework?

Yes

6.3.1 If the person taking the action is a corporation, please provide details of the corporation's environmental policy and planning framework.

As a Commonwealth Agency, the Proponent operates under all Commonwealth legislation and policy, including the EPBC Act, to ensure it remains compliant and meets its obligations with respect to environmental protection on its properties.

6.4 Has the person taking the action previously referred an action under the EPBC Act, or been responsible for undertaking an action referred under the EPBC Act?

Yes

6.4.1 EPBC Act No and/or Name of Proposal.

In the last five years, the Proponent has submitted the following EPBC referrals.

2016/7766

2015/7587

2015/7499

2013/7017

2013/6903

2012/6586

2012/6504

2012/6437

2008/4158

Section 7 – Information sources

You are required to provide the references used in preparing the referral including the reliability of the source.

7.1 List references used in preparing the referral (please provide the reference source reliability and any uncertainties of source).

Reference Source	Reliability	Uncertainties
ACT Government (2015) ACTmapi, accessed online (March, 2017): http://www.actmapi.act.gov.au/home.html.	Moderately reliable.	The data that is used for ACTmapi is collected from numerous sources and is accurate to varying degrees. Where possible, the data source was identified and assessed on an case by case basis.
Clarke, G. M. and O'Dwyer, C. (1998) Genetic Analysis of Populations of the Endangered Golden Sun Moth, (Synemon plana), unpublished report for the Threatened Species Unit (NSW National Parks and Wildlife Service, Southern Zone) and the Wildlife Research and Monitoring Unit (Environment ACT), CSIRO Division of Entomology, Canberra.	High reliability. This survey is widely referenced in the ACT and is still considered accurate.	The research is a little old, and numerous populations of golden sun moth have been identified since this time. The conclusions regarding meta-populations are still considered accurate as all recently identified golden sun moth populations occur within these meta-populations.
Commonwealth Scientific and Industrial Research Organisation (CSIRO) (2017) Australian Soil Resource Information System (ASRIS), accessed online (March, 2017): http://www.asris.csiro.au/.	Moderately reliable. This data is gathered by a reputable organisation. It is to accurate to a coarse scale only, and therefore is not necessarily reliable to a small-scale as applicable to the Project Area.	The data used in ASRIS is accurate to a coarse scale only, and therefore is not necessarily reliable to a small-scale as applicable to the Project Area.
Department of the Environment and Energy (DoEE) (2015) Protected Matters Search Tool, accessed online (February 2017): http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf.	Moderately reliable. This tool is used as a starting point to identify matters protected under the EPBC Act. All information gathered from this source has been checked against project area scale information for	The scale of the data used by the protected matters search tool is large and can be at a coarse scale. By applying a buffer to the search (10 kilometers) and cross-checking results with other information

Reference Source	Reliability	Uncertainties
	accuracy.	sources, the uncertainty is not considered an issue for this Referral.
Environmental Resources Management (ERM) (2016) Block 3, Section 22, Barton ACT Heritage Assessment, unpublished report prepared for the Department of Finance, Canberra.	High reliability. This report is recent, and specific to the Project Area.	The report only covers Block 3 and does not reference Block 15.
Parsons Brinckerhoff (2008) Natural Temperate Grassland Maintenance Plan Block 3 Section 22 Barton, ACT, unpublished report prepared for the Department of Finance, Canberra.	High reliability. This report is used to provide context to this Referral by providing information on historic use and surveys.	There is uncertainty regarding the source of the fill that is said to have been dumped within the Project Area. This is not considered pertinent to this Referral, beyond providing context.
Rowell, A (2007) Survey and Impact Assessment at Golden Sun Moth Synemon plana site, Blocks 3 and 7, Section 22 Barton (York Park), unpublished report prepared for Parsons Brinckerhoff, Canberra.	High reliability. All surveys were completed according to appropriate guidelines and at the Project Area scale.	The information regarding the natural temperate grassland and golden sun moth populations has been superseded by more recent survey and monitoring efforts.
Threatened Species Scientific Committee (TSSC) (2016) Environment Protection and Biodiversity Conservation Act 1999 (s266B) Approved Conservation Advice (including Listing Advice) for the Natural Temperate Grassland of the South Eastern Highlands (EC152), accessed online (March, 2017): www.environment.gov.au/biodiversity/threatened/communities/pubs/152-conservation-advice.pdf.	High reliability. This document has been prepared very recently by the Department of the Environment and Energy.	This document is a National scale document, therefore must be used to provide context to the EPBC listed natural temperate grassland present within the Project Area.
Umwelt (2016a) Golden Sun Moth and Natural Temperate Grassland Vegetation Management Plan Block 3, Section 22, Barton ACT, unpublished report prepared for the Department of Finance,	High reliability. All surveys were completed according to appropriate guidelines and at the Project Area scale.	Due to inherent limitations in the survey guidelines, conclusions regarding the ongoing trends of the golden sun moth population cannot be determined.

Reference Source	Reliability	Uncertainties
Canberra.		
Umwelt (2016b) Offset Analysis Report, Block 3 Section 22 and Proposed Offset Sites, unpublished report prepared for the Department of Finance, Canberra.	High reliability. This report used the most recent survey data available for the Project Area and considers the Commonwealth's Offset Policy and Guidelines.	It is noted that the final conclusions regarding the appropriateness of offsets are to be determined by the Department of the Environment and Energy.
Department of the Environment, Water, Heritage and the Arts (DEWHA) (2009) Significant Impact Guidelines for the Critically Endangered Golden Sun Moth (Synemon plana): Nationally threatened species and ecological communities EPBC Act Policy Statement 3.12, accessed online (February 2017): http://www.environment.gov.au/system/files/resources/b945f32e-3f75-4739-a793-9f672893f3bb/files/golden-sun-moth.pdf.	High reliability. These guidelines are the current standard for assessing impacts to golden sun moth under the EPBC Act.	No uncertainties.
Umwelt (2014) Natural Temperate Grassland Maintenance Plan Block 3 Section 22 Barton ACT, unpublished report prepared for Department of Finance, Canberra.	High reliability. This report was completed based on site scale inspection and all surveys were conducted according to appropriate guidelines and methodologies.	This report has been superseded by more recent surveys. Due to inherent limitations in the survey guidelines, conclusions regarding the ongoing trends of the golden sun moth population cannot be determined.
Umwelt (2015) Natural Temperate Grassland Condition Assessment and Golden Sun Moth Monitoring Event Block 3 Section 22 Barton ACT, unpublished report prepared for Department of Finance, Canberra.	High reliability. This report was completed based on site scale inspection and all surveys were conducted according to appropriate guidelines and methodologies.	This report has been superseded by more recent surveys. Due to inherent limitations in the survey guidelines, conclusions regarding the ongoing trends of the golden sun moth population cannot be determined.
Umwelt (2016c) Vegetation Management Plan, Block 48 Wallaroo Road, unpublished report prepared for Department of Finance, Canberra.	High reliability. This report was completed based on site scale inspection and all surveys were conducted according to appropriate guidelines and methodologies.	The management plan includes an adaptive management strategy that will allow any uncertainties to be dealt with as, and if, they arise.
Umwelt (2017) Impact Assessment to support and	High reliability. This report was completed based on site scale	The report uses the precautionary principle to

Reference Source	Reliability	Uncertainties
EPBC Act Referral for the proposed divestment of Blocks 3 and 15, Section 22, Barton ACT 2600, unpublished report prepared for Department of Finance, Canberra.	inspection and concurrently with the preparation of this referral.	assess the likelihood of impacts as a result of the proposed action. Due to this, it is considered unlikely that any residual uncertainty would have effect on the outcomes of the Referral.

Section 8 – Proposed alternatives

You are required to complete this section if you have any feasible alternatives to taking the proposed action (including not taking the action) that were considered but not proposed.

8.0 Provide a description of the feasible alternative?

There is not considered to be any feasible alternatives to the proposed action. As stated in **Section 4**, the impacts to GSM and NTG are considered unavoidable due to the patch of habitat's size and isolation.

8.1 Select the relevant alternatives related to your proposed action.

8.27 Do you have another alternative?

No

Section 9 – Contacts, signatures and declarations

Where applicable, you must provide the contact details of each of the following entities: Person Proposing the Action; Proposed Designated Proponent and; Person Preparing the Referral. You will also be required to provide signed declarations from each of the identified entities.

9.0 Is the person proposing to take the action an Organisation or an Individual?

Organisation

9.2 Organisation

9.2.1 Job Title

A/g Assistant Secretary

9.2.2 First Name

Elizabeth

9.2.3 Last Name

Hickey

9.2.4 E-mail

divestmenttaskforce@finance.gov.au

9.2.5 Postal Address

1 Canberra Avenue

One Canberra
Forrest ACT 2603
Australia

9.2.6 ABN/ACN

ABN

61970632495 - DEPARTMENT OF FINANCE

9.2.7 Organisation Telephone

0262152222

9.2.8 Organisation E-mail

divestmenttaskforce@finance.gov.au

9.2.9 I qualify for exemption from fees under section 520(4C)(e)(v) of the EPBC Act because I am:

Not applicable

Small Business Declaration

I have read the Department of the Environment and Energy's guidance in the online form concerning the definition of a small a business entity and confirm that I qualify for a small business exemption.

Signature:………………………………… Date: ………………………………

9.2.9.2 I would like to apply for a waiver of full or partial fees under Schedule 1, 5.21A of the EPBC Regulations

No

9.2.9.3 Under sub regulation 5.21A(5), you must include information about the applicant (if not you) the grounds on which the waiver is sought and the reasons why it should be made

Declaration

I, ________________________________, declare that to the best of my knowledge the information I have given on, or attached to the EPBC Act Referral is complete, current and correct. I understand that giving false or misleading information is a serious offence. I declare that I am not taking the action on behalf of or for the benefit of any other person or entity.

Signature:……………………………… Date: ………………………………

I, ________________________________, the person proposing the action, consent to the designation of ________________________________ as the proponent of the purposes of the action describe in this EPBC Act Referral.

Signature:……………………………… Date: ………………………………

9.3 Is the Proposed Designated Proponent an Organisation or Individual?

Organisation

9.5 Organisation

9.5.1 Job Title

A/g Assistant Secretary

9.5.2 First Name

Elizabeth

9.5.3 Last Name

Hickey

9.5.4 E-mail

divestmenttaskforce@finance.gov.au

9.5.5 Postal Address

1 Canberra Avenue

One Canberra
Forrest ACT 2603
Australia

9.5.6 ABN/ACN

ABN

61970632495 - DEPARTMENT OF FINANCE

9.5.7 Organisation Telephone

0262152222

9.5.8 Organisation E-mail

divestmenttaskforce@finance.gov.au

Proposed designated proponent - Declaration

I, ___________________________________, the proposed designated proponent, consent to the designation of myself as the proponent for the purposes of the action described in this EPBC Act Referral.

Signature:……………………………… Date: ………………………………

9.6 Is the Referring Party an Organisation or Individual?

Organisation

9.8 Organisation

9.8.1 Job Title

Environmental Scientist

9.8.2 First Name

Amanda

9.8.3 Last Name

Mulherin

9.8.4 E-mail

amulherin@umwelt.com.au

9.8.5 Postal Address

56 Bluebell Street

City Edge
O'Connor ACT 2602
Australia

9.8.6 ABN/ACN

ABN

18059519041 - UMWELT (AUSTRALIA) PTY. LTD.

9.8.7 Organisation Telephone

(02) 6262 9484

9.8.8 Organisation E-mail

reception@umwelt.com.au

Referring Party - Declaration

I, ___________________________________, I declare that to the best of my knowledge the information I have given on, or attached to this EPBC Act Referral is complete, current and correct. I understand that giving false or misleading information is a serious offence.

Signature:……………………………… Date: ………………………………

Appendix A - Attachments

The following attachments have been supplied with this EPBC Act Referral:

1. 1.4_landscape_aerial_with_block_dimensions_actmapi_20170824_a4.pdf
2. 1.13.1_heritage_assessment_block_3_section_22_erm_2016.pdf
3. 2.14_epbc_pmst_5km.pdf
4. 2.14_full_impact_assessment_brief_umwelt_2017.pdf
5. 3.1.1_block_3_barton_vmp_and_monitoring_umwelt_2016.pdf
6. 3.1.1_gsm_habitat_pop_survey_impact_assessment_rowell_2007.pdf
7. 4.3_block_48_vmp_umwelt_2016.pdf
8. 4.3_offset_analysis_report_umwelt_2016.pdf
9. epbc_referral_section_22_barton_project_area_shapefiles.zip

ACTmapi

Aerial Layout of Block 3 and 15, Section 22, Barton

Notes:

1: 1,000

DISCLAIMER

The map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current or otherwise reliable.

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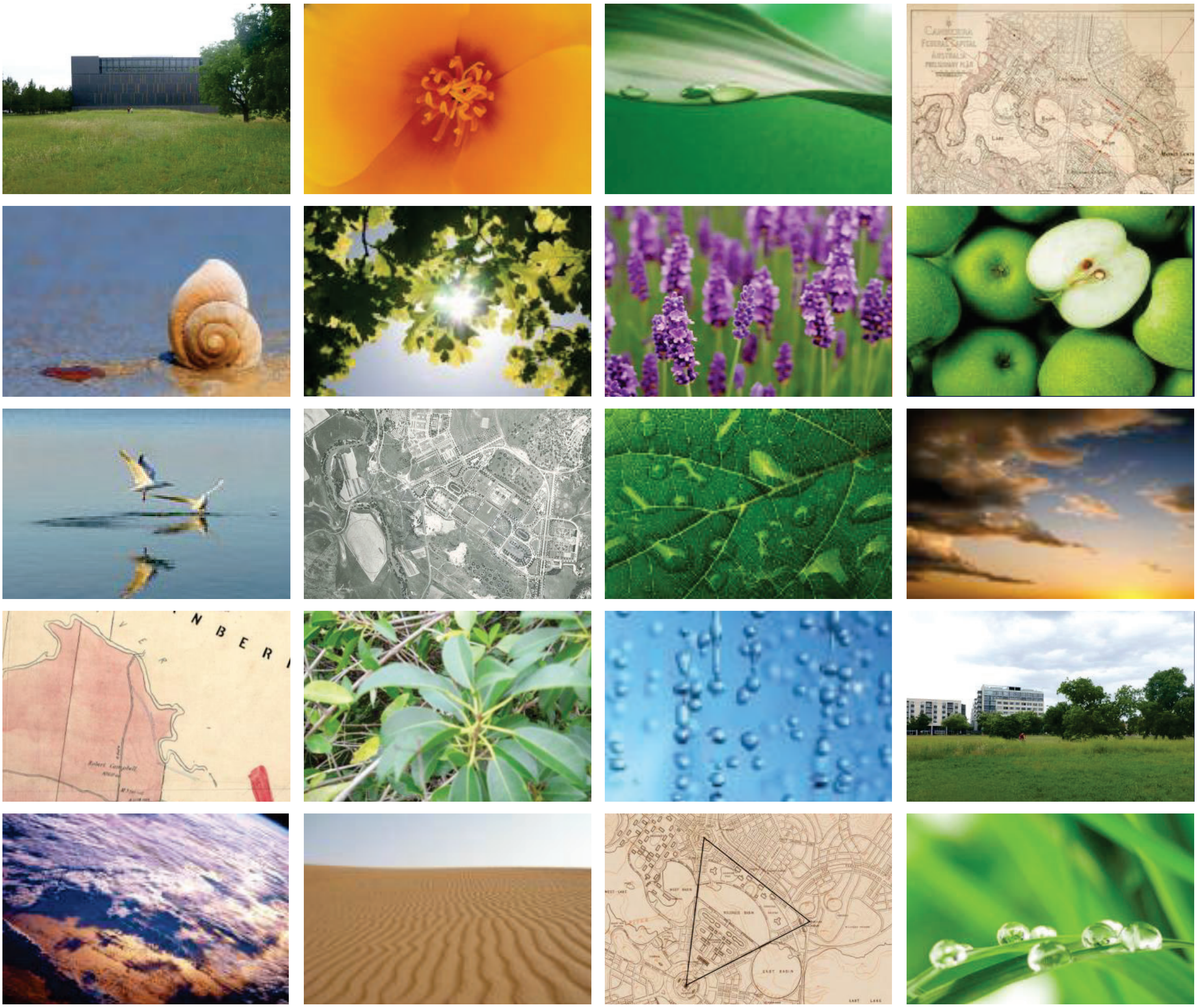
ACT Government



Department of Finance

Block 3, Section 22, Barton ACT

Heritage Assessment

Final

0325464

April 2016

ERM

The world's leading sustainability consultancy

Block 3, Section 22

Approved by:	Janene May
Position:	*Project Manager*
Signed:	Janene
Date:	27 April, 2016
Approved by:	Peter Lavelle
Position:	*Partner Director*
Signed:	[illegible]
Date:	27 April, 2016

Environmental Resources Management Australia Pty Ltd Quality System

Heritage Assessment

Department of Finance

April 2016

0325464

www.erm.com

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ACRONYMS AND ABBREVIATIONS

AHC	Australian Heritage Council
AHD	Australian Heritage Database
AHPI	Australian Heritage Places Inventory
CHL	Commonwealth Heritage List
DoE	Department of the Environment (Commonwealth)
EPBC Act	Environment Protection & Biodiversity Conservation Act 1999
ERM	Environmental Resources Management Australia Pty Ltd
Finance	Department of Finance
HA	Heritage Assessment
NES	National Environmental Significance
NHC	Natural Heritage Charter
NHL	National Heritage List
PAD	Potential Archaeological Deposit
RAO	Registered Aboriginal Organisation
The Burra Charter	The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance (Adopted 31 October 2013)

EXECUTIVE SUMMARY

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by the Department of Finance (Finance) in November 2015 to prepare an updated Heritage Assessment (HA) for Block 3 Section 22 property site located within Barton, ACT (henceforth referred to as 'the Site').

This assessment has been undertaken to meet Finance's obligations with respect to the requirements of the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). This HA examines the potential Indigenous, natural and historic heritage values of the Site.

The desktop review indicated that one previous Indigenous heritage item was recorded at the Site, Barton Potential Archaeological Deposit (PAD) 1. Sub-surface testing was undertaken at this PAD site with no archaeological deposits found. A field survey undertaken by an ERM Archaeologist and ACT Representative Aboriginal Organisations (RAO) on 26 November 2015 identified that no Indigenous heritage values exist within, or in close proximity to, the Site. Comments from the ACT RAOs during this field survey indicated that the Site and surrounding area had been subjected to extensive ground disturbance and was unlikely to contain Indigenous heritage items. This assessment concluded that this site does not have Indigenous heritage values.

The potential natural heritage values of the Site do not meet Commonwealth or ACT heritage listing criteria. However, the Site contains natural features that are protected under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 and the ACT Nature Conservation Act 2014. These include a Territory-listed endangered ecological community and a Commonwealth and Territory-listed endangered species. The presence of these features has some value however is not sufficient to meet the eligibility criteria for inclusion on the ACT Heritage Register or Commonwealth Heritage List.

Desktop review indicated that no previously recorded historic heritage sites had been recorded at the Site and previous heritage assessments for the Site found no historic heritage items to occur. A field survey undertaken by an ERM Archaeologist on 26 November 2015 identified no potential historic heritage items within the Site, and determined that there was a low potential for historic heritage values to occur.

The following recommendations are provided to facilitate the ongoing protection of heritage values at the Site. These recommendations are provided in relation to Finance's current ownership of the Site and its potential future divestment.

<u>Recommendation 1:</u> The Unexpected Finds Procedures for Indigenous and Historic heritage objects should be implemented for the Site (see Section 6).

<u>Recommendation 2</u>: A copy of this report should be disclosed to a future purchaser and ACT Heritage if divested from Commonwealth ownership.

<u>Recommendation 3:</u> In the event that the property is divested from Commonwealth ownership, requirements for the implementation of the Unexpected Finds Procedures (refer Section 6) should be provided to any new owners as sales clauses.

1 INTRODUCTION

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by the Department of Finance (Finance) in November 2015 to update a Heritage Assessment (HA) of the property at Block 3 Section 22 located with the suburb of Barton, Australian Capital Territory (ACT) (henceforth referred to as 'the Site').

This assessment has been undertaken in order to meet Finance's obligations with respect to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

1.1 SITE OWNERSHIP

The Site is owned by the Commonwealth government and is part of Finance's property portfolio.

1.2 HERITAGE STATUS

The Site is not currently cited within any Commonwealth or ACT heritage lists for its Indigenous, natural or built heritage values. A 2009 Cultural Heritage Assessment (CHA) prepared for the site which included a desktop review, field survey and consultation with Representative Aboriginal Organisations (RAOs) identified one area of Potential Archaeological Deposit (PAD) within the Site (herein referred to as Barton PAD 1).

The Site includes approximately 0.4 hectares (ha) of conservation area containing a population of the Golden Sun Moth and its associated habitat of Natural Temperate Grassland, both of which are protected under the EPBC Act.

1.3 SITE LOCATION

The Site comprises approximately 1.2 ha of land at the corner of National Circuit and Sydney Avenue in Barton, ACT (refer to *Figure 1.1*). The Site is surrounded by roads and several recently constructed hotels and large high rise buildings.

1.4 OBJECTIVES

The objectives of this HA are to assess the potential Indigenous, natural and built heritage values of the Site to identify any areas that require further investigation and advise/inform any policies for managing potential heritage values in accordance with the EPBC Act.

1.5 *METHODOLOGY*

This HA has been prepared in accordance with the following guidelines and requirements:

- EPBC Act and Regulations requirements for the assessment of places against the Commonwealth Heritage criteria and Commonwealth Heritage Management Principles;
- The Finance HA Format;
- The Commonwealth Heritage Criteria;
- Australia ICOMOS *Burra Charter 2013 – The Australia ICOMOS Charter for Places of Cultural Significance*;
- *Ask First: A Guide to Respecting Indigenous Heritage Places and Values*;
- *The Australian Natural Heritage Charter for the Conservation of Places of Natural Heritage Significance*;
- The former Department of Sustainability, Environment, Water, Population and Communities (now Department of the Environment - DoE) Guide: *Australia's Commonwealth Heritage – Working Together – Managing Commonwealth Heritage Places*;
- Australian Heritage Council, 2010 *Identifying Commonwealth Heritage values and Establishing a Heritage Register: A Guide for Commonwealth Agencies*;
- *ACT Heritage Act 2004*; and
- ACT *Cultural Heritage Reporting Policy* 2015.

To assess the potential heritage values of the Site, the following tasks were undertaken:

- *Background research:* review of historical and other relevant information pertaining to the Site was sourced from the National Archives, previous reports, and NSW Department of Lands Historic Parish Maps (which covers the ACT), vegetation, soil and geology mapping products. This information was used to formulate a historical overview of the Site and to understand its associated historic themes;

- *Database searches:* Searches of relevant heritage databases were undertaken including:
  - ACT Heritage Register for Indigenous and historic heritage sites;
  - Commonwealth Department of Environment (DoE) Protected Matters Search Tool (PMST) for ecological Matters of National Environmental Significance (MNES) e.g. threatened ecological communities (TECs) and species and migratory species listed under the EPBC Act;
- *Site inspection:* during this inspection the general site layout and physical condition of the Site features were observed;
- *Assessment against heritage criteria:* an individual assessment of Indigenous, natural and built heritage values was undertaken against the Commonwealth heritage criteria and the ACT heritage criteria. This included a comparative analysis of the Site's potential values in the context of the wider environment to identify the relative importance and eligibility for listing under the criteria;
- *Significance Ranking:* heritage values were ranked using the Finance Significance Ranking Guide provided in *Annex A;* and
- *Summary, Conclusion and Recommendations*: a summary statement of significance was prepared for the Site. Recommendations to assist with the ongoing protection and management of known and potential unknown heritage values of the Site are provided.

1.6 CONSULTATION

Consultation between ERM and Finance was initiated with an inception meeting 5 November 2015 and continued through the project via email and telephone correspondence.

ERM also consulted with the ACT RAOs including Buru Ngunawal Aboriginal Corporation, King Brown Tribal Group, Little Gudgenby River Tribal Council and Ngarigu Currawong Clan as part of this HA. James Mundy of Ngarigu Currawong Clan and Kristal House of Little Gudgenby River Tribal Council attended the site visit and provided input into the Indigenous heritage values assessment. Members of the King Brown Tribal Group and Buru Ngunawal Aboriginal Corporation were not available to participate in the site visit.

All groups were provided with the draft report for comment on 1 March 2016. No comments on the draft report were received.

1.7 AUTHORSHIP

The primary author of this HA was ERM Heritage Consultant Janene May. ERM Senior Ecologist Matthew Flower prepared the natural heritage assessment sections. ERM Principal Environmental Consultant, Claire Arthur, undertook a technical review of the report, and ERM Partner Alan Simonic provided the Quality Assurance review.

1.8 ACKNOWLEDGEMENTS

ERM wishes to acknowledge and thank the ACT RAOs Kristal House and James Mundy for their time and assistance in undertaking the field survey of the Site.

ERM also gratefully acknowledges the assistance provided by Finance staff members.

Legend

Site Boundary

Source:
ACT LPI 2015
NSW DLPI WMS Basemap 2015

N

0 10 20m

Client:	Department of Finance
Drawing No:	0325464s_B3S22HA_G001_R0.mxd
Date:	10/12/2015 Drawing Size: A4
Drawn By:	GC Reviewed By: JM

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 1.1 - Site Location

Heritage Assessment
Block 3, Barton ACT

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Melbourne, Newcastle, Perth, Port Macquarie, Sydney

ERM

2 *LEGISLATION*

The Site is Commonwealth owned and therefore is subject to Commonwealth legislation. The primary environment and heritage legislation to be addressed in the management of the Site is therefore the EPBC Act. Finance also employs a practice of complying with State and Territory environmental policies, initiatives and legislation where these do not conflict with Commonwealth Legislation. In addition, under s.26 and s.28 of the EPBC Act, Finance is required to avoid, minimise or manage potentially significant impacts on the environment. This provision takes in the broader suite of issues listed under the EPBC Act and can include State and Territory listed species and heritage values.

2.1 *STATUTORY CONSIDERATIONS*

2.1.1 *Environment Protection and Biodiversity Conservation Act 1999*

The EPBC Act is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the Act as matters of national environmental significance (NES).

The EPBC Act enables the Australian Government to join with the States and Territories in providing a national scheme of environment and heritage protection and biodiversity conservation. The EPBC Act focuses Australian Government interests on the protection of matters of NES, with the Territories having responsibility for matters of Territory and local significance.

The key parts of the EPBC Act that are of direct relevance to this HA are:

- Part 3, Division 1: Requirements Relating to Matters of National Environmental Significance;
- Section 26: Requirement for approval of activities involving Commonwealth land;
- Section 28: Requirement for approval of activities undertaken by a Commonwealth agency with the potential to have a significant impact on the environment;
- Section 183/188: Requirement to manage the environment in accordance with any management actions listed in a threat abatement plan developed to control a listed key threatening process with the potential to have a significant impact on the environment;

- Section 341S: Requirement that a Commonwealth agency must make a written plan to protect and manage the Commonwealth Heritage values of a Commonwealth Heritage place it owns or controls;

- Section 341ZC: Requirement to minimise adverse impacts on the heritage values of a place included on the National and/or Commonwealth Heritage List; and

- Section 341ZE: Requirement to provide ongoing protection of heritage values of a place included on the Commonwealth Heritage List in the event of sale or transfer.

Matters of National Environmental Significance (NES)

Part 3, Division 1 of the EPBC Act requires that actions that have, will have or are likely to have a significant impact on NES matters require approval. The NES matters are:

- World Heritage Areas;

- National Heritage Places;

- Wetlands of international importance (Ramsar wetlands);

- Listed threatened species and endangered communities;

- the Great Barrier Reef Marine Park;

- Listed migratory species;

- Nuclear actions;

- Commonwealth marine environments; and

- A water resource in relation to coal seam gas development or large coal mining development.

Under this Section of the Act, any action that will or is likely to have a significant impact on an NES matter is to be referred to the Department of Environment (DoE) for consideration by the Minister for that portfolio.

DoE administers a web-based search tool that allows a geographic search of all the species and ecological communities listed under the EPBC Act, and National and Commonwealth Heritage List places that are expected/likely to be present within a given area. This tool does not preclude Site verification.

Sections 26 and 28

Section 26 relates to actions undertaken on Commonwealth land which will, or are likely to significantly impact the environment and Section 28 relates to actions undertaken by a Commonwealth agency (such as Finance) which will, or are likely to significantly impact the environment. The term 'environment' has a broader coverage than NES matters and relates to environmental matters that are not necessarily formally listed.

The Act defines the environment as:

a) *ecosystems and their constituent parts, including people and communities; and*

b) *natural and physical resources; and*

c) *the qualities and characteristics of locations, places and areas; and*

d) *heritage values of places; and*

e) *the social, economic and cultural aspects of a thing mentioned in paragraph (a), (b), (c) or (d).*

Any actions which will, or are likely to significantly impact the environment need to be assessed. If potentially significant impacts are identified, opportunities for their avoidance, reduction or management must be sought. A referral under the EPBC Act may also need to be considered.

Sections 183 and 188

These sections detail the listing of key threatening processes and amendment of these key threatening processes relating to listed threatened species and ecological communities.

Section 341ZC

This section of the EPBC Act requires the minimisation of adverse impacts to the heritage values of a National or Commonwealth Heritage place. This might be direct impacts from physical disturbance or could also include secondary impacts in the event of activities that would impact on the visual aspect, cultural importance, landscaping and curtilage of an adjacent listed property.

Section 341ZE

This section of the EPBC Act applies if Finance (as a Commonwealth Agency) sells or leases all or part of a Commonwealth area that is or includes part of a Commonwealth Heritage place, for example the Commonwealth Heritage List (CHL) or National Heritage List (NHL). Finance must notify the Minister for DoE of such an intent at least 40 business days prior to the transfer or sale, and include in the sale or lease contract a covenant to protect the Commonwealth Heritage values of the place during the sale process and after the property has left Commonwealth control.

Commonwealth Heritage List Criteria

A place can be included on the CHL if it is found to be significant at a National, Territory or local level for one or more of the following criteria:

a) the place has significant heritage value because of the place’s importance in the course, or pattern, of Australia’s natural or cultural history.

b) the place has significant heritage value because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history.

c) the place has significant heritage value because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history.

d) the place has significant heritage value because of the place's importance in demonstrating the principal characteristics of:

    i) a class of Australia's natural or cultural places; or

    ii) a class of Australia's natural or cultural environments.

e) the place has significant heritage value because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group.

f) the place has significant heritage value because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period.

g) the place has significant heritage value because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons.

h) the place has significant heritage value because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history.

i) the place has significant heritage value because of the place's importance as part of Indigenous tradition.

CHL/NHL Thresholds

DoE online heritage information provides some guidance on determining the level of heritage significance a place may have. DoE states that as well as assessing a place against criteria for its heritage value, the Australian Heritage Council applies a 'significance threshold' test. This test helps the Council to determine the level of significance of a place's heritage value by asking 'just how important are these values?'

To reach the threshold for the NHL, a place must have 'outstanding' heritage value to the nation against one or more criteria. To be entered on the CHL, a place must have 'significant' heritage value against one or more criteria. It is noted that the Australian Heritage Council's (AHC) publication *Identifying Commonwealth Heritage Values and Establishing a Heritage Register A Guideline for Commonwealth agencies* states that the threshold for inclusion on the Commonwealth Heritage List is local heritage significance (AHC 2010).

2.1.2 *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*

The *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* protects areas and/or objects which are of significance to Indigenous people and which are under threat of destruction. The Act can, in certain circumstances override State and Territory provisions, or it can be implemented in circumstances where State or Territory provisions are lacking or are not enforced. A significant area or object is defined as one that is of particular importance to Indigenous people according to Indigenous tradition. The Act must be invoked by or on behalf of an Aboriginal or Torres Strait Islander or organisation.

2.2 ACT HERITAGE ACT 2004

Although the primary heritage legislation that applies to the study area, as Commonwealth land, is the EPCB Act, it is important to consider the ACT *Heritage Act 2004*. Should responsibility for this land be divested to the ACT government, this will be the primary legislation applying to the study area.

The *Heritage Act 2004* has been updated with new amendments in place since 30 March 2012. The Heritage Act provides for the recognition, registration and conservation of places and object of natural and cultural significance. Further, the Act details offences relating to damaging heritage, heritage directions and enforcement, obligations of public authorities, and incentives for heritage conservation.

Under Section 10 of the Heritage Act, a range of criteria for the assessment of heritage values and significance (including archaeological) have been defined. Under Section 10 of the Heritage Act *a place or object has heritage significance if the place or object meets 1 or more of the following criteria (the heritage significance criteria):*

a) importance to the course or pattern of the ACT's cultural or natural history;

b) has uncommon, rare or endangered aspects of the ACT's cultural or natural history;

c) potential to yield information that will contribute to an understanding of the ACT's cultural or natural history;

d) importance in demonstrating the principal characteristics of a class of cultural or natural places or objects;

e) importance in exhibiting particular aesthetic characteristics valued by the ACT community or a cultural group in the ACT;

f) importance in demonstrating a high degree of creative or technical achievement for a particular period;

g) has a strong or special association with the ACT community, or a cultural group in the ACT for social, cultural or spiritual reasons;

Section 74 and 75 of the *Heritage Act 2004* makes it an offence to disturb, damage or destroy or cause or permit to be disturbed, damaged or destroyed an unregistered Aboriginal place without reasonable excuse unless that place had first been registered to the Heritage Places Register and the registration then been cancelled.

Under Section 9 of the *Heritage Act 2004*, an 'Aboriginal place' is a place of significance in Aboriginal tradition. 'Aboriginal tradition' means "traditions, observances, customs or beliefs of the people who inhabited Australia before European colonisation and include traditions, observances, customs or beliefs that have evolved or developed from that tradition since European colonisation".

Section 76 of the *Heritage Act 2004* includes administrative provisions which permit the disturbances of an Aboriginal site or place when that site or place has been registered to the Heritage Places Register with a specific conservation requirements allowing disturbance.

Section 51 of the H*eritage Act 2004* requires that a person who discovers an unregistered Aboriginal place report the discovery to the council within five days. A report to the Minister can then be made through ACT Heritage.

2.2.1 *ACT Heritage (Representative Aboriginal Organisations) Declaration 2006 (No 1)*

Under the *Heritage Act 2004* (Section 14), this instrument provides for the scope of consultation with declared Representative Aboriginal Organisations (RAOs).

2.2.2 *Nature Conservation Act*

The *Nature Conservation Act 199*2 commenced on 19 December 1994. The Act is based on principles to conserve biological diversity, foster ecologically sustainable use of wildlife, ecologically sustainable development and the application of international criteria developed by the World Conservation Union (International Union for the Conservation of Nature and Natural Resources) for establishing and managing protected areas.

Natural heritage values identified at the Site were assessed under the *Nature Conservation Act*. The *Nature Conservation Act* protects native plants and animals within the ACT and provides for the management of the conservation reserve network. Native species within the ACT can be identified as threatened and protected under this Act. Two species present at the Site have been identified as critically endangered and endangered under this Act.

2.2.3 *Heritage and Development in the ACT*

The ordinary definition of 'development' under the *Planning and Land Management Act 1988* is broadened where the land to be developed is in an urban lease area and is registered or nominated for registration under the ACT Heritage Register. In this circumstance, any works that would affect the landscape of the land are considered to be 'development' and therefore must be considered for approval by the ACT Environment and Planning Directorate and the ACT Heritage Council, as appropriate.

For development which requires an Environmental Impact Assessment (EIA), consideration must be given to the heritage significance of the land including the surrounding land. Development applications that have potential to damage heritage items listed on the Heritage Register are sent from ACT Planning and Land Authority to the Heritage Council for advice.

While the Site remains in Commonwealth ownership, the requirements of the ACT Heritage Act provide relevant information in the event that divestment of the Site is considered in the future.

2.2.4 *National Capital Plan*

The National Capital Plan (NCP) is administered by the NCA and outlines planning principles and policies, standards for the maintenance and enhancement of the national capital and general aesthetic principles. The Commonwealth and ACT governments must not undertake an activity that is inconsistent with the NCP. The NCP was updated with amendments in December 2012.

2.3 *NON-STATUTORY CONSIDERATIONS*

2.3.1 *Ask First*

The Commonwealth Policy Ask First: A guide to respecting Indigenous heritage places and values provides a practical guide for land developers, land users and managers, cultural heritage professionals and many others who may have an impact on Indigenous heritage. The *Ask First* guidelines are considered the national best practice guidelines for cultural heritage management.

This guideline sets out principles and processes to encourage the consultation with and active involvement of Indigenous people in the identification, conservation and management of Indigenous Cultural Heritage. In particular, the document emphasises that Indigenous people should be the determinants of the significance of places in accordance with their culture. A copy of *Ask First* can be accessed at: www.environment.gov.au/heritage/ahc/publications/commission/books/ask-first.html.

2.3.2 *National Heritage Charter*

The Natural Heritage Charter (NHC) provides best practice guidance for the conservation and management of natural heritage values in Australia. It provides a framework for making appropriate decisions for managing and restoring natural heritage values based on ecological processes which occur in natural systems and provides a process that can be used to support and implement local, State and Territory, national and international policies, agreements, strategies and plans. A copy of the charter can be accessed at: www.environment.gov.au/heritage/ahc/publications/commission/books/pubs/australian-natural-heritage-charter.pdf.

2.3.3 *The Burra Charter*

The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance (Adopted 31 October 2013) (The Burra Charter) sets a standard of practice for those who provide advice, make decisions about, or undertake works to places of cultural significance including owners, managers and custodians.

The Charter provides specific guidance for physical and procedural actions that should occur in relation to significant places. A copy of the 2013 charter can also be accessed at: http://australia.icomos.org/wp-content/uploads/The-Burra-Charter-2013-Adopted-31.10.2013.pdf.

2.3.4 *National Trust*

The National Trust is a community-based, non-government organisation, and has no statutory power. The National Trust has been gathering information about heritage places in Australia for decades. This list contains individual buildings, precincts, natural environment places or culturally significant artefacts. Inclusion on the National Trust Heritage List does not provide any legal protection for a place, nor does a listing place the owner of a listed property under any legal obligation. The National Trust of ACT Heritage list is recognised as an authoritative statement of the significance of particular places and is held in high esteem by the public. The National Trust also has an advisory role, regularly lobbying all levels of government regarding sensitive heritage issues for communities across the Territory.

2.3.5 *The Register of the National Estate*

The Register of the National Estate (RNE) is an archive of important natural, Aboriginal and historic places throughout Australia. The RNE is maintained on a non-statutory basis as a publicly available archive and educational resource.

3 SITE BACKGROUND

The following Chapter provides an environmental and heritage background to the Site.

3.1 SITE DESCRIPTION

3.1.1 Setting

The Site consists of a cleared block situated on Sydney Avenue in Barton, Canberra. The Site is surrounded be large high rise buildings, including the recently constructed hotel at the north-west corner of the Site. Four trees are located within the south-west border of the Site and a line of trees are present along the Sydney Avenue border and north-west border of the Site. A pedestrian access track (Windsor Walk) also runs along the north-west border of the Site. Views to and from the Site are limited due to surrounding development.

3.1.2 Geology and Soils

The Site is situated on the Canberra Formation from the Wenlock period of the Early Silurian. The Smc deposit of the Canberra formation underlying the Site is described by (Abell 1992) as consisting of mudstone, siltstone, minor sandstone, limestone, hornfels, dacitic, ignimbrite and volcaniclastic sediments.

Soils at the Site were examined and described by Navin Officer during sub-surface testing of Barton PAD 1 (Navin Officer 2010). Soils were described as:

The soil profiles were generally characterised by a natural stratigraphy with gradual and regular transitions from a brown or grey-brown clay loam to an orange or yellow-grey gravelly clay, indicative of a decomposing bedrock layer. However, the test pits in the north-eastern area (e.g. Pits 3-5) were characterised by a very thin A horizon, which has been interpreted as evidence of previous land surface modification that has resulted in removal of substantial portions of the upper sections of the soil profile (Navin Officer 2010:7).

3.1.3 Topography and Landforms

The western portion of the Site is slightly raised with underlying fill. The Site dips within the eastern portion of the Site.

3.1.4 Hydrology

The Site is situated approximately 800 m south of Lake Burley Griffin which runs into the Molonglo River approximately 2 km to the north-east. Prior to development of the Site a small creek ran east-west through the central portion of the Site.

3.2 *INDIGENOUS HERITAGE*

Results of an ACT Heritage Register search were received on the 23 November 2015. This search revealed that there are no previously recorded Indigenous heritage objects within the Site. However, 52 Indigenous heritage sites have been previously recorded within the Barton area and surrounding suburbs. Further details pertaining to the regional Indigenous heritage archaeological record are provided in *Section 4.4*.

3.3 *HISTORIC HERITAGE*

Based on the desktop information reviewed and the field survey, the Site comprises a cleared lot surrounded by large buildings, roads and a pedestrian access track to the north-west. No buildings, structures or areas of historic interest were identified within the site (based on desktop information and the field survey). The Site has been historically used for agricultural purposes. Desktop information and the field survey identified a potential former garden shed within the north-west corner of the Site.

3.4 *NATURAL HERITAGE*

Substantial survey and maintenance effort has been undertaken to understand and manage the Natural Temperate Grassland (NTG) and Golden Sun Moth (GSM) population at the Site since the early 1990s (Umwelt 2014). Most recently, vegetation condition assessment and GSM monitoring occurred in 2014 (Umwelt 2015).

Umwelt (2014) notes the north-western part of the Site appears to have received fill material (during nearby development) and is dominated by exotic species (Umwelt 2014). The eastern portion of the Site however, known as York Park, contains an area of approximately 0.5 ha of NTG (endangered under the *Nature Conservation Act* (NC Act) and EPBC Act) and a population of GSM (critically endangered under the EPBC Act and endangered under the NC Act).

Surveys of GSM and NTG undertaken in 2013 and 2014 report the vegetation and habitat values of the Site are relatively stable, and that a population of GSM persists at the Site. The conservation value, and relative level of disturbance to the Site, was assessed using the criteria presented in the *ACT Lowland Native Grassland Conservation Strategy* (ACT Government 2005). Based on this assessment, the NTG was assigned:

- a Botanical Significance Rating of 4 (Low), as the species present at the Site include species moderately tolerant of disturbance; and

- a Conservation Rating of 2 (Complementary Conservation Site), as, despite the low Botanical Significance Rating, the Site provides habitat for a threatened species that is considered viable in the medium term (Umwelt 2014)..

In addition to the NTG and GSM, active burrows of the uncommon Canberra Raspy Cricket (*Cooraboorama canberrae*) were recorded at the Site in 2006 and 2007, however the burrows or other signs of the species were not observed during 2013 surveys (Umwelt 2014). The species has a restricted distribution within the ACT and nearby parts of NSW, and occurs only in relatively undisturbed grasslands (Umwelt 2014).

Details of natural heritage features present at the Site are provided below. These features are assessed for their heritage value in *Section 5.2* of this report.

4 HISTORICAL BACKGROUND

This chapter outlines the history of the Site and the surrounding region.

4.1 PREHISTORY

Archaeological evidence suggests that Aboriginal people had occupied all of Australia's environmental zones by 31 000 years before present (BP) (Flood 1995: 286). Ethnographic information relating to the Aboriginal occupation of the study area has been obtained predominantly from historical documentation written by early European settlers and government officials during the mid to late 18th century (Barwick 1984).

Australian Aboriginal people occupied land according to a system of spatial organisation and land occupancy (Clark 1990: 11-14). Individual groups were intimately familiar with their own geographical regions and the seasonal availability of resources within it. Tribal boundaries were often defined through linguistic associations, social relations, and spiritual links to the land. These boundaries were most likely fluid, changing position over time. If this was the case, then tribal boundaries recorded by European people at, or after, the point of contact can only be considered as current to that period and were probably quite different prior to European observation. To make things more ambiguous, the few European accounts of Aboriginal groups in the broad study region are limited in detail, often confused in regard to Aboriginal group names and give varying interpretations of territorial boundaries (Flood 1980: 2).

In general, early settlers recorded very little of their observations, particularly in regard to the Aboriginal people they encountered (Flood 1980: 26). The best recorded observations come from the journals of early explorers, government surveyors and authors of travel books. By the early 1840s, Currie, Bennet, Lhotsky, Backhouse, and George August Robinson had each recorded small amounts of detail regarding the Aboriginal people within a broad region surrounding the study area. These records are not detailed and by the 1880s, when more serious ethnographers came into the region, the consequences of European settlement had already greatly altered the traditional Aboriginal way of life (Flood 1980: 26).

As far as can be ascertained, the Aboriginal groups living permanently in the Canberra region spoke different, but related languages (all most likely associated with the dominant Ngarigo) (Cooke 1988: 33; Flood 1980: 194). Aboriginal people in the broader Canberra district are associated collectively within the Ngunawal boundaries (refer to *Figure 4.1*). These people are thought to have lived in small, highly mobile, kin-based groups.

Individual groups came together regularly to participate in trade, marriage and ceremonial gatherings.

An early ethnographic account from Bennett (1834: 173) records their diet as including flying squirrel, kangaroo, wallaby, wombat, koala, possum, emu, duck, swan, snake, goanna, platypus, ant eggs, insects, fish, mussels, yabbies, plant tubers, berries and seeds.

Currently, four Aboriginal groups are representative of the Australian Capital Territory region. These groups are:

- Buru Ngunawal Aboriginal Corporation;
- King Brown Tribal Group;
- Little Gudgenby River Tribal Council; and
- Ngarigu Currawong Clan.

Figure 4.1 Tribal boundaries of the Canberra and wider region (after Tindale 1974).

4.2 *HISTORICAL DEVELOPMENT*

The first documented case of Europeans visiting the Canberra/Queanbeyan region is in 1820 when Charles Throsby passed through the area in search of the Murrumbidgee River. In locating the Murrumbidgee River, Throsby and his party followed the river to the Queanbeyan River and further into the eastern part of the Canberra region (Cross 1985).

The Site is located within land that originally formed part of the Campbell's Estate. This section briefly describes the Campbell family and the nature of their Estate.

4.2.1 *Duntroon Estate and the Campbell Family*

The land on which the Site is situated was first owned in the European sense, by the Campbells (a European family) in 1824. Robert Campbell was a Sydney merchant who, whilst conducting services for the government, lost his ship – the 'Sydney'. As compensation, he was awarded a land grant in the Canberra Queanbeyan region, known as 'Pialligo' (ERM 2005). At its height (as a sheep grazing estate) Campbell's land holdings encompassed 32,000 acres, had 27 workers cottages, including 'The Oaks Estate', Blundell's Cottage, several stables, an apple shed, an apiary, a dairy, and a woolshed.

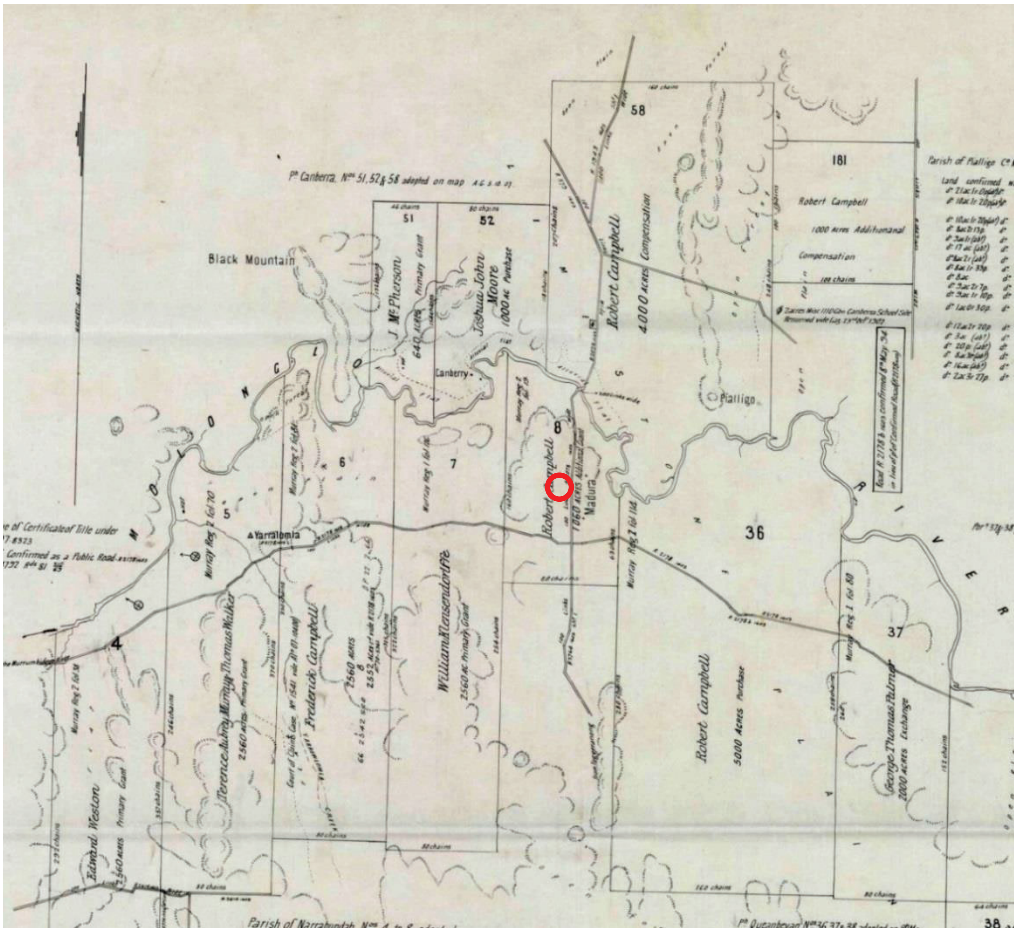

Figure 4.2 ***Extract from 1832 Parish Map Showing Campbell's Land Holdings. Approximate location of the Site is circled in red. (Source ACT Land Titles Office).***

Campbell advertised for tenant farmers to work his estate. The tenant farmers were given a house and an area of land to farm, with a portion of each crop going to Campbell (Saunders 2004: 11). Campbell's main overseer, James Ainslie, found the land on the banks of the Molonglo River to be excellent for livestock grazing. This was most probably the first European use of land associated with the Site.

In 1833, Campbell contracted stonemasons from Sydney to construct a homestead from local stone on his Estate, approximately 2.5 kilometres south-east of Site. This homestead was named Duntroon House (*Figure 4.3*). During this early period of European settlement, the area was considered remote and did not attract development. In 1834, the Polish naturalist, John Lhotsky, described Robert Campbell's house as being at the end of the world and declared that he was heading into a 'land with no government'.

The house was used as a residence for the Campbell family until 1903, when Robert Campbell's wife Marianne died, and the remaining family moved away. The house remained vacant from 1903 to 1910. In 1910 a lease was taken by the Commonwealth Government for two years which covered the homestead and 374 acres of surrounding land. On this land the Royal Military College of Australia was established in 1911, and continues to operate as an active officer training facility (ERM 2005).

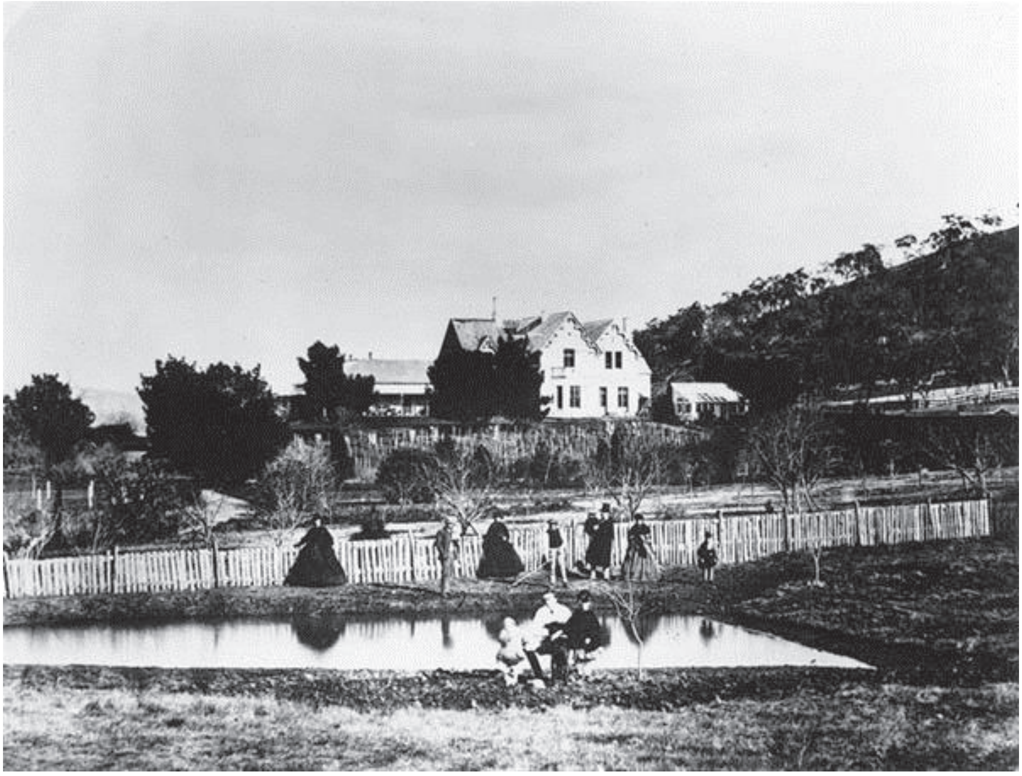

Figure 4.3 ***The Campbell family at Duntroon House 1870 (Image Courtesy of the ACT Heritage Library Image Number: 006888).***

By 1913, the Commonwealth for the Federal Capital Territory resumed Portion 36 as part of their plan for the development of Canberra. By this time a few substantial houses had been built within the Canberra area such as Duntroon, Acton and Yarralumla. However, most of the regions early houses were basic arrangements built with rough wooden frames and earthen walls. As far as could be ascertained, no housing or other structures associated with the Campbell's ownership were built on the Site.

4.2.2 The Nation's Capital

The search for a location to house the nation's capital took place between 1902 and 1908. Forty already settled districts were proposed, 23 of these were inspected by an official party who then narrowed the choice to seven. Albury, Bombala, Lake George, Lyndhurst, Tumut, Dalgety and Queanbeyan-Canberra were all examined closely, particularly with regard to water supplies, climate and landforms suitable for the building of a 'garden city'.

In 1908, the Queanbeyan-Canberra area was selected as capable of fulfilling all requirements, and 2,368 km^2 were set aside as the Australian Capital Territory (ACT), with a separate coastal area selected at Jervis Bay for access to the sea.

Charles Scrivener, Surveyor-General selected the most suitable area of the ACT for the construction of a city. He chose the broad flood-plain of the Molonglo River, 550 metres above sea-level with additional land to the north and south, including two lines of hills on the north side rising 300 metres above the plain.

An international competition for a city plan was launched in 1911 and attracted 137 entries. First prize was awarded to American landscape architect Walter Burley Griffin (*Figure 4.4*). Griffin's plan laid out a city for a population of 25,000 people, with flexibility to expand to 75,000 people. The plan for the Nation's capital was heavily influenced by the natural topography and setting of the area (Vernon 2002). Griffin's plan for the Nation's capital was largely centred on one key design concept, the 'Parliamentary Triangle', comprising three 'nodes' or zones connected by major roadways (refer *Figures 4.5, 4.6,* and *4.7*). The three nodes included the military node at the eastern apex, the civic node at the western apex and the parliamentary node at the south.

After the First World War, under the guidance of the Federal Capital Advisory Committee, the construction of Canberra progressed. Road and sewerage developments continued, tree plantings were carried out, and the construction of a temporary Parliament House was completed in 1926. Shops were built at Civic, Manuka and Kingston, and offices, hostels and houses were completed for 1,100 public servants (Hutchison 2000).

Figure 4.4 *One of Walter Burley Griffin's 1913 Plans for Canberra (Source: NAA Series A1, 1917/7242)*

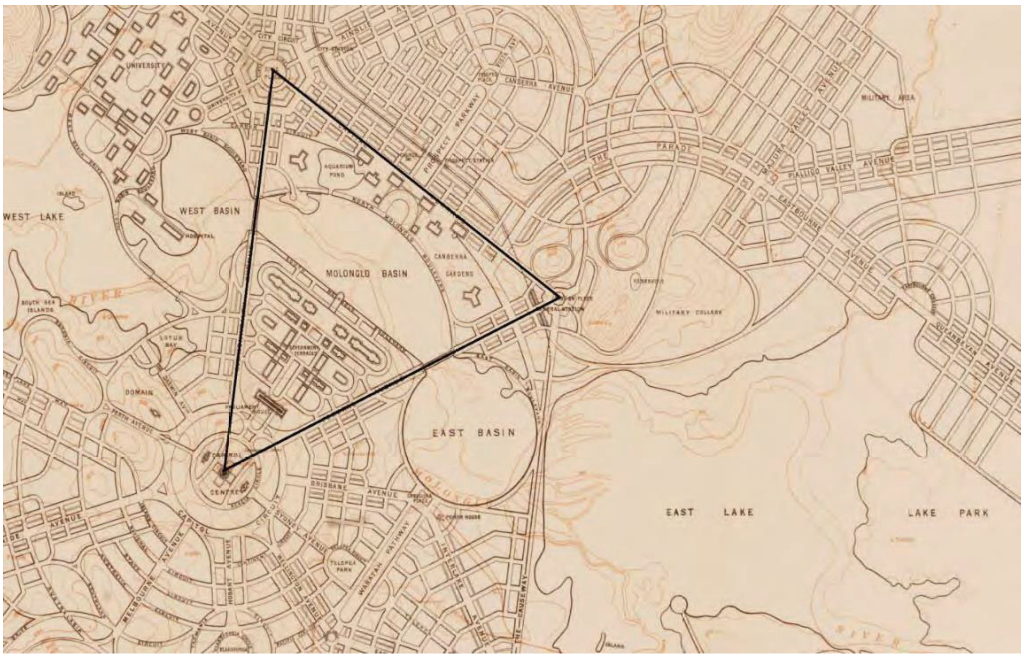

Figure 4.5 ***Close-up of Griffin's plan, showing Parliamentary Triangle (defined in black) and site of East Lake and East Lake Park (Source: NAA Item 7013065)***

Shortages during the Depression, Second World War and post-war slowed the development of Canberra, with only a small number of national projects, such as the Australian War Memorial (1941) and the Australian-American Memorial (1954), being completed.

Figure 4.6 ***1950 Aerial Photograph of the Parliamentary Zone. The planning for the Parliamentary Zone is clearly apparent (Source: ACT Land Titles Office).***

4.2.3 National Capital Development Commission

In April 1957, Australian Parliament established the National Capital Development Commission (NCDC) to plan and continue the development of Canberra. John Overall, a distinguished Army Officer and architectural designer, was appointed the first Commissioner of the newly established NCDC. In this role, Overall made a significant contribution to the development of Canberra. With Overall as Commissioner of the NCDC, the general administration of the ACT lay with the Department of the Interior.

Upon completion of the new Parliament House in 1988 (which was built by the Parliament House Construction Authority, not the NCDC) and the introduction of self-government to the ACT, the Government concluded that the Commission's role was no longer needed.

The NCDC was abolished in 1989 and most of its functions and staff transferred to the new ACT Government. A new National Capital Planning Authority (NCA) was established to represent the Commonwealth's interest in the future planning and development of the national capital. (History section of the NCA website: nationalcapital.gov.au accessed 10 January 2013).

4.2.4 *Block 3 Section 22 Barton*

Aerial photography and parish maps show the Site has not been developed. The Site originally formed part of Robert Campbell's estate as described above, and was used for agricultural purposes during this time, refer to *Figure 4.7.*

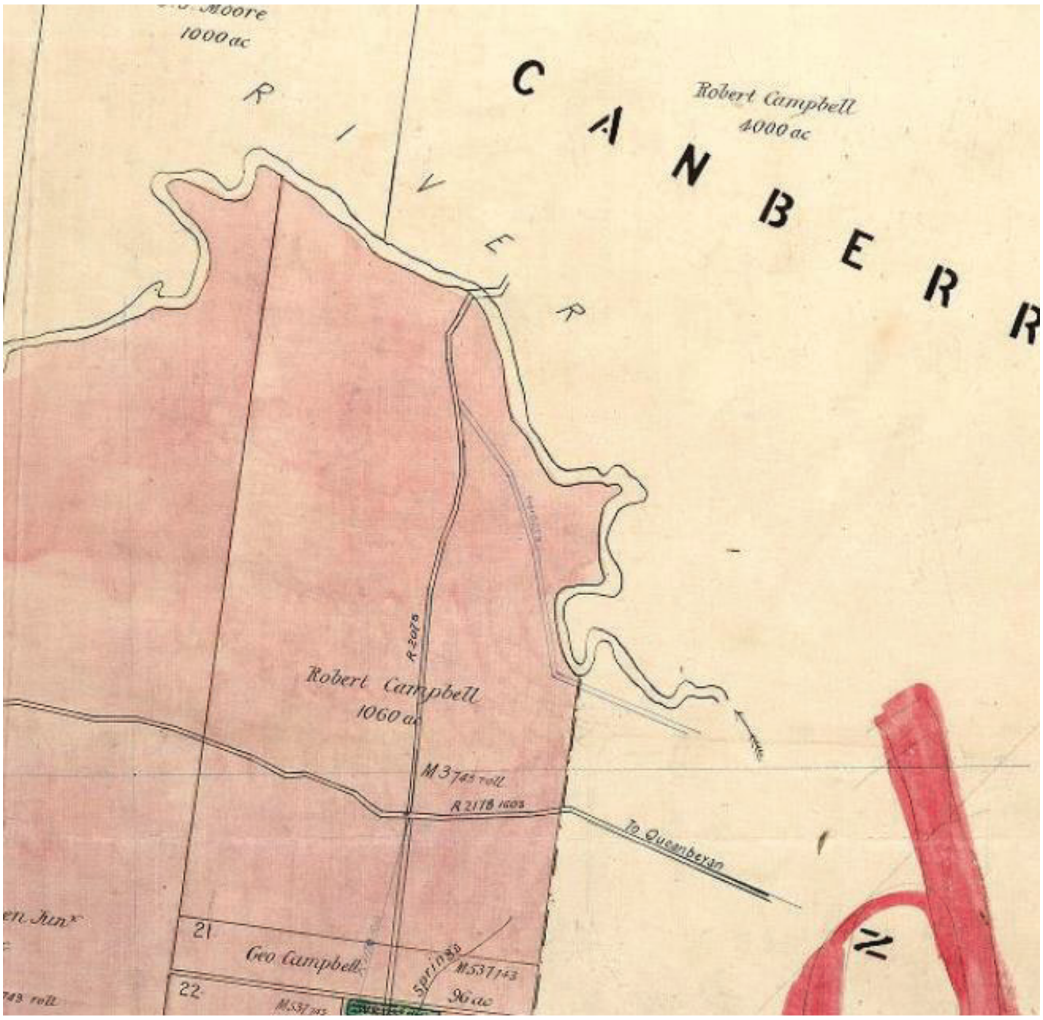

Figure 4.7 ***1882 Parish Map showing the location of the Site (NSW Department of Lands).***

The development of Canberra commenced following World War I, with the construction of Parliament House completed in 1926. Development of shops, offices, hostels and houses followed in surrounding areas. The Site appears to have remained cleared during this time and throughout the 20th century as surrounding development occurred.

Figure 4.8 ***1964 aerial photograph showing the approximate location of the Site (National Library of Australia Picture nla.pic-an14324452-54).***

4.3 USES AND PROCESSES

A timeline for the historical events associated with the Site is provided in *Table 4.1*.

Table 4.1 ***Historical timeline for the Site and local region***

Date	Activity or Event
Pre-European settlement	Ngunawal people travelling through the region, utilising resources on the annual gatherings for moth hunting and initiation ceremonies.
1830s	Pastoral settlement of the region, large areas of land granted to and purchased by Robert Campbell. Introduction of sheep farming.
1910s	Walter Burley Griffin wins design competition for the new Federal Capital. Construction of Canberra begins.
1926	Parliament House established and development commences in areas surrounding the Site.
1960s	Site still comprises a cleared lot, development of surrounding area increase.
2015	Site has been established as 'York Park' and is surrounded by large buildings and roads.

4.4 *ARCHAEOLOGICAL BACKGROUND*

The Site was surveyed by Navin Officer Heritage in 1992 as part of a wider archaeological assessment of the York Park development area. No cultural heritage sites were identified during the 1992 assessment. A former compound and shed were identified to be potentially located within the north-western corner of the Site but currently located underneath a layer of fill.

Navin Officer also prepared a Cultural Heritage Assessment (CHA) of the Site in 2009. The CHA was undertaken to determine the potential impacts to heritage values of a proposed new office building at the Site, and the associated divestment of the property. The CHA included a desktop assessment, a field survey and consultation with the ACT RAOs. Desktop assessment for the Site indicated that no Indigenous or historic heritage sites had been previously recorded within the study area. A field survey of the Site identified no Aboriginal or historic heritage objects or places within the Site, however one area of PAD was identified (Barton PAD1) (refer to *Figure 4.9*).

This site was described as:

One of the last remaining relatively undisturbed areas within Barton and the Parliamentary Triangle.

Old aerial photographs and a 1992 survey indicate that the area has never been developed and that the drainage line present on the site is an original feature. The PAD includes that grassland reserve.

It is considered that the area has moderate potential to contain relatively undisturbed subsurface archaeological deposits and for these deposits to be of moderate archaeological significance. The site is therefore assessed as having moderate archaeological potential (Navin Officer 2009).

A program of archaeological test excavation was recommended to be undertaken at Barton PAD1 prior to any land disturbance.

Figure 4.9 ***Barton PAD 1 (yellow) (Adapted from Figure 7.2 of Navin Officer 2009).***

The 2009 CHA provided the following recommendations:

- *A program of archaeological test excavations should be conducted within Barton PAD 1 prior to any land surface disturbance relating to development of the site. The PAD is located in a Designated Area, and as a consequence, approval to conduct the archaeological test excavations should be sought and gained from the NCA.*

- *A copy of this draft report should be provided to each of the RAOs for input and comment* (Navin Officer 2009).

Navin Officer (2010) subsequently undertook archaeological sub-surface testing of the Barton PAD 1 site. A total of nine test pits were dug across the Barton PAD 1 site (refer to *Figure 4.10*). Results of the sub-surface excavation indicated that the location was relatively undisturbed. However, no Indigenous heritage objects were found during the excavation. Navin Officer (2010) determined that this area was unlikely intensely utilised by Indigenous people in the past, however, the area may have been used for movement through country, hunting and gathering or similar activities that can result in extremely low or negligible densities of artefactual material.

Figure 4.10 ***Location of test pits dug at Barton PAD 1 (Figure 5.1 in Navin Officer 2010).***

Navin Officer (2010) concluded that while the landform and aspect of the Barton PAD 1 site conforms to predicted areas suitable for human occupation, the distance to water sources and other features in the landscape has resulted in very little or no archaeological evidence is now present. Based on results of the sub-surface testing, Navin Officer (2010) recommended that:

- *No further archaeological assessment is required in relation to the area of Aboriginal archaeological potential at Barton PAD 1.*
- *Any development within the PAD1 area should adhere to the stop work procedures as defined in the Unanticipated Discovery Plan provide in Appendix 5* (of Navin Officer 2010).

4.4.1 ACT Heritage Database Searches

A search of the ACT Heritage Register indicates that there are currently no Indigenous heritage sites recorded within the Site. Barton PAD 1 was recorded by Navin Officer in 2009 during a field survey. However, subsequent sub-surface testing of the PAD in 2010 found no archaeological deposits at this location (Navin Officer 2010).

The ACT Heritage Register search revealed 52 Indigenous heritage sites previously recorded within the Barton area and surrounding suburbs. These sites predominantly consist of stone artefact sites including stone artefact scatters and isolated finds. The spatial distribution of these sites shows a concentration of stone artefact sites within proximity to water sources including Lake Burley Griffin and the Molonglo River and on footslopes of Black Mountain and Mount Ainslie. Numerous scarred trees have also been identified approximately 4.5 km south of the Site within gently sloping open valley depression.

The nearest recorded site on the ACT Heritage Register is OPH1, a hatchet and boomerang found 100 m west of Old Parliament House. OPH1 is located approximately 1 km north-west of the Site.

4.5 *PREDICTIVE MODEL*

Information obtained relating to the environmental context of the Site, regional archaeological patterning and ethnographic information has enabled a set of parameters to be established which can be used to predict the potential location of Indigenous heritage sites across the wider region. These parameters are:.

- Indigenous sites are most likely to be stone artefact sites.
- Stone artefact sites are most likely to occur within 400 m of a permanent water course, although smaller creeks may have associated artefact scatters, particularly if near to larger water courses.
- Surface expressions of artefacts are most likely to be found on raised level or gently sloping ground associated with the crest or shoulder of a ridge line, and on flats associated with river valleys.
- Scarred trees (with an Aboriginal cultural origin) could occur on mature trees.
- Obvious local landscape features, such as spur lines or flat elevated terrain, could provide a suitable camping position and view point across the generally flat region.
- Flood (1980) has suggested that there appears to be a preference in the Canberra region for locations away from cold air drainage, sheltered from prevailing winds, with an easterly or north-east outlook.
- Human burials are rare, but if present would most likely be in the alluvial ‘slope wash’ soils that make up the study area’s flood plain, creek and river terraces or found in recesses within rock outcrops.

The knowledge gained from examining landforms, geology, the regional archaeological pattern, and prior archaeological reports have enabled a set of parameters to be established to predict the potential location of Indigenous sites within the Site. Predictions for Indigenous heritage sites to occur within the Site are:

- Indigenous sites are most likely to be stone artefact sites.
- As no mature trees are present at the Site, no scarred trees are expected to occur.

Based on historical use of the Site, previous survey results and sub-surface test excavation it is considered that there is an overall low potential for Indigenous heritage sites to occur.

4.6 SITE INSPECTION RESULTS

The Site was inspected by ERM Archaeologist Janene May, ERM Ecologist Matthew Flower, James Mundy of Ngarigu Currawong Clan and Kristal House of Little Gudgenby River Tribal Council on 26 November 2015. No Indigenous or historic heritage items were identified during this site inspection. The Site was covered in grass and ground surface visibility was poor. Due to results of previous archaeological investigations (Navin Officer 2009; 2010), disturbance at the site and conversations with RAOs, it is considered that the Site has a low potential to contain unknown heritage items.

Photograph 4.1 View of the Site looking north (ERM 2015).

5 ASSESSMENT OF HERITAGE SIGNIFICANCE

The Site has been assessed for its Indigenous, natural and historic heritage values against the CHL and ACT Heritage criteria. The CHL heritage criteria are provided in *Table 5.1*. The CHL values have been ranked using Finance Significance Ranking Guide provided in *Annex A*. The ACT Heritage Assessment Policy was used to provide further guidance on assessments against the ACT heritage criteria.

Table 5.1 CHL Significance Criteria

Criterion	Description
a	*the place's importance in the course, or pattern, of Australia's natural or cultural history;*
b	*the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history;*
c	*the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history;*
d	*the place's importance in demonstrating the principal characteristics of:* *i) a class of Australia's natural or cultural places; or* *ii) a class of Australia's natural or cultural environments;*
e	*the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;*
f	*the place's importance in demonstrating a high degree of creative or technical achievement at a particular period;*
g	*the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;*
h	*the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history;* and
i	*The place's importance as part of Indigenous tradition.*

The ACT heritage significance criteria are outlined in the *Heritage Act 2004*. These criteria are provided in *Table 5.2*. In order to be entered into the ACT Heritage Register a place must meet at least one of these criteria.

Table 5.2 ACT Heritage Significance Criteria

Criterion	Description
a	*importance to the course or pattern of the ACT's cultural or natural history;*
b	*has uncommon, rare or endangered aspects of the ACT's cultural or natural history;*
c	*potential to yield information that will contribute to an understanding of the ACT's cultural or natural history;*
d	*importance in demonstrating the principal characteristics of a class of cultural or natural places or objects;*
e	*importance in exhibiting particular aesthetic characteristics valued by the ACT community or a cultural group in the ACT;*
f	*importance in demonstrating a high degree of creative or technical achievement for a particular period;*

Criterion	Description
g	*has a strong or special association with the ACT community, or a cultural group in the ACT for social, cultural or spiritual reasons;*
h	*has a special association with the life or work of a person, or people, important to the history of the ACT.*

5.1 *INDIGENOUS HERITAGE ASSESSMENT*

The assessment of the Indigenous heritage significance of the Site has been undertaken in accordance with the Commonwealth *Ask First: A guide to respecting Indigenous heritage places and values* and with Finance's HA template.

5.1.1 *Description*

Background research has indicated that one PAD has been previously recorded within the Site (Barton PAD 1). However, sub-surface testing of this PAD yielded no archaeological deposits (Navin Officer 2010). No Indigenous heritage sites were recorded during the ERM 2015 field survey. The Site was observed to be highly disturbed and unlikely to contain any unknown Indigenous heritage objects or places.

5.1.2 *Archaeological Potential*

The results of the field survey, coupled with an understanding of local and regional Aboriginal site patterning, permits the designation of zones that potentially hold archaeological deposits (PADs). PAD areas can be defined as locations where the possibility of discovering new Aboriginal sites exists (on the surface or in subsurface contexts). The archaeological potential is based upon three measures:

- the statistical likelihood of finding a site (based upon a background understanding such as predictive modelling);
- the condition of the area (the condition of the natural materials within the study area); and
- the integrity of sites (how much the study area has been disturbed since it was created).

A basic ranking system can be applied - high, moderate, low or no potential. No areas of archaeological potential were identified during the field survey.

5.1.3 *Comparative Analysis*

No Indigenous heritage sites are known to occur within the Site and a comparative analysis is therefore not required.

5.1.4 *Assessment of Indigenous Heritage Significance*

Although considered to have a low potential, unknown Indigenous heritage values could still be present within the Site. Discussions with James Mundy of Ngarigu Currawong Clan and Kristal House of Little Gudgenby River Tribal Council during the field survey and previous archaeological research indicate that Indigenous heritage sites found across the general region demonstrate the use of the wider landscape by Indigenous people in the past.

An assessment of the Indigenous heritage values of the Site against the CHL criteria is provided in *Table 5.3*.

Table 5.3 Indigenous heritage assessment against the CHL criteria

Criteria	ERM Assessment	Finance Ranking
a	There are no known Indigenous heritage sites within the Site. Due to the extensive level of disturbance to the Site, it is considered that there is a low potential for unknown Indigenous heritage objects to occur. **Criterion not met.**	None
b	There are no known Indigenous heritage sites within the Site. Due to the extensive level of disturbance to the Site, it is considered that there is a low potential for unknown Indigenous heritage objects to occur. **Criterion not met.**	None
c	Due to the extensive level of disturbance to the Site, the potential for the Site to yield Indigenous heritage objects that may contribute to an understanding of Australia's cultural history is low. Further, sub-surface testing undertaken of the identified PAD site yielded no archaeological deposits. **Criterion not met.**	None
d	The Site does not contain any known Indigenous heritage objects or places that demonstrate principal characteristics of a class of cultural places or environments. **Criterion not met.**	None
e	The Site does not contain any known Indigenous heritage objects or places that exhibit aesthetic qualities valued by a community or cultural group. **Criterion not met.**	None
f	The Site does not contain any known Indigenous heritage objects or places that demonstrate a high degree of creative or technical achievement. **Criterion not met.**	None
g	The Site does not contain any known Indigenous heritage objects or places that have a special or strong association with the Indigenous community. **Criterion not met.**	None
h	The Site does not contain any known Indigenous heritage objects or places that have a special association with the life or works of a person or group of persons of important in Australia's cultural history. **Criterion not met.**	None

Criteria	ERM Assessment	Finance Ranking
i	There are no known Indigenous heritage objects or places within the Site that are of importance as part of Indigenous tradition. Due to the high level of disturbance at the Site, the potential for unknown Indigenous heritage objects to occur is considered to be low. **Criterion not met.**	None

Table 5.4 presents an assessment of the Indigenous heritage values of the Site against the ACT heritage significance criteria.

Table 5.4 Indigenous heritage assessment against the ACT criteria

Criteria	ERM Assessment
a	There are no known Indigenous heritage sites within the Site. Due to the extensive level of disturbance to the Site, it is considered that there is a low potential for unknown Indigenous heritage objects to occur. **Criterion not met.**
b	There are no known Indigenous heritage sites within the Site. Due to the extensive level of disturbance to the Site, it is considered that there is a low potential for unknown Indigenous heritage objects to occur. **Criterion not met.**
c	Due to the extensive level of disturbance to the Site, the potential for the Site to yield Indigenous heritage objects that may contribute to an understanding of Australia's cultural history is low. **Criterion not met.**
d	The Site does not contain Indigenous heritage objects or places that demonstrate principal characteristics of a class of cultural places or environments. **Criterion not met.**
e	The Site does not contain Indigenous heritage objects or places that exhibit aesthetic qualities valued by a community or cultural group. **Criterion not met.**
f	The Site does not contain Indigenous heritage objects or places that demonstrate a high degree of creative or technical achievement. **Criterion not met.**
g	The Site does not contain Indigenous heritage objects or places that have a special or strong association with the Indigenous community. **Criterion not met.**
h	The Site does not contain Indigenous heritage objects or places that have a special or strong association with the Indigenous community. **Criterion not met.**

5.2 NATURAL HERITAGE ASSESSMENT

Background research indicated the eastern portion of the Site contains a Territory and Commonwealth-listed endangered ecological community, and a population of the endangered GSM (Umwelt 2014).

5.2.1 *Natural Features of the Site*

This section describes the natural features of the Site in these broad categories:

- Ecosystems;
- Vegetation (including TECs/EECs);
- Flora (including threatened species); and
- Fauna (including threatened species).

Ecosystems

The Site is a grassland in an urbanised area.

Vegetation

Two general vegetation assemblages are present at the Site, described in *Table 5.5* and shown in *Figure 5.1*.

Table 5.5 Vegetation assemblages recorded during the ERM field survey

Vegetation Assemblage	Description	Listing Status
Exotic grassland with scattered non-native trees	This vegetation occurs on the north western half of the Site. It is dominated by non-native perennial grasses and has abundant non-native legumes (clovers) and other non-native herbs. Scattered non-native trees present include Rowan (*Sorbus domestica*), Black Alder (*Alnus glutinosa*) and Ash (*Fraxinus angustifolia*).	-
Native Grassland	The eastern half of the Site is a mostly native grassland that provides habitat for the threatened invertebrate species: GSM (*Synemon plana*).	This vegetation on the Site meets the criteria of Natural Temperate Grassland as listed under the NC Act and EPBC Act.

Client:	Department of Finance		
Drawing No:	0325464s_B3S22HA_G004_R0.mxd		
Date:	14/12/2015	Drawing Size:	A4
Drawn By:	GC	Reviewed By:	MF

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 5.1 - Block 3 Natural Features (adapted from Umwelt - 2015)

Heritage Assessment
Block 3, Barton ACT

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Melbourne, Newcastle, Perth, Port Macquarie, Sydney

ERM

Flora Species

The western half of the Site is dominated by introduced grasses, legumes and herbs and the eastern half is dominated by native grasses. No threatened flora species were observed during the ERM Site assessment and no records of threatened flora were identified through database searches.

Fauna Species

The Site contains a known population of GSM, described further in *Annex B*.

Natural Features Summary

The natural features of the Site include:

- An area of native grassland that constitutes NC Act-listed endangered ecological community, Natural Temperate Grassland; and EPBC Act-listed threatened ecological community, Natural Temperate Grassland of the Southern Tablelands of NSW and the ACT;

- a population of Golden Sun Moth (critically endangered under the EPBC Act; endangered under the NC Act); and

- previous records of burrows of the uncommon Canberra Raspy Cricket (*Cooraboorama canberrae*), however these have not been recorded since 2007 (Umwelt 2014).

5.2.2 *Assessment of Natural Heritage Significance*

The assessment of natural heritage significance against the CHL criteria and ACT heritage assessment criteria are presented in *Table 5.6* and *Table 5.7*.

5.2.3 *Comparative Analysis*

A comparative analysis for natural heritage values of the Site is provided in *Annex B*. The Golden Sun Moth (critically endangered under the EPBC Act and endangered under the NC Act) and Natural Temperate Grassland (endangered under the *Nature Conservation Act* (NC Act) and EPBC Act) have been identified at the Site.

The comparative analysis presented in *Annex B* has found that extensive populations of the GSM are present at Majura Training Area, Canberra International Airport and the Belconnen Naval Station. Large, intact and protected areas of known GSM populations or key habitat in the ACT include Crace Nature Reserve (136 ha in area), Dunlop Nature Reserve (82ha in area) and Mulangarri Nature Reserve (69 ha in area) (Act Government 2005; Environment ACT 2006a). Other populations, although less extensive, are present at 'Woden' in the Jerrabomberra Valley, Mulanggari Grassland Reserve (Gungahlin) and Crace Grassland Reserve (Gungahlin).

The Site is identified as a 'smaller site' of GSM. Comparative analysis has found that the Site is not a significant example of GSM and that there are better examples of larger populations in other parts of the ACT.

Large, intact and protected areas of known NTG in the ACT include >400 ha of NTG in the Gungahlin Grassland Reserves (Crace Nature Reserve, Mulangarri Nature Reserve and Gungaderra Nature Reserve) and Dunlop Nature Reserve (ACT Government 2005; Environment ACT 2006b). The *ACT Lowland Native Grassland Strategy* (ACT Government 2005: 55) states that in the ACT there are 47 native grassland sites, of which there are 11 sites greater than 100 ha in size. Eight of those 11 sites contain NTG in moderate to good condition and are greater than 50 ha in size (ACT Government 2005: 55). Comparative analysis has found that better examples of larger NTG remnants exist in other parts of ACT

A detailed comparative analysis supporting these conclusions is provided in *Annex B*.

Table 5.6 Natural heritage assessment against the CHL criteria

CHL Criteria	ERM Assessment	Finance Ranking
(a) The place has significant heritage value because of the place's importance in the course, or pattern, of Australia's natural or cultural history.	The eastern portion of the Site provides for the continued breeding of a critically endangered invertebrate, the GSM, in an otherwise urban environment. However, as other GSM populations persist in other parts of the ACT, New South Wales and Victoria (refer *Annex B*), the Site is not considered to have significant natural heritage value. **Criterion not met**	None
(b) The place has significant heritage value because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history.	The Site contains an area of grassland, identified as endangered at a Territory and Commonwealth level, and a population of the nationally critically endangered (EPBC Act) GSM. This combination of a critically endangered species and native grassland is rare in the context of the urban Canberra environment, however occurs in numerous other locations within and outside the ACT (refer *Annex B*). Due to the existence of numerous other GSM populations in Australia, and in consideration of the small extent of GSM habitat at the Site (0.5ha), the presence of the critically endangered GSM at this location is not considered to have significant natural heritage value. **Criterion not met**	None
(c) The place has significant heritage value because of the place's potential to yield information that will contribute to an understanding of Australia's natural or	The GSM population at the Site has been the subject of past studies and is the subject of ongoing monitoring. These studies have the potential to reveal important information relating to the species' life cycles and habitat requirements. However, this is not considered to be a significant natural heritage value, as other places can yield the same kind of information. Refer to *Annex B* for a more detailed comparative analysis against this criterion.	None

CHL Criteria	ERM Assessment	Finance Ranking
cultural history.	**Criterion not met**	
(d) The place has significant heritage value because of the place's importance in demonstrating the principal characteristics of: (i) a class of Australia's natural or cultural places; or (ii) a class of Australia's natural or cultural environments.	While the native vegetation at the Site demonstrates the characteristics of NTG, the Site has been modified from its natural state due to fragmentation from other patches caused by neighbouring urban development leading to reduced grass and herb diversity. It is expected that more representative examples of this community are available in the surrounding region. **Criterion not met**	None
(e) The place has significant heritage value because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group.	The Site is typical of the surrounding agricultural landscape and is not considered to provide significant aesthetic value. **Criterion not met**	None
(f) The place has significant heritage value because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period.	Not relevant to natural heritage values. **Criterion not met**	None
(g) The place has significant heritage value because of the place's strong or special association with a particular community or cultural group for social, cultural, or spiritual reasons.	No evidence was identified to suggest an association between the natural features of the Site and any community group. **Criterion not met**	None
(h) The place has significant heritage value because of the place's special association with the life or works of a person, or group of persons, or importance in Australia's natural or cultural history.	No such association has been identified. **Criterion not met**	None

CHL Criteria	ERM Assessment	Finance Ranking
(i) The place has significant heritage value because of the place's importance as part of indigenous tradition.	No such association has been identified. **Criterion not met**	None

Table 5.7 Natural heritage assessment against the ACT Heritage Assessment Criteria

Criteria	ERM Assessment
(a) importance to the course or pattern of the ACT's cultural or natural history	The eastern portion of the Site demonstrates continuity of the breeding of a critically endangered invertebrate, the GSM, in an otherwise urban environment. However, the GSM is known to occur and breed at a number of locations throughout ACT, and, due to the isolated context of GSM habitat at the Site, the Site is not considered to provide an important example of the continuity of this process. In addition, the Heritage Assessment policy indicates that places already protected under the NC Act do not warrant protection under the *Heritage Act 2004*, and therefore, the Site does not meet this criterion. **Criterion not met**
(b) has uncommon, rare or endangered aspects of the ACT's cultural or natural history	The Site contains an area of NTG (endangered under the NC Act and EPBC Act) and a population of GSM (endangered under the NC Act and critically endangered under the EPBC Act). This combination of a critically endangered species and ecological community is rare in the context of the urban Canberra environment, however is not uncommon in the broader ACT and a detailed comparative analysis demonstrates that the Site does not meet the eligibility for this criterion. **Criterion not met**
(c) potential to yield information that will contribute to an understanding of the ACT's cultural or natural history	The GSM population at the Site has been the subject of past studies and is the subject of ongoing monitoring. These studies have the potential to reveal important information relating to the species' life cycles and habitat requirements. However, this is not considered to be a significant natural heritage value, as the information is readily available from other sites of GSM populations within NTG. **Criterion not met**
(d) importance in demonstrating the principal characteristics of a class of cultural or natural places or objects	While the native vegetation at the Site demonstrates the characteristics of NTG, the Site has been modified from its natural state due to fragmentation from other patches caused by neighbouring urban development leading to reduced grass and herb diversity. It is expected that more representative examples of this community are available in the surrounding region. **Criterion not met**
(e) importance in exhibiting particular aesthetic characteristics valued by the ACT community or a cultural group in the ACT	The Site is typical of the surrounding agricultural landscape and is not considered to provide significant aesthetic value. **Criterion not met**

Criteria	ERM Assessment
(f) importance in demonstrating a high degree of creative or technical achievement for a particular period	Not relevant to natural heritage values. **Criterion not met**
(g) has a strong or special association with the ACT community or a cultural group within the ACT for social, cultural or spiritual reasons	No evidence was identified to suggest an association between the natural features of the Site and any group of people. **Criterion not met**
(h) has a special association with the life or work of a person, or people, important to the history of the ACT.	No such association has been identified. **Criterion not met**

5.3 *HISTORIC HERITAGE ASSESSMENT*

5.3.1 *Description*

The Site was historically part of a land grant to Robert Campbell. The area surrounding the Site was developed throughout the 20th century commencing with the construction of Parliament House in 1926. The Site is situated on one of Burley Griffins' major axes, which later became Sydney Avenue (refer to *Figure 4.4*). It appears that there were no specific plans to establish the Site as an open space as part of Burley Griffins' plan of the Canberra area (refer to *Figure 4.4*).

The area remained a cleared lot and is now established as York Park. The Site is now surrounded on all sides by development including large hotels and multi-storey buildings. It remains one of the few open spaces within the heavily developed Barton area.

Based on the desktop information reviewed and the field survey, there is no known evidence of this history present within the Site. Based on the history of the Site, there would be potential for sheds or domestic structures and artefacts to be located within the area, however no evidence of former structures was identified by the field survey.

5.3.2 *Comparative Analysis*

No historic heritage values are known to occur within the Site. The Site has been identified has having potential scientific and research values for its natural heritage values. Comparative analysis of natural heritage values is provided in *Annex B*. This analysis demonstrates that the Site has been extensively utilised for scientific research and has been the subject of ongoing monitoring. These studies have potential to yield information relating to life cycles and habitat requirements of the GSM and information pertaining to NTG. The Site is located within an urban environment and is therefore easily accessible for scientific research. However, several other locations within Canberra and the wider ACT afford opportunity for scientific research and provide more intact, larger examples of the GSM and NTG which are also accessible (refer to *Section B.2* of *Annex B*).

5.3.3 *Assessment of Historic Heritage Values against the CHL Criteria*

An assessment of the historic heritage values of the Site against the CHL criteria is provided in *Table 5.8*.

Table 5.8 Historic heritage assessment against the CHL Heritage criteria

Criteria	ERM Assessment	Finance Ranking
a	There is no known evidence of the 19th century land-holders remaining on site. Historic parish maps do not indicate the presence of any structures located within the site, and it is considered that it was likely utilised for grazing. The Site is situated on one of Burley Griffins' major axes, which later became Sydney Avenue however it appears that there were no specific plans to establish the Site as an open space as part of Burley Griffins' plan of the Canberra area. The site does not provide a significant insight into the course of Australia's cultural history. **Criterion not met**	None
b	The desktop review did not identify any aspects of the site with importance to Australia's natural history. **Criterion not met**	None
c	The site is unlikely to yield information relevant to an understanding of Australia's natural history. **Criterion not met**	None
d	The Site is highly modified from its natural state and does not demonstrate the principal characteristics of a class of Australia's cultural places. **Criterion not met**	None
e	The Site is one of the few remaining open spaces within the heavily developed Barton area. However, it does not exhibit particular aesthetic characteristics valued by a community group. The Site does not contain any assets with significant architectural qualities. The Site is situated on one of Burley Griffins' major axes, which later became Sydney Avenue, however there were no specific plans to establish the Site as an open space as part of Burley Griffins' plan of the Canberra area **Criterion not met**	None

Criteria	ERM Assessment	Finance Ranking
f	The Site does not exhibit any features of technical or creative achievement. **Criterion not met**	None
g	There is no evidence to suggest the place has a strong association with a particular group of people. **Criterion not met**	None
h	There is no evidence to suggest the place has a special association with a particular person or group of people. **Criterion not met**	None
i	This criterion is not applicable to historic heritage. **Criterion not met**	None

5.3.4 *Assessment of Historic Heritage Values against the ACT Significance Criteria*

An assessment of the built heritage values of the Site against the ACT Heritage criteria is provided below in *Table 5.9*.

Table 5.9 Built heritage assessment against the ACT Heritage criteria

Criteria	ERM Assessment
a	There are no known historic heritage sites within the Site. Due to the extensive level of disturbance to the Site, it is considered that there is a low potential for unknown historic heritage objects to occur. **Criterion not met.**
b	There are no known historic heritage sites within the Site. Due to the extensive level of disturbance to the Site, it is considered that there is a low potential for unknown historic heritage objects to occur. **Criterion not met.**
c	Due to the extensive level of disturbance to the Site, the potential for the Site to yield historic heritage objects that may contribute to an understanding of Australia's cultural history is low. **Criterion not met.**
d	The Site does not contain historic heritage objects or places that demonstrate principal characteristics of a class of cultural places or environments. **Criterion not met.**
e	The Site does not contain historic heritage objects or places that exhibit aesthetic qualities valued by a community or cultural group. **Criterion not met.**
f	The Site does not contain historic heritage objects or places that demonstrate a high degree of creative or technical achievement. **Criterion not met.**
g	The Site does not contain historic heritage objects or places that have a special or strong association with local community. **Criterion not met.**
h	This criterion is not applicable to built heritage. **Criterion not met.**

5.4 *ASSESSMENT OF SIGNIFICANCE*

A significance assessment of the Indigenous, natural and historic heritage values of the Site has been undertaken against the CHL and ACT significance criteria, as provided in the sections above. The Site is not known to contain historic heritage values at a Commonwealth, Territory or local level.

The natural heritage values of the Site do not meet Commonwealth or ACT heritage listing criteria, however the presence of a Territory-listed endangered ecological community and a Commonwealth and Territory-listed endangered species, present some ecological values.

The Site has not been found to have heritage values that meet thresholds of the CHL or ACT heritage significance criteria and a Statement of Significance is therefore not required.

6 RECOMMENDATIONS

The following recommendations are provided for the future management of the Site.

6.1 INDIGENOUS HERITAGE

This HA has found that there are no known Indigenous heritage objects or places within the Site, and the Site has a low potential to contain unknown Indigenous heritage sites. Consultation with the ACT RAOs has further confirmed that the Site has a low potential to contain Indigenous heritage objects or places. However, there is still potential Indigenous heritage values may occur within the Site. It is recommended that in the event that Indigenous heritage objects are found within the Site, an Unexpected Finds Procedure should be implemented. An Unexpected Finds Procedure is provided in *Section 6.1.1* of this report. This procedure has included steps for the Site while it is Commonwealth owned, and in the event that it is divested.

6.1.1 Indigenous Heritage Unexpected Finds Procedure

If any heritage sites, as protected under ACT legislation, are uncovered at the Site, then the following steps should be followed:

- all activity in the immediate area should cease;
- an appropriately qualified heritage professional should be consulted;
- the DoE should be notified; and in the event that the Site is divested, ACT Heritage should be immediately contacted;
- local ACT RAOs should be notified; and
- an appropriately qualified heritage professional should record the location and attributes of the Site and determine the significance of the find.

In the event of the discovery of human skeletal material (or suspected human skeletal material) in the Site the following steps should be followed:

- all activities and/or works in the immediate area must cease;
- the DoE should be contacted while the Site is under Commonwealth ownership, and in the event that the Site is divested, ACT Heritage and ACT RAOs should be contacted; and
- any sand/soils removed from the near vicinity of the find must be identified and set aside for assessment by the investigating authorities.

6.2 HISTORIC HERITAGE

This HA has found that there are no known historic heritage objects or places within the Site, and the Site has a low potential to contain unknown historic heritage sites. However, there is still a chance historic heritage values may occur within the Site. It is recommended that in the event that historic heritage objects are found within the Site, an Unexpected Finds Procedure should be implemented. An Unexpected Finds Procedure is provided in *Section 6.3.1* of this report.

6.2.1 *Historic Heritage Unexpected Finds Procedure*

In the unlikely event that evidence of former structures, or other artefacts are found during the proposed works the steps outlined below should be followed.

Historic heritage items could include or archaeological features. It is not considered likely that archaeological deposits will be found however the following steps are provided below in the event that deposits are found.

- where a potential historic heritage item is found during works, all works within the vicinity of the item, or with the potential to impact the item should cease and a temporary exclusion zone established;

- an appropriately qualified heritage consultant should examine the item to assess its significance and further archaeological potential; and

- where a suspected historic heritage item is found, the DoE should be notified while the Site is under Commonwealth ownership, and in the event that the Site is divested, ACT Heritage should be notified. Approval will likely be required prior to the continuation of works. Other archaeological deposits should be recorded and assessed for significance and potential salvage by an appropriately qualified heritage consultant.

6.3 DIVESTMENT RECOMMENDATIONS

In the event that the Site is divested it is further recommended that:

- This report is disclosed to any future landowners; and

- Clauses should be included in sales contracts for the protection of any unknown heritage values present at the Site (including the Unexpected Finds Protocol).

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Annex A

Finance Significance Ranking Guide

ERM

Significance Ranking For Commonwealth Heritage Listed Properties

Ranking significance assists with identifying management priorities in the first instance. Ranking also assists with determining if a property meets the threshold for inclusion on the Commonwealth Heritage List (CHL). The criteria state that a place needs to have "significant" value in order to meet one or more criterion.

Ranking of significance is also a tool to be used in the development of management recommendations, maintenance priorities and long term planning decisions. Secondarily, they can be used in support of funding and resource allocations.

Therefore, ranking is a critical component underpinning specific management planning development.

The significance rankings described here are divided into three categories – Item, Precinct/Group and Intangible. These categories are based on our experience with large and complex sites and with managing European, Indigenous and Natural values. This allows a more meaningful use of ranking when:

a) Comparing of individual items and precincts within the site itself (ie multiple items which may have varying degrees of significance based on their context, integrity and condition);

b) Comparing a property with other similar sites (eg two buildings of comparable significance at 2 different sites may have settings of differing significance, thereby allowing a clearer comparison and more informed and secure basis for the overall ranking);

c) Identifying CH values across the site and making management recommendations specific to those defining qualities;

d) Providing a context to the ranking where an element may be contributory rather than significant as an individual item. This underpins management of the item as a part of a larger context and assists in prioritising maintenance resources.

The values identified can then either be managed under the CH provisions or broader environmental requirements of the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) depending on whether the CH threshold has been met. We find that this system allows us to be more

specific about why a place has value, which in turn helps us to develop more targeted management methods.

The ranking system has been developed in reference to the ICOMOS, Burra Charter, World Heritage Guidelines, Ask First Guideline for Indigenous places and the Natural Heritage Charter. We have included “universal” level ranking for identifying potential national or World Heritage values.

The tables below outline the categories and ranking levels for built and Indigenous values (Table 1) and natural values (Table 2).

Table 1 Summary of Significance Rankings for Built and Indigenous Heritage

Ranking	Justification – Item	Justification – Precinct/Group	Justification – Intangible
Universal (only to be used for World Heritage Sites)	**Monuments:** architectural works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of outstanding universal value from the point of view of history, art or science;	**Groups of buildings:** groups of separate or connected buildings which, because of their architecture, their homogeneity or their place in the landscape, are of outstanding universal value from the point of view of history, art or science;	**Sites:** works of man or the combined works of nature and man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view.
Exceptional	The item is a demonstrably rare, outstanding and / or an irreplaceable example of its type. It has a high degree of intact and original fabric that is readily interpreted. Loss or alteration would substantively undermine the Commonwealth heritage values of the place overall.	The precinct/group demonstrates collective characteristics that are rare or unique in Australia Precinct/group is intact and readily interpreted Loss, alteration or removal of component elements would substantially undermine the CH values of the place overall	The site represents significant social, cultural, natural and/or mythological values that may not be embodied in any physical item but which demonstrate unique, iconic markers in Australia's past or ongoing dynamic histories and / or processes.
High	The item demonstrates a rare example of its type Is largely intact and interpretable Loss or unsympathetic alteration may diminish the Commonwealth Heritage values of the item and of the place overall	The precinct/group demonstrates a rare example of collective characteristics or features physically linking or defining the space Precinct/group is largely intact and interpretable Loss, unsympathetic alteration or removal of component elements or defining qualities may detract from the CH values of the precinct/group and of the site overall	The site represents important social, cultural, natural and/or mythological values that may not be embodied in any physical item but which demonstrate rare points in Australia's past or ongoing dynamic histories and / or processes.
Moderate	The item may have altered or modified elements Item is intact enough to be partially interpretable as a single item or as part of the site in its entirety Loss or unsympathetic alteration is likely to diminish the	Precinct/group demonstrates valuable (although modified) collective characteristics and linking/defining spatial qualities Precinct/group intact enough to be interpreted as a discrete space or as part of the site overall Loss, unsympathetic alteration or	The site represents social, cultural, natural and/or mythological values that may not be embodied in any physical item but which demonstrate points in Australia's past or ongoing dynamic histories and / or

	Commonwealth Heritage values of the item and potentially the place if inappropriately managed	removal of component elements or defining qualities may detract from the CH values of the precinct/group and potentially of the site overall if inappropriately managed	processes.
Low	The item may be largely altered Does not demonstrate the key defining qualities of the CH values, but may be contributory Alteration and / or modification may make it difficult to interpret the item depending on the existing integrity of the item Loss may not diminish the Commonwealth Heritage values of the place overall.	Precinct/group demonstrates some (but possibly largely altered) collective characteristics and/or linking/defining spatial qualities Precinct/group not easily interpreted and represents unclear spatial definition in relation to the rest of the site Loss, alteration or removal of component elements may not detract from the CH values of the place overall	The site represents some social, cultural, natural and/or mythological values that may not be embodied in any physical item but which demonstrate points in the site's history, associative values and/or historical themes.
None (Does not meet CHL criteria)	Item does not reflect or demonstrate any Commonwealth heritage values	Precinct/group does not reflect or demonstrate any CH values	The site represents no social, cultural, natural or methodological themes or values
Intrusive	Potentially detracts from the overall Commonwealth heritage values of the place as an intrusive element. Loss may actually contribute to the Commonwealth Heritage values of the place. The item is an intrusive element in the heritage values of the place in its entirety	Precinct/group potentially detracts from the interpretation and understanding of the site overall Loss, alteration or removal of component elements actually contribute to the CH values of the place overall	N/A

Table 2 Summary of Significance Ranking for Natural Heritage Values

Significance Ranking	Justification – Natural
Universal (only to be used for World Heritage Sites)	**Natural features** consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view; **Geological and physiographical formations** and precisely delineated areas which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation; **Natural sites** or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty.
Exceptional	The species, area or ecosystem demonstrates individual or collective characteristics that are rare or unique in Australia Species, area or ecosystem is in high level of health, condition and integrity Loss, alteration or removal of component elements would substantially undermine the CH values of the place overall
High	The species, area or ecosystem demonstrates a rare example of individual or collective characteristics or features physically linking or defining space Species, area or ecosystem is largely intact and in good state of health Loss, damage or removal of components or defining qualities may detract from the CH values of the area or ecosystem and of the site overall
Moderate	Area or ecosystem demonstrates valuable (although modified) qualities Intact enough to be interpreted as a discrete space or as part of the site overall with ability to be regenerated Loss, damage or removal of component elements or defining qualities may detract from the CH values of the area or ecosystem and potentially of the site overall if inappropriately managed
Low	Species, area or ecosystem demonstrates some (but possibly largely altered) defining qualities Area or ecosystem not in a good state of health and regeneration in doubt Loss, alteration or removal of component elements may not detract from the CH values of the place overall
None (Does not meet CHL criteria)	Species, area or ecosystem does not reflect or demonstrate any CH values
Intrusive	Loss, alteration or removal of component elements actually contribute to the CH values of the place overall

Annex B

Natural Heritage Comparative Analysis

B.1 INTRODUCTION

This annex presents a comparative analysis of natural heritage values of the Site, focussing on three criteria of particular importance (note that wording here is from the ACT criteria):

- (b) The place has significant heritage value because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history.
- (c) The place has significant heritage value because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history.
- (g) The place has significant heritage value because of the place's strong or special association with a particular community or cultural group for social, cultural, or spiritual reasons.

Assessment of natural heritage values is conducted at both the scales of the Commonwealth and the ACT, however the detailed analysis provided here relies heavily on the guidance of the ACT Heritage Assessment Policy (ACT Government 2015). The ACT Heritage Assessment Policy provides highly detailed explanations of the eligibility criteria, and is explicit in its guidance of what should meet the eligibility criteria for each criterion. The ACT and Commonwealth heritage listing criteria are both derived from the HERCON (Heritage Convention) criteria, a standard set of heritage significance criteria agreed to by all Australian jurisdictions, and therefore analysis between the two contexts is very similar.

B.2 CRITERION (B) – HAS UNCOMMON, RARE OR ENDANGERED ASPECTS OF THE ACT'S CULTURAL OR NATURAL HISTORY (ACT GOVERNMENT 2015; P15)

B.2.1 Explanatory Note

The relevant part of the ACT Heritage Policy 'explanatory notes' (ACT Government 2015; p15) regarding this criterion states that it applies to, "*places which provide a significant habitat for qualifying native species (i.e. rare, threatened, uncommon, at limits of range etc.) or places which are important in the life cycle of a qualifying native species not normally resident in the ACT*" (ACT Government 2015; p15).

B.2.2 *Relative Importance Against Explanatory Note*

The discussions below focus on the potential for the Site to 'provide a significant habitat' for GSM and NTG. The second part of the explanatory note above does not apply, as both the GSM and NTG are resident within the Site.

The analysis was undertaken relying on the following sources of information:

- The Act Lowland Native Grassland Strategy (Act Government 2005);
- GSM Information Sheet (Environment ACT 2006a); and
- NTG Information Sheet (Environment ACT 2006b).

Golden Sun Moth

Environment ACT (2006a) states that the extensive populations of this species are present at Majura Training Area, Canberra International Airport and the Belconnen Naval Station. Other populations, although less extensive, are present at 'Woden' in the Jerrabomberra Valley, Mulanggari Grassland Reserve (Gungahlin) and Crace Grassland Reserve (Gungahlin). York Park is listed amongst a number of other 'smaller sites'. The stated threats to the species include that relevant to York Park which is the loss of habitat due to urban development. A number of conservation actions are identified, the most relevant of which being to "*seek protection of key habitat known to support viable populations of the species*" (Environment ACT 2006a; p2).

Large, intact and protected areas of known GSM populations or key habitat in the ACT include Crace Nature Reserve (136ha in area), Dunlop Nature Reserve (82ha in area) and Mulangarri Nature Reserve (69ha in area) (Act Government 2005; Environment ACT 2006a).

Section 3.5 of the *ACT Lowland Native Grassland Strategy* (the 'Grassland Strategy') (ACT Government 2005) assesses the conservation value of ACT's native grasslands and provides a categorisation of sites based on their ecological value. The three categories into which native grasslands are categorised in descending ecological value are:

- Category 1: Core Conservation Sites
- Category 2: Complementary Conservation Sites
- Category 3: Landscape and Urban Sites

York Park is categorised into Category 2. Category 2 generally includes those sites exhibiting a greater level of disturbance than the Category 1 'core' sites or those that do not contain key threatened species habitat. Category 2 sites may contain threatened species habitat that is not key habitat (defined as being of medium-long term viability (>50 years)) (ACT Government 2005; p56), however may complement core conservation grassland by providing habitat and/or a buffer (ACT Government 2005; p58). Category 2 sites are further categorised into four sub-categories:

- rural sites;
- near-urban sites;
- sites with threatened species, but not containing key habitat for those species;
- isolated urban sites [of reasonable botanical significance].

York Park is listed in the third sub-category: 'sites with threatened species, but not containing key habitat for those species'.

Section 3.4.6 of the Grassland Strategy discusses the key characteristics of the ACT grassland sites. Of importance to understanding the relative ecological value of York Park is fragmentation of the grassland remnants. The Grassland Strategy states that grasslands remaining in central Canberra (such as York Park) have occurred by chance due to the setting aside of area for "*public institutions and government offices... in the Central National Area of Canberra*" (ACT Government 2005; p55). Those remaining have a highly fragmented distribution (ACT Government 2005; p55). Some, such as York Park, "*exist in an extensive matrix of developed land uses with no possibility of restoring connectivity*" (ACT Government 2005; p55). York Park is an isolated remnant within a highly modified urbanised landscape.

Due to its isolation, York Park is likely in Category 2 because of the GSM presence, rather than providing a buffer that complements areas of higher conservation significance. The categorisation of York Park in the Grassland Strategy can therefore be understood to be based solely on the presence of the GSM. The Grassland Strategy identifies that the GSM presence at York Park is not key habitat and is therefore, by definition, not likely to be viable over a timeframe of >50 years. Due to surrounding land uses and urban development, the opportunity to increase the presence of favourable habitat to the species (identified as of major conservation significance to this species) is not possible beyond modest increases (in the order of 0.1-0.2ha).

York Park is grouped geographically in the Grassland Strategy in the 'Central Canberra and Tuggeranong' sites, and is one area measuring 0.4ha of the 12 remnants totalling 37ha in area. The Grassland Strategy concedes that, "*Restoring ecological connectivity between [grassland] remnants is impossible*" (ACT Government 2005; p68). Of these 12 remnants, seven contain the GSM (including York Park) and York Park is the smallest.

The analysis concludes that York Park is not <u>significant habitat for qualifying native species</u> (the GSM) because it:

- does not contain key habitat i.e. does not contain a viable GSM population in the medium-long term; and
- is isolated with no possibility of restoring connectivity (therefore can't provide complementary conservation purposes).

Natural Temperate Grassland

Large, intact and protected areas of known NTG in the ACT include >400ha of NTG in the Gungahlin Grassland Reserves (Crace Nature Reserve, Mulangarri Nature Reserve and Gungaderra Nature Reserve) and Dunlop Nature Reserve (ACT Government 2005; Environment ACT 2006b). The Grassland Strategy states that in the ACT there are 47 native grassland sites, of which there are 11 sites greater than 100ha in size (ACT Government 2005; p55). Eight of those 11 sites contain NTG in moderate to good condition and are greater than 50ha in size (ACT Government 2005; p55). There are 808ha of NTG in the ACT (equalling 81% of that remaining) that are categorised in the Grassland Strategy as 'Core Conservation Sites' (Category 1) (ACT Government 2005; p59).

Most of the discussion included above in the GSM section regarding the Grassland Strategy categorisation of the York Park grassland as Category 2: 'Complementary Conservation Sites' is relevant not only to the GSM but also to the NTG as they are treated in the Grassland Strategy complementarily. The Grassland Strategy identifies that York Park is of low long-term viability and is isolated with no chance of restoring connectivity (ACT Government 2005; p55-6). As an urban grassland site in the 'Central Canberra and Tuggeranong' group, it is one area measuring 0.4ha of the 12 grassland remnants totalling 37ha in area (of which, all twelve grassland remnants contain NTG which measure 35.8ha in total). Previous grassland monitoring using a relative metric measure of botanical diversity have ranked the Botanical Significance of York Park as 'low' (i.e. a score of 4 on a scale of 1-5 where 1 is highly significant and 5 is of low significance) (Umwelt 2014).

The analysis concludes that York Park is not significant habitat for qualifying native species (NTG) because it:

- does not contain key habitat;
- the botanical significance is relatively low (Umwelt 2014); and
- is isolated with no possibility of restoring connectivity (therefore can't provide complementary conservation purposes).

B.2.3 Relative Importance against Inclusion Guidelines

Table B.1 presents the relevant inclusion guidelines under this criterion (ACT Government 2015; p15) and a statement against each.

B.2.4 Conclusion for Criterion (B)

The discussion presented above, and in *Table B.1* identifies that neither the GSM population nor NTG area at the York Park Site are of sufficient importance to qualify for inclusion under criterion (b).

Table B.1 Criterion (b) Inclusion Guidelines

Inclusion Guideline[1,2]	Clarifying Information[1]	Statement for GSM	Statement for NTG
It is the only and/or the only extant example within the ACT with integrity or authenticity	-	No; discussion above identifies other populations of the GSM in the ACT.	No; discussion above identifies other large areas of NTG in the ACT.
Few examples *of its kind* exist because the original population of examples has decreased due to destruction	-	No; discussion identifies that the York Park population is not viable in the medium-long term and is isolated. Other, more substantial populations (in size) and with greater long term viability exist in the ACT.	No; discussion identifies that the York Park does not contain key habitat, its botanical significance is relatively low and it is isolated. Other, more substantial NTG (in size) and with greater quality exist in the ACT.
It has a mix or composition of features which is rare or uncommon in ACT	Rarity and uncommonness is judged in context of similar places in ACT. Rarity and uncommonness in one location compared with abundance in another location may not be automatically eligible. A rare, uncommon or endangered place must have sufficient integrity to be able to demonstrate those qualities. 'Endangered' is not as the ecological sense, but defined as that the place/object has become so rare over time that there is a risk in the short to medium term that no such item will remain.	No; GSM is uncommon/rare, however discussion above identifies that York Park is not a significant example and that better examples of larger populations exist in other parts of ACT. Also, that it is one of seven urban populations in the ACT is not enough to meet this criteria because the relative abundance elsewhere must be considered and despite being an endangered species, some large, extensive and well-protected populations occur in other parts of ACT outside the Central Canberra region. The integrity is not high (the discussion above identifies that the GSM population has low viability). Considering larger, well-protected populations in reserves, the loss of York Park population will not likely lead to a loss of the GSM.	No; NTG is uncommon/rare, however discussion above identifies that York Park is not a significant example and that better examples of larger NTG remnants exist in other parts of ACT. Also, that it is an urban occurrence of NTG in the ACT is not enough to meet this criteria because the relative abundance elsewhere must be considered and despite being an endangered ecological community, some large, extensive and well-protected areas occur in other parts of ACT outside the Central Canberra region. The integrity is not high. Considering larger, well-protected NTG communities in reserves, the loss of the York Park NTG would not likely lead to a loss of the NTG.

1. Taken from ACT Government (2015; p15).

2. Only relevant inclusion guidelines have been discussed here.

B.3 CRITERION (C) – POTENTIAL TO YIELD INFORMATION THAT WILL CONTRIBUTE TO AN UNDERSTANDING OF THE ACT'S CULTURAL OR NATURAL HISTORY (ACT GOVERNMENT 2015; P18)

B.3.1 *Explanatory Note*

The relevant part of the ACT Heritage Policy 'explanatory notes' (ACT Government 2015; p18) regarding this criterion states that it applies to, "*places and objects that have the potential to provide substantial information that will contribute to our knowledge and understanding of significant aspects of the natural… history of the ACT*". The explanatory notes state further that the criterion applies not to sites where a significant body of information has already been gathered, but that the site must contain the potential to yield further information and that any site is relatively more important if it is the only known source of information (ACT Government 2015; p18). The 'inclusion guidelines' state that,

> "*The place or object must itself be important to the understanding and not simply replicate or confirm evidence provided by other similar places… Every Aboriginal and historic site and every natural area has the possibility of contributing some evidence, but not all have the potential to yield important or substantial information.*" (ACT Government 2015; p18)

B.3.2 *Relative Importance against Explanatory Note*

The eligibility of York Park's GSM and NTG features are analysed for this criterion considering the identified relative importance of the features in the context of the ACT. Umwelt (2014) identify that the Site has been subject to a large amount of ecological studies, particularly for the GSM population including studies focussed on population dynamics and genetic studies for more than 20 years (Umwelt 2014; p6). There is no doubt that the GSM and NTG of York Park have yielded significant scientific information in the past as is described in Umwelt (2014) the Site has been subject to studies for more than 20 years. It is not likely that these various studies have occurred in York Park because it is the only or best available occurrence of these features, but perhaps due to convenience being located in the National Capital District of Canberra. It is not asserted that the Site has no further potential to yield information regarding GSM or NTG, however, according to the explanatory notes for this criterion, a site must essentially provide information that can't be gained from other areas or examples of its type to be eligible for listing under this criterion.

Table B.2 and *Table B.3* demonstrate that there are GSM and NTG sites present in conservation reserves and areas managed for conservation purposes, as well as a number present in areas of other land use.

There are 474ha of Core Conservation Sites (Category 1 sites) on Territory Land that are protected in four publicly accessible reserves in the ACT (ACT Government 2005; p57). There are a further five Category 1 sites, totalling 479ha, that are on National Land that are managed under Memoranda of Understanding (ACT Government 2005; p57). These Category 1 sites are significantly larger than York Park and contain GSM populations and NTG communities that are likely to better represent areas and populations less impacted by development, and are therefore likely to contain more potential to yield important or substantial information regarding these natural heritage values.

Table B.2 Known Populations of GSM and Land Use

Site[1]	Conservation Category[1,2]	Land Use[1,2]
Majura Valley		
Majura Valley East (Airport)	1	Airport
'Malcolm Vale'	2	Rural Lease
Campbell Park	1	Defence
Majura West	1	Rural Lease
Jerrabomberra Valley		
Harman-Bonshaw South	1	Defence, Rural Lease
Gungahlin Valley		
Gungaderra Nature Reserve	1	Reserve
North Mitchell	2	Vacant
Belconnen		
Dunlop Nature Reserve	1	Reserve
Lake Ginninderra	2	UOS
Central Canberra and Tuggeranong		
CSIRO Headquarters	2	CSIRO
Constitution Avenue, Reid	2	UOS
St John's Church, Reid	2	Urban Lease
ACCC, Barton	1	Urban Lease
York Park, Barton	2	UOS
Dudley Street, Yarralumla	2	UOS
Black Street, Yarralumla	2	UOS

1. Based on Tables 3.2, 3.4-3.8: Native Grassland in the ACT: List of Sites Grouped by Geographic Location (pp48-49).

2.

UOS = Urban Open Space which means, "generally Public Land under The Territory Plan" (ACT Government 2005; p52).

Category 1 sites that are on Territory Land and are designated as 'Reserve' are protected by reservation under the Land (Planning and Environment) Act 1991 (ACT Government 2005; p57).

Category 2 sites that are 'Urban Open Space' on Territory Land are managed by the relevant ACT Government Agency. For those sites that are on National Land, the ACT Grassland Strategy recommends management and protection via Memoranda of Understanding with Commonwealth Government agencies are appropriate (ACT Government 2005; p58). In the case of York Park, it is currently maintained by the National Capital Authority which carries out weed control and other management activities under an MOU with Environment ACT (ACT Government 2005; p70).

Table B.3 Known Areas of NTG and Land Use

Site[1]	Conservation Category[1,2]	Land Use[1,2]	Area (ha)
Majura Valley			
Majura Valley East (Majura Training Area)	1	Defence	113.7
Majura Valley East (Air Services Beacon)	1	Airport Services	10.7
Majura Valley East (Airport)	1	Airport	73.6
Campbell Park	1	Defence	10.9
Jerrabomberra Valley			
'Mugga Mugga'	2	Reserve	15.0
'Callum Brae'	1	Rural lease/ Reserve	162.7
'Woden Station'	1	Reserve	115.2
Woods Lane	2	Roadside	10.3
'Woden Station' east	1	Reserve	62.2
Harman-Bonshaw North	1	Defence, Rural Lease	46.3
AMTECH, Fyshwick	2	Vacant	18.0
Tennant St, Fyshwick	2	Agisted	0.3
Gungahlin Valley			
Mulangarri Nature Reserve	1	Reserve	58.6
Gungaderra Nature Reserve	1	Reserve	41.9
Grace Hill [Crace] Nature Reserve	1	Reserve	61.6
North Mitchell	2	Vacant	14.8
Mitchell	2	Rural (agisted)	1.6
Belconnen Pony Club	2	Rural	0.3
Wells Station Road	3	Roadside	0.2
Belconnen			
Ginninderra Experimental Station	2	Research	18.9
Dunlop Nature Reserve	1	Reserve	81.9
'Jarramlee'	2	Rural (agisted)	52.0
Umbagong Park	2	UOS	9.0
Evatt powerlines	2	UOS	1.1
Lake Ginninderra	2	UOS	1.9
Lawson (Territory)	3	Rural (agisted)	3.3
Kaleen east paddocks	3	Rural (agisted)	4.0
Caswell Drive	1	UOS	5.8
Glenloch Interchange	1	UOS	2.2
Central Canberra and Tuggeranong			
CSIRO Headquarters	2	CSIRO	3.0
Constitution Avenue, Reid	2	UOS	0.7
St John's Church, Reid	2	Urban Lease	0.9
ACCC, Barton	1	Urban Lease	1.9
York Park, Barton	2	UOS	0.4
Yarramundi Reach	2	UOS	21.2
Lady Denman Drive, Yarralumla	2	Roadside	0.4
Dudley Street, Yarralumla	2	UOS	1.5
Kintore Street, Yarralumla	2	Vacant	0.8
Novar Street, Yarralumla	3	UOS	0.2
Black Street, Yarralumla	2	UOS	3.6
Isabella Pond, Monash	1	UOS	1.2

1. Based on Tables 3.2, 3.4-3.8: Native Grassland in the ACT: List of Sites Grouped by Geographic Location (pp48-49).

2.

UOS = Urban Open Space which means, "generally Public Land under The Territory Plan" (p52).

Site[1]	Conservation Category[1,2]	Land Use[1,2]	Area (ha)
Category 1 sites that are on Territory Land and are designated as 'Reserve' are protected by reservation under the Land (Planning and Environment) Act 1991 (ACT Government 2005; p57).			
Category 1 sites that are on National Land are managed through Memoranda of Understanding between the ACT and Commonwealth Government agencies.			
Category 2 sites that are on Territory Land and designated as 'Reserve' allow activities "compatible with conservation of native grassland values, providing appropriate conservation management is in place" (ACT Government 2005; p58). The responsibility for managing the conservation values of these lands lies with the relevant ACT Government agency (ACT Government 2005; p58).			
Category 2 sites that are 'Urban Open Space' on Territory Land are managed by the relevant ACT Government Agency. For those sites that are on National Land, the ACT Grassland Strategy recommends management and protection via Memoranda of Understanding with Commonwealth Government agencies are appropriate (ACT Government 2005; p58). In the case of York Park, it is currently maintained by the National Capital Authority which carries out weed control and other management activities under an MOU with Environment ACT (ACT Government 2005; p70).			

The GSM flies ephemerally at seasonally opportune times during the summer and the time at which this occurs is important to researchers conducting studies and seasonal surveys of the GSM. The researchers will observe the flight of a known population (a 'reference site') at which time they will then know that they can conduct surveys at any other site subject to GSM study to determine their presence. The value of any known population as a 'reference site' is high, significantly higher if it is the only known reference site. In the case of York Park, ***Error! Reference source not found.*** demonstrates that there are a large number of known populations in publicly accessible reserves in the ACT. Furthermore, as identified in the Grassland Strategy (ACT Government 2005), the York Park population is not viable in the medium-long term and therefore its value as a reliable reference site will diminish over time as the GSM population declines. The value as a reference site is therefore not greater than any other area in which the GSM occurs.

As discussed under the explanation for Criterion (b), the York Park GSM and NTG do not demonstrate a higher ecological value than other examples or occurrences of these features. The potential to yield further scientific information (as required for this criterion) will likely diminish over time as the Grassland Strategy (ACT Government 2005) states that the ecological features are not viable in the medium-long term and that the Site is ecologically isolated with no potential to restore connectivity. The Grassland Strategy also categorises York Park as a Category 2 grassland, one that could complement conservation efforts for species or communities but does not represent core habitat itself. More important or significant information that could be gained about these features in the future would be more likely available from studying larger, long-term viable populations of core habitat in reserved areas.

B.3.3 Conclusion For Criterion (C)

The above discussion identifies that the GSM population and NTG area at the York Park Site do not contain the potential to yield sufficiently important or significant information to qualify for inclusion under criterion (c).

B.4 CRITERION (G) – HAS A STRONG OR SPECIAL ASSOCIATION WITH THE ACT COMMUNITY, OR A CULTURAL GROUP IN THE ACT FOR SOCIAL, CULTURAL OR SPIRITUAL REASONS (ACT GOVERNMENT 2015; P27)

B.4.1 Explanatory Note

The explanatory notes for this criterion (ACT Government 2015; pp27-8) states that "*An ordinary person should be able to easily recognise the association between the community or cultural group and the place or object*" and that "*Professional groups and special interest groups do not constitute the community or a cultural group*".

B.4.2 Relative Importance Against Explanatory Note

Umwelt (2014) states that York Park has been subject to a large amount of ecological studies, particularly for the GSM population including studies focussed on population dynamics and genetic studies for more than 20 years (Umwelt 2014; p6). There is a high likelihood that the Site holds social values to both the ecologists who have conducted surveys at the Site in the past, as well as those ACT ecologists currently involved with seasonal GSM surveys throughout the ACT.

B.4.3 Conclusion for Criterion (G)

This criterion is not met because an ordinary person would not be able to recognise the link between ecologists and the ecological values at the Site. Furthermore, ecologists would be considered professional or special interest groups which the explanatory note discounts from eligibility under this criterion.

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umwelt

Briefing Note

To: Matthew Priest, Department of Finance

cc: Antoinette Perry, Department of Finance; Ben Ripley, Deloitte Real Estate

From: Umwelt (Australia) Pty Limited

Author: Amanda Mulherin

Date: 24 August 2017

Subject: Impact Assessment to support an EPBC Act Referral for the proposed divestment of Blocks 3 and 15, Section 22, Barton ACT 2600

Purpose

Umwelt (Australia) Pty Limited (Umwelt) is currently preparing a Referral under section 9 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for the proposed divestment of Blocks 3 and 15, Section 22, Barton, Australian Capital Territory (ACT) 2600 (the Project Area).

This briefing note provides additional assessment information relating to matters of national environmental significance (MNES) protected under the EPBC Act that may occur within the Project Area; and to support the assessment on potential impacts to the 'whole of the environment'.

It is anticipated that this briefing note will be submitted with the EPBC Act Referral to further document the impact assessment process relevant to the proposed action.

Key messages

This assessment identifies two MNES as being likely to be impacted by the proposed action. These are the following:

- critically endangered ecological community: natural temperate grassland of the south eastern highlands (natural temperate grassland); and
- critically endangered species: golden sun moth (*Synemon plana*).

These matters will require further discussion and assessment as part of the EPBC Act Referral. All other MNES as identified by the 'protected matters search tool' (PMST) (DoEE 2017) were assessed as not likely to occur within the Project Area or unlikely to be impacted by the proposed action.

The proposed action is assessed as not likely to have a significant impact on the 'whole of the environment' if certain mitigation and management measures are implemented. These measures will target potential erosion, sedimentation, and air quality (i.e. dust) impacts.

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Attachments

1.0 Introduction

Umwelt (Australia) Pty Limited (Umwelt) is currently preparing a Referral under section 9 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) for the proposed divestment of Blocks 3 and 15, Section 22, Barton, Australian Capital Territory (ACT) 2600 (the Project Area). Block 3 is currently National Land, managed by the Department of Finance (Finance) and Block 15 is currently Territory Land, managed by the ACT Government. Accordingly, the proposed action will be undertaken by Finance with agreement from the ACT Government to include Block 15.

The proposed divestment of this land is expected to result in urban development that is consistent with the *National Capital Plan 1990* (as amended). This potential development is not part of the proposed action for the Referral, rather a consequential impact that must be considered in the context of this impact assessment.

Alternatively, if the transfer of Block 15 is not agreed to by the ACT Government, Finance will proceed to divest only Block 3, in a single, open market sale. In this instance, Finance may seek agreement from the ACT Government to allow Block 15 to be used to provide access to and maximise potential future development of Block 3.

To prepare the Project Area for sale, Finance proposes to clear all of the vegetation present and subsequently maintain the site. This will only occur on the Blocks ultimately included in the divestment. Regardless of the extent of clearing, it will occur between exchange and completion of contracts, prior to the finalisation of sale. Once the divestment of land has been formalised, any ongoing maintenance requirements (e.g. sedimentation or erosion controls) will be incorporated into the sale contract or Crown lease and be implemented by the purchaser. As the proponent for this proposed action, Finance will retain responsibility for ensuring that the purchaser implements all required maintenance measures through contractual means until development commences.

The Referral process requires an assessment of potential impacts of the proposed action on matters of national environmental significance (MNES) and to the 'whole of the environment' as defined by the EPBC Act.

This briefing note will be used to support the Referral by providing additional information regarding the following topics:

- Species and ecological communities that were identified by relevant database searches as potentially occurring within the Project Area, therefore potentially being impacted by the proposed action.

- Specific elements of the environment that require consideration as part of the assessment of potential impacts to the 'whole of the environment.

This additional information is provided with consideration of the Commonwealth's Significant Impact Guidelines 1.1 and 1.2 respectively (Department of the Environment 2013[1]; DSEWPaC 2013[2]).

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[1] Department of the Environment (2013) *Matters of National Environmental Significance Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999*, Commonwealth of Australia, Canberra, accessed online (March, 2017): https://www.environment.gov.au/system/files/resources/42f84df4-720b-4dcf-b262-48679a3aba58/files/nes-guidelines_1.pdf.

[2] Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2013) *Actions on, or Impacting Upon, Commonwealth Land, and Actions by Commonwealth Agencies Significant Impact Guidelines 1.2 Environment Protection and Biodiversity conservation Act 1999*, Commonwealth of Australia, Canberra, accessed online (March, 2017): http://www.environment.gov.au/system/files/resources/a0af2153-29dc-453c-8f04-3de35bca5264/files/commonwealth-guidelines_1.pdf.

2.0 Description of the Project Area and Surrounding Environment

The Project Area is currently vacant land, located on the corner of Sydney Avenue and National Circuit within the highly developed suburb of Barton in Canberra, ACT. Surrounding land uses include accommodation (hotels), office space, residential (apartments), and major roads.

A majority of the Project Area has been assessed as exotic vegetation, predominantly in the form of grassland. These areas are dominated by Phalaris (*Phalaris aquatica*), hoary mustard (*Hirschfeldia incana*), and wild oats (*Avena* spp.) with some scattered native wallaby grasses (*Rytidosperma laevis* and *R. bipartitum*) (Rowell 2007[3]). This exotic grassland extends into the higher quality south-east portion of the Project Area where it also includes cocksfoot (*Dactylis glomerata*), fescue species (*Festuca* spp.), and paspalum (*Paspalum dilatatum*) (Umwelt 2016[4]).

The south-east of the Project Area contains 0.32 hectares of natural temperate grassland of the south eastern highlands (natural temperate grassland) an EPBC Act critically endangered ecological community. This area is dominated by spear grass (*Austrostipa bigeniculata*), red-leg grass (*Bothriochloa macra*), various wallaby grasses (*Rytidosperma* spp.), and native forbs (including *Chrysocephalum apiculatum*, *Goodenia pinnatifida*, *Calocephalus citreus*, and *Tricoryne elatior*) (Umwelt 2016). This grassland type is broadly consistent with vegetation association 5: wallaby-grass – tall speargrass – common everlasting tussock grassland of South Eastern Highlands bioregion, as described in the natural temperate grassland approved Conservation Advice (including Listing Advice) (Threatened Species Scientific Committee 2016[5]).

A strip of planted kangaroo grass (*Themeda triandra*) occurs along the south-eastern border of the grassland. This native grass was planted following disturbance as a result of footpath upgrades. Despite being a native, it is considered invasive in this context as it is encroaching on the natural temperate grassland (Umwelt 2016). Exotic grass species: African love-grass (*Eragrostis curvula*) and Chilean needlegrass (*Nassella neesiana*) have previously been mapped between the footpath and road along National Circuit. These values have since been replaced by gravel; as confirmed by an Umwelt site inspection on 6 February 2017.

The north-west of Block 3 is also reported to contain fill from other, historic, off-site developments (Parsons Brinckerhoff 2008[6]). This area is considered highly disturbed and does not support any environmental values. Four exotic tree species also occur within the central portion of the Project Area; and a fence separates the highly disturbed, exotic north-west portion of Block 3 from the native dominated south-east.

The median strips of Sydney Avenue, to the south and south-east of the Project Area are also known to provide habitat for the critically endangered golden sun moth (*Synemon plana*). Given the size and location of these habitat patches, it is considered likely that they rely on the population of golden sun moth that occurs within the Project Area for ongoing viability. In 2009, when they were confirmed as habitat, these patches were considered low quality; however their current condition and vegetation composition is unknown.

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[3] Rowell, A. (2007) *Survey and Impact Assessment at Golden Sun Moth* *Synemon plana* *site, Blocks 3 and 7, Section 22 Barton (York Park)*, unpublished report prepared for Parsons Brinckerhoff, Canberra.

[4] Umwelt (2016) *Golden Sun Moth and Natural Temperate Grassland Vegetation Management Plan Block 3, Section 22, Barton ACT*, unpublished report prepared for the Department of Finance, Canberra.

[5] Threatened Species Scientific Committee (2016) *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (s266B) Approved Conservation Advice (including Listing Advice) for the Natural Temperate Grassland of the South Eastern Highlands (EC 152)*, access online (March, 2017): http://www.environment.gov.au/biodiversity/threatened/communities/pubs/152-conservation-advice.pdf.

[6] Parsons Brinckerhoff (2008) *Natural Temperate Grassland Maintenance Plan Block 3 Section 22 Barton, ACT*, unpublished report prepared for the Department of Finance and Deregulation, Canberra.

3.0 Matters of National Environmental Significance

The EPBC Act identifies nine MNES that must be considered when assessing the likely significance of impacts that are the result of a proposed action. These are the following:

- world heritage properties;
- national heritage places;
- wetland of international importance (i.e. Ramsar wetlands);
- listed threatened species and ecological communities;
- migratory species;
- Commonwealth marine areas;
- the Great Barrier Reef Marine Park;
- nuclear actions (including uranium mines); and
- a water resource, in relation to coal seam gas development and large coal mining development.

The proposed action does not occur within Commonwealth marine areas or the Great Barrier Reef; or involve nuclear actions (including uranium mining), coal seam gas development, or large coal mining development. As such, these MNES are not assessed further in this briefing note.

The 'protected matters search tool' (PMST) (DoEE 2017[7]) was used to identify MNES that may occur within ten kilometres of the Project Area. The following **Sections 3.1** to **3.5** discuss the results of this search and the full report is provided as **Attachment 1**.

3.1 World Heritage Properties

No World Heritage Properties were identified by the PMST as being within ten kilometres of the Project Area.

The proposed action will not impact upon any World Heritage Properties.

3.2 National Heritage Places

Four National Heritage Places were identified by the PMST as being within ten kilometres of the Project Area. These are the following:

- Australian Academy of Science Building;
- Australian War Memorial and the Memorial Parade;
- High Court – National Gallery Precinct; and
- Old Parliament House and Curtilage.

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[7] Department of the Environment and Energy (DoEE) (2017) *EPBC Act Protected Matters Search Tool*, accessed online (23 February 2017): http://www.environment.gov.au/epbc/pmst/.

All of these buildings and relevant associated landscapes are considered sufficient distance from the Project Area that the proposed action will not impact them. The approvals process under the *National Capital Plan 1990*, will further ensure that any consequential development as a result of the proposed action will not impact upon National Heritage Places.

3.3 Wetlands of International Importance

The Project Area is within the catchment (Murray Darling Basin) of four wetlands of international importance (Ramsar Wetlands) as identified by the PMST. These are the following:

- Banrock Station wetland complex;
- Hattah-Kulkyne lakes;
- Riverland; and
- the Coorong, and Lakes Alexandrina and Albert wetland.

Due to their location at a substantial distance downstream from the Project Area (these wetlands are in Victoria and South Australia) there is unlikely to be any measurable impact to these wetlands as a result of the proposed action.

3.4 Listed Threatened Species and Ecological Communities

Two threatened ecological communities and 32 threatened species were identified by the PMST as being within ten kilometres of the Project Area. These are listed in **Tables 1** and **2** respectively, which also describe the likelihood that each matter occurs within or surrounding the Project Area. Justification for these values is provided below.

Table 1 Listed Threatened Ecological Communities identified by the PMST

Community	Status	Likelihood of Occurrence
Natural Temperate Grassland of the South Eastern Highlands	critically endangered	known
White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland	critically endangered	unlikely

Table 2 Listed Threatened Species identified by the PMST

Species (Scientific name)	Status	Likelihood of Occurrence
BIRD SPECIES		
regent honeyeater (*Anthochaera phrygia*)	critically endangered	nil
curlew sandpiper (*Calidris ferruginea*)	critically endangered	nil
painted honeyeater (*Grantiella picta*)	vulnerable	nil
swift parrot (*Lathamus discolor*)	critically endangered	unlikely
bar-tailed godwit (*Limosa lapponica baueri*)	vulnerable	nil
northern Siberian bar-tailed godwit (*Limosa lapponica menzbieri*)	critically endangered	nil

Species (Scientific name)	Status	Likelihood of Occurrence
eastern curlew (*Numenius madagascariensis*)	critically endangered	nil
superb parrot (*Polytelis swainsonii*)	vulnerable	unlikely
Australian painted snipe (*Rostratula australis*)	endangered	nil
FISH SPECIES		
Murray cod (*Maccullochella peelii*)	vulnerable	known in nearby Lake Burly Griffin
Macquarie perch (*Macquaria australasica*)	endangered	known in nearby Lake Burly Griffin
***FROG* SPECIES**		
green and golden bell frog (*Litoria aurea*)	vulnerable	nil
yellow-spotted tree frog (*Litoria castanea*)	endangered	nil
INSECT SPECIES		
golden sun moth (*Synemon plana*)	critically endangered	known
MAMMAL SPECIES		
spotted-tail quoll (*Dasyurus maculatus maculatus*) (south-east mainland population)	endangered	unlikely
greater glider (*Petauroides volans*)	vulnerable	nil
koala (*Phascolarctos cinereus*) (combined populations of Queensland, New South Wales, and the ACT)	vulnerable	unlikely
grey-headed flying-fox (*Pteropus poliocephalus*)	vulnerable	flyover only
PLANT SPECIES		
Canberra spider orchid (*Caladenia actensis*)	critically endangered	low
black gum (*Eucalyptus aggregata*)	vulnerable	nil
Ginninderra peppercress (*Lepidium ginninderrense*)	vulnerable	unlikely
basalt peppercress (*Lepidium hyssopifolium*)	endangered	unlikely
hoary sunray (*Leucochrysum albicans* var. *tricolor*)	endangered	nil
Omeo stork's-bill (*Pelargonium* sp. *Striatellum* (G. W. Carr 10345))	endangered	nil
Tarengo leek orchid (*Prasophyllum petilum*)*	endangered	unlikely
a leek-orchid (*Prasophyllum* sp. Wybong (C. Phelps ORG 5269))*	critically endangered	unlikely
button wrinklewort (*Rutidosis leptorrhynchoides*)	endangered	unlikely
small purple-pea (*Swainsona recta*)	endangered	unlikely
Austral toadflax (*Thesium australe*)	vulnerable	unlikely
REPTILE SPECIES		
pink-tailed worm-lizard (*Aprasia parapulchella*)	vulnerable	nil
striped legless lizard (*Delma impar*)	vulnerable	unlikely
grassland earless dragon (*Tympanocryptis pinguicolla*)	vulnerable	unlikely

Threatened ecological communities and species with a likelihood of occurrence of nil, unlikely, or low in **Tables 1** and **2** above are assessed as such due to the following:

- The elevation and surrounding landscape context; which makes it unlikely that 'white box – yellow box – Blakely's red gum grassy woodland and derived native grassland' occurs within the Project Area (Umwelt 2016). Historically, this community would have occurred as a mosaic throughout the area alongside natural temperate grassland (Parsons Brinckerhoff 2008).

- A lack of forest, woodland, or wetland habitat present within the Project Area. This is relevant for all threatened bird and frog species identified, in addition to greater glider and grey-headed flying fox. Grey-headed flying-fox are known to flyover Barton as they move from their roosting site at Commonwealth Park, Canberra City, to foraging habitats throughout the broader Canberra region. The tree species present would not provide feed for this species.

- Individuals of spotted-tail quoll and koala may be recorded throughout the urban areas of Canberra as they move through the landscape. There is no habitat for either species present within or in close proximity to the Project Area, therefore, they are not expected to utilise the blocks if they happen to be in the vicinity.

- Suitable habitat for flora species assessed as 'nil likelihood of occurrence' in **Table 2** does not occur within the Project Area as they are all associated with woodland habitats.

- Flora species assessed as having an 'unlikely or low likelihood to occur' in **Table 2**, may occur in native grasslands as is present on the Project Area. However, there have been numerous surveys and ecological monitoring events conducted at the blocks since the early 1990s and none of these species has ever been identified (Umwelt 2016).

- The lack of rocky habitat typically associated with this species, pink-tailed worm-lizard is not considered to occur.

- It is likely that striped legless lizard and grassland earless dragon historically occurred within the Project Area. Given the intensity of the surrounding development and disturbance and lack of any records of the species presence, it is considered unlikely that they continue to occupy a small and isolated patch.

Based on the above assessment, a majority (n=29) of threatened species and one threatened ecological community identified by the PMST are considered to not occur, or are unlikely to occur or utilise the habitats present within the Project Area. The following species are known to occur within the Project Area or nearby Lake Burly Griffin:

- natural temperate grassland;

- golden sun moth;

- Murray cod; and

- Macquarie perch.

Indirect impacts of the proposed action are not expected to impact Lake Burly Griffin, therefore Murray cod and Macquarie perch are not considered likely to be significantly impacted.

Natural temperate grassland is known to co-occur with golden sun moth habitat across 0.32 hectares within the Project Area. This constitutes the entire patch of natural temperate grassland in the surrounding landscape.

The Approved Conservation Advice (Threatened Species Scientific Committee 2016) identifies all remaining patches of natural temperate grassland as critical to the survival of the ecological community. The proposed action will therefore not only impact an entire patch, thereby reducing the extent of the threatened ecological community, it will also impact an area critical to the survival of the ecological community. As such, it is considered likely to be a significant impact, in accordance with the MNES Significant Impact Guidelines 1.1 (Department of the Environment 2013).

The golden sun moth habitat (0.32 hectares) that occurs within the Project Area will be directly impacted by the proposed action. The species is also known to occupy two of the Sydney Avenue median strips, directly to the south and south-east of the Project Area (ACT Government 2015). These areas have not been surveyed in detail since 2009, when they were confirmed as occupied (i.e. individual moths were emerging from these sites, as opposed to flying over from the habitat within the Project Area), low quality habitat. Since this time, anecdotal evidence suggests that significant disturbance has occurred in these areas, particularly at the south-eastern verge, as a result of construction activities; which included gravel fill for vehicle parking and material dumping. Similarly, the southern verge appears to have been affected by weed incursion, which may have affected habitat quality and extent (W. Osborne and A. Rowell, 2017 pers. comms. 10 May). As such, the current extent and quality of these habitat areas is unknown.

Regardless of the extent and condition of the Sydney Avenue median strips, given their proximity to the Project Area, it is considered likely that all three areas function as one population. As such, the direct impact to the 0.32 hectares of golden sun moth habitat at the Project Area is expected to also result in an indirect impact to the Sydney Avenue median strips. Thus, the maximum total impact area as a result of the proposed action is considered to be 0.72 hectares; and is expected to result in the total loss of the population.

The impacted habitat is considered to be small and fragmented, therefore, any impact that results in the loss or degradation of habitat is considered significant (DEWHA 2009[8]). As the proposed action is expected to result in the loss of the entire population present and will directly impact 0.32 hectares of habitat and indirectly impact a further 0.4 hectares; it is considered likely to result in a significant impact to the species.

The proposed action is considered likely to result in a significant impact under the EPBC Act to the critically endangered golden sun moth and natural temperate grassland ecological community. It will therefore require appropriate compensation (i.e. offsetting) in accordance with the Commonwealth's Offsetting Policy (DSEWPaC 2012[9]).

3.5 Migratory Species

The PMST identified 14 migratory species as being within ten kilometres of the Project Area. These are listed in **Table 3**.

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[8] Department of the Environment, Water, Heritage and the Arts (DEWHA) (2009) *Significant Impact Guidelines for the Critically Endangered Golden Sun Moth (Synemon plana): Nationally threatened species and ecological communities EPBC Act Policy Statement 3.12*, accessed online (May, 2017): http://www.environment.gov.au/system/files/resources/b945f32e-3f75-4739-a793-9f672893f3bb/files/golden-sun-moth.pdf.

[9] Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2012) *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy*, Commonwealth of Australia, Canberra. Accessed online (March, 2017): http://www.environment.gov.au/system/files/resources/12630bb4-2c10-4c8e-815f-2d7862bf87e7/files/offsets-policy_2.pdf.

Table 3 Migratory Species identified by the PMST

Species (Scientific Name)	Status	Likelihood of Occurrence
fork-tailed swift (*Apus pacificus*)	migratory marine bird	flyover only
white-throated needletail (*Hirundapus caudacutus*)	migratory terrestrial bird	flyover only
black-faced monarch (*Monarcha melanopsis*)	migratory terrestrial bird	nil
yellow wagtail (*Motacilla flava*)	migratory terrestrial bird	nil
satin flycatcher (*Myiagra cyanoleuca*)	migratory terrestrial bird	nil
rufous fantail (*Rhipidura rufifrons*)	migratory terrestrial bird	nil
common sandpiper (*Actitis hypoleucos*)	migratory wetland bird	nil
sharp-tailed sandpiper (*Calidris acuminata*)	migratory wetland bird	nil
curlew sandpiper (*Calidris ferruginea*)	migratory wetland bird	nil
pectoral sandpiper (*Calidris melanotos*)	migratory wetland bird	nil
Latham's snipe (*Gallinago hardwickii*)	migratory wetland bird	nil
bar-tailed godwit (*Limosa lapponica*)	migratory wetland bird	nil
eastern curlew (*Numenius madagascariensis*)	migratory wetland bird	nil
osprey (*Pandion haliaetus*)	migratory wetland bird	nil

Due to a lack of wetland, rainforest, forest, or woodland habitats and a general lack of connectivity throughout the landscape; none of the identified migratory species are considered likely to occur within the Project Area, beyond possible fly-overs for the two species identified in **Table 3**.

Therefore, none of these species are expected to be impacted by the proposed action.

4.0 Whole of the Environment

As a Commonwealth Agency, Finance must consider the potential impacts of any action it proposes to undertake on the 'whole of the environment'.

Section 528 of the EPBC Act states that the environment includes the following:

(a) ecosystems and their constituent parts, including people and communities; and

(b) natural and physical resources; and

(c) the qualities and characteristics of locations, places and areas; and

(d) heritage values of places; and

(e) the social, economic and cultural aspects of a thing mentioned in paragraph (a), (b), (c) or (d).

The Significant Impact Guidelines 1.2 (DSEWPaC 2013) identifies criteria to adequately describe the environmental context of the proposed action and subsequently assess the significance of potential impacts to the environment, given the definition above.

The following **Table 4** sets out these criteria and describes any likely potential impacts of the proposed action.

Table 4 Whole of the Environment EPBC Act Assessment

Aspect of the Environment *Is there a real chance or possibility that the action will:*	**Response**
Landscapes and Soils	
substantially alter natural landscape features?	Given the urban context of and history of disturbance at the Project Area it is considered unlikely to substantially alter natural landscape features.
cause subsidence, instability, or substantial erosion?	The clearing of vegetation in preparation for sale, may result in localised erosion if not appropriately mitigated. Finance will mitigate and manage the impacts of this erosion in accordance with current best practice. The implementation of mitigation and management measures, combined with the localised and small scale of the clearing; result in an impact that is unlikely to be considered substantial.
involve medium- or large- scale excavation of soil or minerals?	The proposed action will not involve the medium- or large-scale excavation of soil or minerals.
Coastal Landscapes and Processes	
alter coastal processes, including wave action, sediment movement or accretion, or water circulation patterns?	Due to the inland location and urban setting of the proposed action, it is not expected to impact upon coastal processes.
permanently alter tidal patterns, water flows, or water quality in estuaries?	Due to the inland location and urban setting of the proposed action, it is not expected to impact upon estuaries.
reduce biological diversity or change species composition in estuaries?	Due to the inland location and urban setting of the proposed action, it is not expected to impact upon estuaries.
extract large volumes of sand or substantially destabilise sand dunes?	The proposed action does not include the extraction of large volumes of sand. Due to the inland location and urban setting of the proposed action, it is not expected to impact upon sand dunes.
Ocean Forms, Ocean Process, and Ocean Life	
reduce biological diversity or change species composition on reefs, seamounts, or in other sensitive marine environments?	Due to the inland location and urban setting of the proposed action, it is not expected to impact upon the biological diversity or species composition of marine environments.
alter water circulation patterns by modification of existing landforms or the addition of artificial reefs or other large structures?	Due to the inland location and urban setting of the proposed action, it is not expected to impact upon water circulation patterns of marine environments.
substantially damage or modify large areas of the seafloor or ocean habitat, such as sea grass?	Due to the inland location and urban setting of the proposed action, it is not expected to impact upon ocean forms, processes, or life.
release oil, fuel, or other toxic substances into the marine environment in sufficient quantity to kill larger marine animals or alter ecosystem processes?	Due to the inland location and urban setting of the proposed action, it is not expected to impact upon ocean forms, processes, or life; including through the release oil, fuel, or other toxic substances.
release large quantities of sewage or other waste into the marine environment?	Due to the inland location, scale, and urban setting of the proposed action, it is not expected to release large quantities of sewage or other waste into the marine environment.

Aspect of the Environment *Is there a real chance or possibility that the action will:*	Response
Water Resources	
measurably reduce the quantity, quality, or availability of surface or ground water?	The clearing of vegetation in preparation for sale, may result in localised erosion if not appropriately mitigated. If not managed correctly, erosion may result in sedimentation and pollution of surface water run-off, affecting the water quality of Lake Burly Griffin. Finance will mitigate and manage the impacts of this erosion in accordance with current best practice. The potential consequential urban development will increase surface water run-off and decrease water quality. However, given the surrounding urban context of the proposed action, this is considered unlikely to result in a measurable effect to water quality. With the implementation of erosion and sedimentation controls following clearing of the vegetation on site, the proposed action is considered unlikely to measurably reduce the quantity, quality, or availability of surface or ground water.
channelise, divert, or impound rivers or creeks; or substantially alter drainage patterns?	The proposed action will not channelise, divert, or impound rivers or creeks. Given the highly altered hydrology of the surrounding landscape, the localised change in surface water drainage across the Project Area is not considered substantial.
measurably alter water table levels?	Due to the relatively small scale of the action and the highly altered hydrology of the surrounding landscape; it is not likely to measurably alter water table levels.
Pollutants, Chemicals, and Toxic Substances	
generate smoke, fumes, chemicals, nutrients, or other pollutants that will substantially reduce local air quality or water quality?	The clearing of vegetation in preparation for sale, may result in dust generation if not appropriately mitigated and managed, resulting in localised air quality impacts. In addition, if sedimentation and erosion are also not managed appropriately following vegetation clearing, these may result in decreased water quality. Finance will mitigate and manage the impacts of this erosion and dust generation in accordance with current best practice. Following the divestment of land, these management strategies will be implemented by the purchaser, as directed by Finance through contractual means. Potential increases in surface water run-off and associated decreases in water quality are considered unlikely to result in a substantial effect, given the urban context of the proposed action. If dust, erosion and sedimentation controls are appropriately implemented following clearing of the vegetation on site, the proposed action is considered unlikely to substantially reduce local air or water quality.
result in the release, leakage, spillage, or explosion of flammable, explosive, toxic, radioactive, carcinogenic, or mutagenic substances through use, storage, transport, or disposal?	The proposed action does not include activities associated with the use, storage, transport, or disposal of flammable, explosive, toxic, radioactive, carcinogenic, or mutagenic substances. It is therefore not going to result in the release, leakage, spillage, or explosion of such substances.

Aspect of the Environment *Is there a real chance or possibility that the action will:*	**Response**
increase atmospheric concentrations of gasses that will contribute to the greenhouse effect or ozone damage?	As the vegetation clearance (including the removal of four trees) associated with the proposed action is considered small-scale; it is considered unlikely to contribute to the greenhouse effect or ozone damage.
substantially disturb contaminated or acid-sulphate soils?	There are no known acid-sulphate soils or contamination present within the Project Area. The proposed action is unlikely to substantially disturb contaminated or acid-sulphate soils.
Plants	
involve medium- or large-scale native vegetation clearance?	The proposed action will result in the removal of 0.32 hectares of native vegetation. This is not considered to be medium- or large- scale clearing.
involve any clearance of any vegetation containing a listed threatened species that is likely to result in a long-term decline in a population or threatens the viability of the species?	There are no known threatened flora species present within the Project Area. The proposed action is therefore considered unlikely to result in a long-term decline in a population or threaten the viability of a threatened flora species.
introduce potentially invasive species?	Any potentially invasive species that may be introduced by the proposed action, namely as a result of ongoing maintenance activities following vegetation clearing, are likely to be already present given the urban context of the surrounding land. The proposed action is considered unlikely to introduce potentially invasive species.
involve the use of chemicals that substantially stunt the growth of native vegetation?	The proposed action does not involve the use of chemicals that substantially stunts the growth of native vegetation.
involve large-scale controlled burning or any controlled burning in sensitive areas, including areas that contain listed threatened species?	The proposed action does not include any burning activities.
Animals	
cause a long-term decrease in or threaten the viability of a native animal population or populations through death, injury, or other harm to individuals?	The removal of a maximum of 0.72 hectares of golden sun moth habitat at the Project Area will impact the entire local population of this species. It will not increase fragmentation of this critically endangered species. However, genetic analysis of the golden sun moth populations in the ACT, including the Project Area, has identified at least five distinct regional (i.e. meta) populations; comprised of smaller, generally isolated local populations (Clarke and O'Dwyer, 1998[10]). Whilst the local population at the Project Area is currently isolated, this genetic analysis demonstrated that genetic (i.e. population) viability can be maintained by focusing

[10] Clarke, G. M. and O'Dwyer, C. (1998) *Genetic Analysis of Populations of the Endangered Golden Sun Moth, (Synemon plana)*, unpublished report for the Threatened Species Unit (NSW National Parks and Wildlife Service, Southern Zone) and the Wildlife Research and Monitoring Unit (Environment ACT), CSIRO Division of Entomology, Canberra.

Aspect of the Environment *Is there a real chance or possibility that the action will:*	**Response**
reduce or fragment available habitat for listed threatened species that is likely to displace a population, result in a long-term decline in a population, or threaten the viability of the species?	conservation efforts on these meta-populations rather than small isolated areas. The regional population that the local Project Area population is a part of, includes larger and more viable populations in Majura Valley East, Mulanggari Grassland Reserve, and Jerrabomberra Reserve. These populations are considered very well protected and much more important for the viability of the meta-population than the local population at the Project Area. As such, the proposed action is not considered to cause a long-term decrease in or threaten the viability of a native animal population. Nor is it going to reduce or fragment available habitat for listed threatened species resulting in a long-term decline in a population or threaten the viability of the species.
displace or substantially limit the movement or dispersal of native animal populations?	The impacted population of golden sun moth is currently isolated from all other populations due to its urban setting. The proposed action is not going to affect the connectivity of any other golden sun moth habitat.
substantially reduce or fragment available habitat for native species?	The habitat values of the Project Area are highly disturbed and generally degraded, with the exception of the 0.32 hectares of natural temperate grassland in the south-east. This habitat is currently isolated from other grassland areas that would provide habitat for native species. The proposed action is unlikely to result in a substantial reduction or fragmentation of available habitat for native species.
introduce exotic species that will substantially reduce habitat or resources for native species?	Any exotic species that are associated with urban development (e.g. cats (*Felis catus*), foxes (*Vulpes vulpes*), rabbits (*Oryctolagus cuniculus*) are likely already present within the surrounding area. The proposed action, including any consequential urban development, is not considered likely to introduce exotic species that will substantially reduce habitat or resources for native species.
undertake any large-scale controlled burning or any controlled burning in sensitive areas containing listed threatened species?	The proposed action does not include any burning activities.
People and Communities	
substantially increase demand for or reduce the availability of community services or infrastructure that have direct or indirect impacts on the environment, including water supply, power supply, roads, waste disposal, and housing?	The proposed action will not substantially increase demand for or reduce the availability of community services or infrastructure. Furthermore, consequential development of the proposed action will be of sufficiently small scale such that it is also not expected to substantially increase demand for or reduce the availability of community services.

Aspect of the Environment *Is there a real chance or possibility that the action will:*	**Response**
affect the health, safety, welfare, or quality of life of the members of a community through factors such as noise, odours, fumes, smoke, or other pollutants?	Potential impacts to the health, safety, welfare, or quality of life of members of the local community as a result of factors such as noise, odours, fumes, smoke, or other pollutants following vegetation clearing will be managed by Finance in accordance with current best practice. In particular, dust generation, erosion, and sedimentation will be targeted. The proposed action will also be undertaken in accordance with all relevant work health and safety standards, and noise restrictions to protect the welfare of the local community. Any residual impacts as a result of vegetation clearing are to be temporary and localised. Potential impacts to the local community as a result of the consequential urban development will be assessed as part of the National Capital Authority approvals process. The development would be in accordance with the provisions of the *National Capital Plan 1990* therefore would unlikely be substantially different to the surrounding land uses. With the application of these mitigation and management measures and by conforming to the requirements of the *National Capital Plan 1990*; the proposed action is not considered likely to affect the health, safety, welfare, or quality of life of the members of the community.
cause physical dislocation of individuals or communities?	The proposed action is not going to cause physical dislocation of individuals or communities as the land is currently vacant.
substantially change or diminish cultural identity, social organisation, or community resources?	The Project Area is not associated with social organisation or community resources. The Project Area has played a small role in the promotion of conservation efforts for golden sun moth in the local community, and with the increase in scientific knowledge associated with the species. However, this has very limited links to cultural identity; restricted to those who have worked in the grassland or live nearby. Both of these groups of people have been identified as key stakeholders and will be given an opportunity to comment on the proposed action as part of the EPBC Referral or National Capital Authority approvals process. As such, the proposed action is not considered likely to substantially change or diminish cultural identify, social organisation, or community resources.
Heritage	
permanently destroy, remove, or substantially alter the fabric (physical material, including structural elements and other components, fixtures, contents, and objects) of a heritage place?	There are no known heritage values present within the Project Area. The proposed action is unlikely to permanently destroy, remove, or substantially alter the fabric of a heritage place.
involve extension, renovation, or substantial alteration of a heritage place in a manner that is inconsistent with the heritage values of the place?	The proposed action does not involve the extension, renovation or substantial alteration of a heritage place.

Aspect of the Environment *Is there a real chance or possibility that the action will:*	**Response**
involve the erection of buildings or other structures adjacent to or within important sight lines of a heritage place that are inconsistent with the heritage values of the place?	There are no known heritage values directly adjacent to the Project Area. The sight lines of known heritage items that occur within the vicinity, do not overlap with the Project Area and are, therefore, unlikely to be impacted by the proposed action.
substantially diminish the heritage value of a heritage place for a community or group for which it is significant?	There are no known heritage values present within the Project Area and any associated development would be consistent with surrounding land use. Therefore, the proposed action is unlikely to substantially diminish the heritage value of a heritage place.
substantially alter the setting of a heritage place in a manner that is inconsistent with the heritage values of the place?	There are no known heritage values present within the Project Area and any associated development would be consistent with surrounding land use. Therefore, the proposed action is unlikely to substantially alter the setting of a heritage place.
substantially restrict or inhibit the existing use of a heritage place as a cultural or ceremonial site?	The proposed action will have no impact on the existing uses of nearby heritage places.

Potential impacts to the 'whole of the environment' as a result of the proposed action are linked to possible erosion, sedimentation, air pollution from dust, and water quality degradation following vegetation removal; and community impacts if the consequential development is not considerate of the surrounding land uses and users. To mitigate and manage these potential impacts, the following will occur:

- Any future urban development will be subject to approval from the National Capital Authority. At this stage, consideration of land-use and impacts to the community will occur. This will be the responsibility of the future purchaser of the Project Area.
- Following the clearing of vegetation and up to the finalisation of the divestment of land, Finance will be responsible for maintaining the Project Area such that erosion, sedimentation, and dust are controlled so they do not result in indirect impacts to the surrounding areas.
- It will be a condition of sale that the purchaser continues to maintain the Project Area such that erosion, sedimentation, and dust are controlled so they do not result in indirect impacts to the surrounding areas until the time construction is completed.

Given the application of these mitigation and management measures and that the proposed action is occurring on a relatively small scale (1.25 hectares) it is considered unlikely that the proposed action will result in a significant impact.

5.0 Conclusion

The proposed action is considered likely to result in a significant impact to the following MNES as the entire patch of habitat is to be directly impacted:

- natural temperate grassland; and
- golden sun moth.

All other MNES are considered unlikely to occur within the Project Area or likely to be affected by indirect impacts, therefore, unlikely to be impacted by the proposed action.

Given the application of these mitigation measures and that the proposed action is occurring on a relatively small scale (1.25 hectares) it is considered unlikely that the proposed action will result in a significant impact to the 'whole of the environment'.

Attachment 1 – Protected Matters Search Tool Report

Australian Government
Department of the Environment and Energy

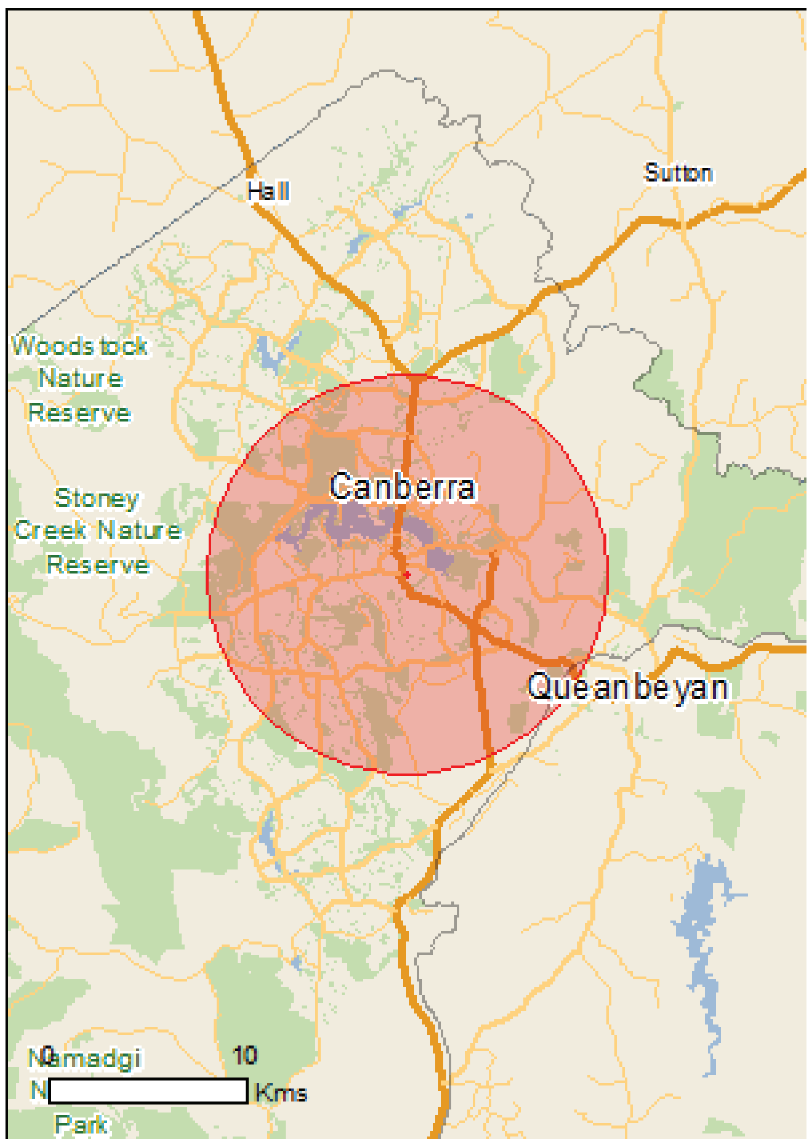
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

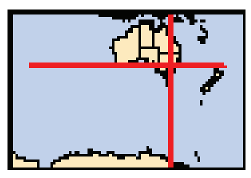
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 05/06/17 13:53:57



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	4
Wetlands of International Importance:	4
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	2
Listed Threatened Species:	32
Listed Migratory Species:	14

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	28
Commonwealth Heritage Places:	76
Listed Marine Species:	20
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	1
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	22
Regional Forest Agreements:	1
Invasive Species:	35
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

National Heritage Properties [Resource Information]

Name	State	Status
Historic		
Australian Academy of Science Building	ACT	Listed place
Australian War Memorial and the Memorial Parade	ACT	Listed place
High Court - National Gallery Precinct	ACT	Listed place
Old Parliament House and Curtilage	ACT	Listed place

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Banrock station wetland complex	800 - 900km upstream
Hattah-kulkyne lakes	600 - 700km upstream
Riverland	700 - 800km upstream
The coorong, and lakes alexandrina and albert wetland	800 - 900km upstream

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Natural Temperate Grassland of the South Eastern Highlands	Critically Endangered	Community likely to occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Polytelis swainsonii		
Superb Parrot [738]	Vulnerable	Species or species habitat known to occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Fish		
Maccullochella peelii		
Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
Macquaria australasica		
Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area
Frogs		
Litoria aurea		
Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat may occur within area
Litoria castanea		
Yellow-spotted Tree Frog, Yellow-spotted Bell Frog [1848]	Endangered	Species or species habitat may occur within area
Insects		
Synemon plana		
Golden Sun Moth [25234]	Critically Endangered	Species or species habitat known to occur within area
Mammals		
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Petauroides volans		
Greater Glider [254]	Vulnerable	Species or species habitat may occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area
Plants		
Caladenia actensis		
Canberra Spider Orchid [76138]	Critically Endangered	Species or species habitat known to occur within area
Eucalyptus aggregata		
Black Gum [20890]	Vulnerable	Species or species habitat likely to occur within area
Lepidium ginninderrense		
Ginninderra Peppercress [78474]	Vulnerable	Species or species habitat likely to occur within area
Lepidium hyssopifolium		
Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat may occur within area
Leucochrysum albicans var. tricolor		
Hoary Sunray, Grassland Paper-daisy [56204]	Endangered	Species or species habitat known to occur within area
Pelargonium sp. Striatellum (G.W.Carr 10345)		
Omeo Stork's-bill [84065]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Prasophyllum petilum Tarengo Leek Orchid [55144]	Endangered	Species or species habitat may occur within area
Prasophyllum sp. Wybong (C.Phelps ORG 5269) a leek-orchid [81964]	Critically Endangered	Species or species habitat may occur within area
Rutidosis leptorrhynchoides Button Wrinklewort [7384]	Endangered	Species or species habitat likely to occur within area
Swainsona recta Small Purple-pea, Mountain Swainson-pea, Small Purple Pea [7580]	Endangered	Species or species habitat likely to occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Aprasia parapulchella Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat known to occur within area
Delma impar Striped Legless Lizard [1649]	Vulnerable	Species or species habitat known to occur within area
Tympanocryptis pinguicolla Grassland Earless Dragon [66727]	Endangered	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land - Australian Postal Corporation
Commonwealth Land - Defence Housing Authority
Defence - 10 WHYALLA ST - FYSHWICK
Defence - 139 CANBERRA AVE - FYSHWICK
Defence - 169 GLADSTONE ST - FYSHWICK
Defence - ADC / JSSC - WESTON
Defence - ADFA MARINE FACILITY - YARRALUMLA
Defence - AIDAB Building
Defence - AUSTRALIAN DEFENCE FORCE ACADEMY
Defence - BELCONNEN RADIO STATION ; BELCONNEN COMMUNICATIONS STATION
Defence - CAMPBELL PARK
Defence - DEAKIN OFFICES
Defence - DEFENCE RECRUITING UNIT - GIO BUILDING
Defence - HEWLETT PACKARD BUILDING - FERNHILL PARK
Defence - HMAS HARMAN - SYMONSTOWN
Defence - MAJURA FIELD FIRING RANGE
Defence - MAJURA NAVIGATION BEACON
Defence - MAJURA NAVIGATIONAL AID SITE
Defence - MAWSON OFFICE ACCOMM
Defence - NAVAL COMBAT DATA SYSTEM CENTRE - FYSHWICK
Defence - NCC BUILDING - CANBERRA CITY
Defence - NORTHBOURNE HOUSE
Defence - NORTHCOTT DRIVE PLAYING FIELDS (Addison Rd)
Defence - PHYSICS FIELD TESTING STATION - CANBERRA
Defence - RAAF BASE FAIRBAIRN
Defence - ROYAL MILITARY COLLEGE - DUNTROON
Defence - RUSSELL HILL COMPLEX
Defence - WERRIWA DEPOT

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Majura Valley Natural Temperate Grassland	ACT	Listed place
State Circle Cutting	ACT	Listed place
Indigenous		

Name	State	Status
Aboriginal Embassy Site	ACT	Within listed place
Historic		
Acton Conservation Area	ACT	Listed place
Acton Peninsula Building 1	ACT	Listed place
Acton Peninsula Building 15	ACT	Listed place
Acton Peninsula Building 2	ACT	Listed place
Acton Peninsula Limestone Outcrops	ACT	Listed place
Anzac Memorial Chapel of St Paul	ACT	Listed place
Apostolic Nunciature	ACT	Listed place
Apple Shed Asset C58	ACT	Listed place
Australian American Memorial and Sir Thomas Blamey Square	ACT	Listed place
Australian Forestry School (former)	ACT	Listed place
Australian National Botanic Gardens (part)	ACT	Listed place
Australian War Memorial	ACT	Listed place
Blowfly Insectary Numbers 1 and 2	ACT	Listed place
Blundells Farmhouse, Slab Outbuilding and Surrounds	ACT	Listed place
CSIRO Main Entomology Building	ACT	Listed place
Canberra School of Art	ACT	Listed place
Canberra School of Music	ACT	Listed place
Captains Quarters Assets B1 to B4	ACT	Listed place
Carillon	ACT	Listed place
Casey House and Garden	ACT	Listed place
Changi Chapel	ACT	Listed place
Commandants House Asset B9	ACT	Listed place
Commencement Column Monument	ACT	Listed place
Communications Centre	ACT	Listed place
Drill Hall Gallery	ACT	Listed place
Duntroon House and Garden	ACT	Listed place
East Block Government Offices	ACT	Listed place
Edmund Barton Offices	ACT	Listed place
General Bridges Grave	ACT	Listed place
Gungahlin Complex	ACT	Listed place
Gungahlin Homestead and Landscape	ACT	Listed place
High Court - National Gallery Precinct	ACT	Listed place
High Court of Australia	ACT	Listed place
Institute of Anatomy (former)	ACT	Listed place
John Gorton Building	ACT	Listed place
King George V Memorial	ACT	Listed place
Lennox House Complex	ACT	Listed place
National Gallery of Australia	ACT	Listed place
National Library of Australia and Surrounds	ACT	Listed place
National Rose Gardens	ACT	Listed place
Old Parliament House Gardens	ACT	Listed place
Old Parliament House and Curtilage	ACT	Listed place
Parade Ground and Associated Buildings Group	ACT	Listed place
Parliament House Vista	ACT	Listed place
Parliament House Vista Extension - Portal Buildings	ACT	Listed place
Patent Office (former)	ACT	Listed place
Phytotron	ACT	Listed place
R G Menzies Building ANU	ACT	Listed place
RMC Duntroon Conservation Area	ACT	Listed place
Redwood Plantation	ACT	Listed place
Reserve Bank of Australia	ACT	Listed place
Residence Asset B5	ACT	Listed place
Residence Asset B7	ACT	Listed place
Residence Asset C12	ACT	Listed place
Residence Asset C13	ACT	Listed place
Residence Asset C14	ACT	Listed place
Residence Asset C15	ACT	Listed place
Residence Asset C7	ACT	Listed place
Residence Asset C8	ACT	Listed place
Russell Precinct Heritage Area	ACT	Listed place
Sculpture Garden National Gallery of Australia	ACT	Listed place
The CSIRO Forestry Precinct	ACT	Listed place
The Lodge	ACT	Listed place
The Royal Australian Mint	ACT	Listed place

Name	State	Status
The Surveyors Hut	ACT	Listed place
Three Wartime Bomb Dump Buildings	ACT	Listed place
Toad Hall ANU	ACT	Listed place
University House and Garden	ACT	Listed place
West Block and the Dugout	ACT	Listed place
Westridge House & Grounds	ACT	Listed place
Yarralumla and Surrounds	ACT	Listed place
York Park North Tree Plantation	ACT	Listed place
Russell Cafeteria	ACT	Within listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area

Commonwealth ReservesTerrestrial [Resource Information]

Name	State	Type
Australian National	ACT	Botanic Gardens

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Aranda Bushland	ACT
Black Mountain	ACT
Bruce Ridge	ACT
Callum Brae	ACT
Crace	ACT
Farrer Ridge	ACT
Gossan Hill	ACT
Isaacs Ridge	ACT
Jerrabomberra Wetlands	ACT
Mt Ainslie	ACT
Mt Majura	ACT
Mt Mugga Mugga	ACT
Mt Painter	ACT
Mt Pleasant	ACT
Mt Taylor	ACT
O'Connor Ridge	ACT
Oakey Hill	ACT
Queanbeyan	NSW
Red Hill	ACT
Unnamed	ACT
Wanniassa Hills	ACT
West Jerrabomberra	ACT

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
Southern RFA	New South Wales

Invasive Species	[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Carduelis chloris European Greenfinch [404]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Alternanthera philoxeroides Alligator Weed [11620]		Species or species habitat likely to occur within area
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Jerrabomberra Wetlands	ACT

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-35.311682 149.130869,-35.311008 149.13148,-35.311375 149.132135,-35.311209 149.132221,-35.311489 149.13266,-35.312303 149.131963,-35.311682 149.130869,-35.311682 149.130869

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-Office of Environment and Heritage, New South Wales
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-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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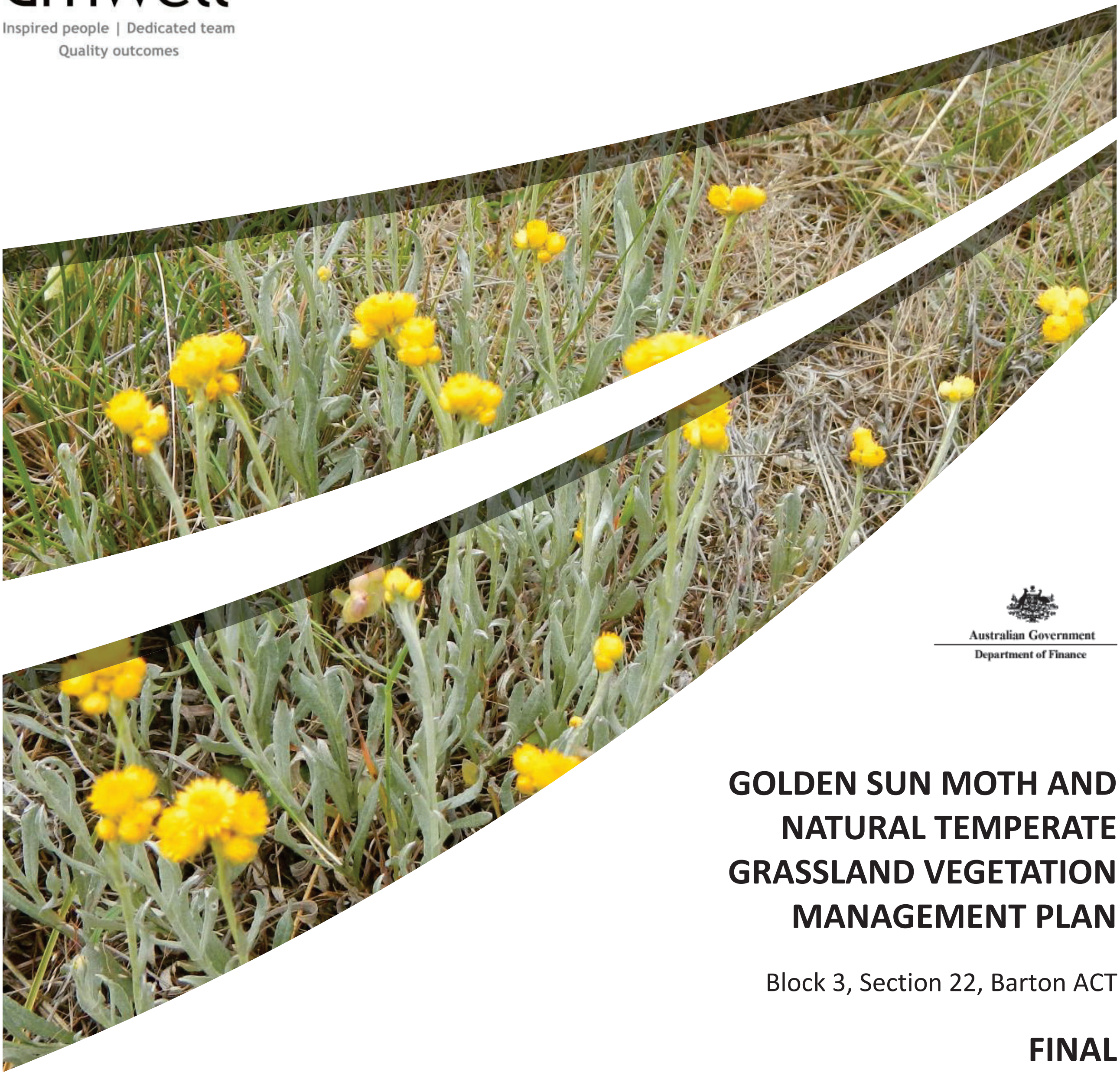

Australian Government
Department of Finance

GOLDEN SUN MOTH AND NATURAL TEMPERATE GRASSLAND VEGETATION MANAGEMENT PLAN

Block 3, Section 22, Barton ACT

FINAL

January 2016

Australian Government
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Block 3, Section 22, Barton ACT

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Department of Finance

Project Director:	Peter Cowper
Project Manager:	Rob Armstrong
Report No.	8018C/R01/V1
Date:	January 2016

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Executive Summary

Block 3 Section 22 Barton, also known as York Park, contains an area of natural temperate grassland and golden sun moth (*Synemon plana*) habitat. The patch, consisting of approximately 0.32 hectares occurs within a fragmented landscape and is highly susceptible to threats such as weed invasion and genetic isolation. As such, the area requires strategic on-going management in order to maintain or improve ecological values on the site, as well as bring awareness to effective management of small sites with conservation value.

This report presents an update of the maintenance plan completed for the site by Umwelt in 2014 (Umwelt, 2014), and includes contemporary assessment of the status and condition trends associated with the natural temperate grassland area and weed distribution. Additionally, it reports on golden sun moth population numbers, although population trends are not able to be predicted due to the highly ephemeral nature of larval hatchings across seasons.

This report concludes that the natural temperate grassland has changed somewhat since 2007 (based in the condition in 2007 surveys undertaken by Parsons Brinkerhoff (PB, 2008), with a decrease in bare ground and increase in vegetation density due to favourable climatic conditions for grass sward growth. Native flora diversity appears to be stable, although there has been a notable increase in some weed species including St. John's wort (*Hypericum perforatum*), cocksfoot (*Dactylis glomerata*) and ribbed plantain (*Plantago lanceolata*). Wallaby grasses (*Rytidosperma* spp.) important for golden sun moth larval fodder are presently at levels considered low for population maintenance (five per cent of proportional vegetation cover; with a monitoring threshold set at seven per cent). Planted kangaroo grass (*Themeda triandra*) along the eastern boundary has expanded slightly into the natural temperate grassland area.

Key recommendations to maintain the natural temperate grassland and golden sun moth population are as follows:

- undertake weed control as recommended in this report (refer to **Table 3.2**)
- as exotic grass distribution is reduced, reseed areas with native wallaby grasses
- contain kangaroo grass to a two metre strip on the eastern boundary, adjacent to National Circuit
- rake and remove slashed material (additional biomass) in areas where dense swards of native grass and exotic pastures are slashed
- undertake annual monitoring of grassland condition and golden sun moth populations
- if required, undertake additional mowing in wetter years when biomass accumulates
- remove exotic trees from the western boundary, including service tree (*Sorbus domestica*) seedlings.

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Appendices

1.0 Background

1.1 The Project

This Maintenance Plan has been prepared for the Department of Finance (Finance). The intent of this Maintenance Plan is to provide a framework for ongoing best-practice management of the ecological values associated with 'York Park' within part of Block 3 and Block 15 Section 22 Barton (ACT). The location of 'York Park', hereafter referred to as the Project Area, is shown in **Figure 1.1**.

In 2007, Parsons Brinckerhoff (PB) prepared a Master Plan for Block 3, which has been partially developed north-west of an area of Natural Temperate Grassland (NTG). The Master Plan identified an area of Block 3 for ongoing conservation of the NTG and associated golden sun moth (GSM, *Synemon plana*) population, with a Maintenance Plan prepared for this area in 2008 (PB, 2008[1]). The Maintenance Plan integrated with the Master Plan in providing a framework for maintenance of the Project Area. Vegetation on part of Block 15 has been removed for an access road under development approval EPBC 2012/6606 (Australian Government, 2013[2]).

In October 2013, Umwelt (Australia) Pty Limited (Umwelt) was engaged to undertake monitoring for GSM and NTG, and use the results from this survey and knowledge of contemporary monitoring techniques to update the original Maintenance Plan (Umwelt, 2014[3]). This report represented an update of the 2008 plan (refer to **Section 1.2**). Subsequently, Umwelt undertook a GSM and NTG monitoring event in late 2014 (Umwelt, 2015[4]). During these surveys, Umwelt confirmed 0.35 hectares of NTG within the Project Area, as well as a healthy GSM population.

In September 2015, Umwelt was engaged to provide an update to the 2013 Maintenance Plan (Umwelt, 2014) as well as complete a 2015 monitoring event for GSM and NTG.

GSM are listed as Critically Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and Endangered under the ACT *Nature Conservation Act 2014* (NC Act). 'Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory' is listed as an endangered ecological community under the EPBC Act 1999; 'Natural temperate Grassland' is listed as an endangered ecological community under the NC Act 2014. It is these values for which this Maintenance Plan intends to conserve.

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[1] PB (2008) Natural Temperate Grassland and Maintenance Plan, Block 3 Section 22 Barton, ACT. Parsons Brinckerhoff, Canberra.

[2] Australian Government (2013) Approval: hotel and carpark development, Block 14 Section 22, Barton, ACT – Stage 1 (EPBC 2012/6066). Approved October 4, 2013. [: http://www.environment .gov.au/epbc/notices/assessments/2012/6606/2012-6606-approval-decision.pdf, URL accessed 16/01/2014]

[3] Umwelt (2014) *Natural Temperate Grassland Maintenance Plan, Block 3, Section 22, Barton ACT.* Prepared by Umwelt Pty Ltd for the Department of Finance and Deregulation, March 2014.

[4] Umwelt (2015) *Natural Temperate Grassland Condition Assessment and Golden Sun Moth Monitoring Events, Block 3, Section 22, Barton ACT.* Prepared by Umwelt Pty Ltd for the Department of Finance, March 2015.

Figure 1.1

Location of Block 3, Section 22 Barton ACT

1.2 Acknowledgements

Umwelt acknowledges Parsons Brinckerhoff, and specifically sub-consultant Alison Rowell, for authorship of the original Maintenance Plan. The Umwelt (2014) Maintenance Plan adopted much of the original Plan and amended, updated and added new sections where appropriate.

The third version of the Maintenance Plan (this report) has been reviewed and updated by representatives from Department of Finance.

1.3 History of the Site

Nearby remnant woodland (Capital Hill, West Block) indicates that the Project Area was near an ecotone between woodland and grassland communities, as mapped in the 'ACT Lowland Native Grassland Conservation Strategy' (ACT Government, 2005[5]).

When the Federal Capital Territory was created in 1911, the area around the Project Area appears to have been open grazing land with few trees. In the 1920s, the Provisional Parliament House and some of the associated roads were built. A 1933 map shows that the Project Area was then part of a larger undeveloped area bounded by National Circuit, State Circle, Kings Avenue and Canberra Avenue (Marshall 2007[6]) (for an aerial photo taken circa 1940's refer to http://www.flickr.com/photos/archivesact/11074074125/sizes/l/in/photo stream/). At this time, the nearest building was the Methodist Church diagonally opposite. The Project Area would have maintained some connectivity to other grassland or native pasture until fairly recently, with surrounding blocks and roads being developed from the 1970s onwards.

The north-western part of Block 3 appears to have received fill during the construction of surrounding buildings, and is now dominated by exotic species.

[5] ACT Government (2005) A Vision Splendid of the Grassy Plains Extended: ACT Lowland Native Grassland Conservation Strategy. Action Plan No. 28 (Arts, Heritage and Environment, Canberra).

[6] Marshall, D., Boden, R., Mann, A., Rowell, A. & Fogarty, P. (2007) Heritage Management Plan for the York Park North Oak Plantation, Barton ACT. Prepared for the National Capital Authority, Canberra.

2.0 Environmental Values of the Site

2.1 Natural Temperate Grassland

The NTG endangered ecological community is typically found between 560 and 1200 metres above sea level in valleys and broad plains. The dominant cover is native tussock grasses, with forbs such as daisies, lilies and native legumes in the inter-tussock spaces. It is estimated that approximately 5 per cent of the original area of the community in the ACT survives in moderate to good condition (ESSS, 2000[7]), a figure which has most likely reduced further in recent years.

2.1.1 Site Values

The grassland on the Project Area has been given a Botanical Significance Rating of 4 (Low), and a Conservation Rating of 2 (Complementary Conservation Site). Botanical Significance Ratings are shown in **Table 2.1**. The Conservation Rating reflects that the Project Area has only a low to moderate Botanical Significance, but contains a population of a threatened species that is considered to be viable in the medium term (ACT Government, 2005).

Table 2.1 Botanical Significance Rating for Natural Temperate Grassland

Degree of Disturbance	Ground Layer Species	Examples of Characteristic Species	Typical Flora of the Ground Layer	BSR Rating
very low	disturbance sensitive species	*Diuris* spp., *Caladenia* spp., and *Thelymitra* spp.	Native species including orchids, lilies, and other highly sensitive species as well as more tolerant species.	1
low	moderately disturbance tolerant species	*Dichopogon* spp., *Bulbine bulbosa*, *Craspedia variabilis*, *Cryptandra amara*, *Themeda triandra*, *Pimelea* spp., and *Wurmbea dioica*.	Species present include those moderately tolerant of disturbance, as well as more tolerant species.	2
moderate	disturbance tolerant species	*Chrysocephalum apiculatum*, *Plantago varia*, *Convolvulus angustissimus*, *Asperula conferta*, *Glycine* spp., and *Hibbertia obtusifolia*.	Native species include those commonly found in a range of sites that have been subject to moderate disturbance; sensitive plants are rarely present.	3, 4

[7] ESSS (2000) Commonwealth Listing Advice on Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory. Advice to the Minister for the Environment and Heritage from the Endangered Species Scientific Subcommittee (ESSS) on a proposal to add an ecological community to Schedule 2 of the *Endangered Species Protection Act 1992*.

Degree of Disturbance	Ground Layer Species	Examples of Characteristic Species	Typical Flora of the Ground Layer	BSR Rating
high	disturbance tolerant native grasses	*Poa* spp., *Rytidosperma* spp., *Austrostipa* spp., *Bothriochloa macra*, and *Microlaena stipoides*.	Sites may contain a variety of native grass species but have few or no native forbs present.	5*
very high	exotic species	Perennial and annual weeds, introduced or adventitious species.	Either dominated by perennial exotic species or a low cover and diversity of native species, of which most are grasses.	E*

* Not considered natural temperate grassland.

Since 1992, the NTG on the Project Area has been part of a long-term grassland monitoring program being undertaken by the ACT Government and surveys commissioned by the Department of Finance, and the vegetation quality in the Project Area has been previously been assessed and mapped (Davis & Hogg, 1992[8]; ERM, 2005[9];' Rowell, 2007[10]; Rowell, 2012[11]; Umwelt, 2014; Umwelt, 2015; and numerous unpublished datasets from ACT Government). **Appendix 1** contains a summary of plant species recorded on the Project Area across numerous surveys between 1991 and 2015, with **Appendix 2** and **Appendix 3** showing cumulative quadrat and step-point transect survey data respectively. These data are not strictly comparable from year to year, having been collected by a variety of methods. However, the list shows trends such as the apparent loss of some native species and the recent arrival and persistence of some undesirable exotic species, most notably St John's wort (*Hypericum perforatum*).

The NTG area is dominated by tall speargrass (*Austrostipa bigeniculata*), red-leg grass (*Bothriochloa macra*), various wallaby grasses (*Rytidosperma* spp.) and forbs including *Chrysocephalum apiculatum*, *Goodenia pinnatifida*, *Calocephalus citreus* and *Tricoryne elatior*. This species assemblage is consistent with the plant community 'r5: *Rytidosperma* spp. – *Austrostipa bigeniculata* – *Chrysocephalum apiculatum* tussock grassland of the South Eastern Highlands bioregion' as described by Armstrong et al. (2013[12]). This grassland type is broadly distributed across the northern ACT, with other main occurrences from around Bungendore to north of Goulburn. Across its range, this community has been extensively cleared and remnants are subject to weed invasion, small-scale clearing, grazing pressures and nutrient run-on from adjacent management activities (Armstrong et al., 2013).

[8] Davis, M. S. & Hogg, D. McC. (1992) York Park, Barton. Botanical Survey. Report to the National Capital Planning Authority by David Hogg Pty. Ltd.

[9] ERM (2005) Strategic advice on the development potential of Block 3, Section 22: York Park, Barton. Report prepared for Department of Finance and Administration by Environmental Resources and Management, Australia.

[10] Rowell, A. M. (2007) Survey and impact assessment at Golden Sun Moth *Synemon plana* site, Blocks 3 and 7, Section 22 Barton (York Park). Report prepared for Parsons Brinckerhoff and Department of Finance.

[11] Rowell, A. (2012) Block 3, Section 22 Barton ACT: Five-year monitoring event for Golden Sun moth and condition Assessment of Natural Temperate Grassland. Report to Department of Finance and Deregulation by Alison Rowell, May 2012.

[12] Armstrong, R.C., Turner, K.D., McDougall, K.L., Rehwinkel, R. and Crooks, J.I. (2013) Plant communities of the upper Murrumbidgee catchment in New South Wales and the Australian Capital Territory. *Cunninghamia* **13**(1): 125-266.

2.2 Golden Sun Moth (*Synemon plana*)

2.2.1 Distribution

Prior to European settlement GSM were widespread in native grasslands in south-eastern Australia, from near Bathurst in New South Wales through the Australian Capital Territory and Victoria to Bordertown in South Australia (Edwards, 1993[13]; 1994[14]). This distribution was correlated with grasslands dominated by low-growing wallaby grasses (*Rytidosperma* spp.), and has contracted substantially over time (O'Dwyer & Attiwill, 1999[15]). GSM are now only found in a few relatively small breeding areas due to habitat loss, fragmentation and degradation. Possibly less than one percent of the original habitat now remains, much of it degraded by weed invasion (Clarke & O'Dwyer, 1997[16], O'Dwyer & Attiwill, 1999, ACT Government, 2005).

2.2.2 Description and Life History

GSM is a medium sized day-flying moth in the family Castniidae. The male has a wingspan of about 34 millimetres, the female slightly less. The upper forewings of both are grey/brown with paler patterns. The male has dark brown upper hindwings, and in the female these are bright yellow/orange edged with black spots (ACT Government, 1998[17]).

GSM larvae feed on the subterranean parts of wallaby grasses (Edwards, 1993; O'Dwyer & Attiwill 1999), and may sometimes feed on other native and introduced C3 grasses (Braby & Dunford, 2006[18]; Richter et al*.,* 2010[19]). Larval development time is unknown and may vary between one and three years.

The adults live for only one to four days after emerging during late spring to early summer, and do not feed as they have no functional mouth parts. In the middle of the day when conditions are sunny and warm, males patrol the grassland in search of the females, which have reduced hind-wings and are poor fliers. The starting date and duration of the flight season vary from year to year, probably depending on spring weather conditions, with the season starting earlier in a warm dry spring (Cook & Edwards, 1993[20]). The limited flight ability of the female moths adds to the species' vulnerability to extinction on small sites, and makes natural re-colonisation from other sites unlikely.

2.2.3 Site Values

Although small, the Project Area is rated as having a Moderate Conservation Value rating, because of the previous scientific work undertaken (ACT Government, 1998). Clarke & O'Dwyer (1998[21]) also

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13 Edwards, E. D. (1993) The Golden Sun Moth *Synemon plana* – an endangered species. ANIC News No. 2: 7-8.

14 Edwards, E. D. (1994) Survey of lowland grassland sites in ACT for the Golden Sun Moth *Synemon plana*. CSIRO Report to the Wildlife Research Unit, ACT Parks and Conservation Service, Canberra.

15 O'Dwyer, C. & Attiwill, P. M. (1999) A comparative study of habitats of the Golden Sun Moth *Synemon plana* Walker (Lepidoptera: Castniidae): implications for restoration*. Biol. Cons.* **89**: 131-141.

16 Clarke, G.M. and O'Dwyer, C. (1997) A survey of native grassland sites in south-eastern New South Wales for the endangered Golden Sun Moth, *Synemon plana*. A report prepared for the Threatened Species Unit, NSW National Parks and Wildlife Service, southern zone.

17 ACT Government (1998) Golden Sun Moth (*Synemon plana*): An endangered species. Action Plan No. 7. Environment ACT, Canberra.

18 Braby, M. F. & Dunford, M. (2006) Field observations on the ecology of the Golden Sun Moth, *Synemon plana* Walker (Lepidoptera: Castniidae). *Australian Entomologist* **33**, 103-110.

19 Richter A, Osborne W & Traugott M (2010) Dietary specialisation in the Golden Sun Moth *Synemon plana* – the key to understanding habitat requirements and site rehabilitation for this critically endangered species. Final report to Biodiversity and Programs Branch, Department of Sustainability and Environment (Victoria).

20 Cook, L. & Edwards, E. D. (1993) Population Monitoring of Endangered Moth *Synemon plana* 1992-93, York Park, Barton. CSIRO Australia. Report to the National Capital Planning Authority.

21 Clarke, G. M. & O'Dwyer, C. (1998) Genetic analysis of populations of the endangered Golden Sun Moth, *Synemon plana*. Report for Threatened Species Unit, NSW National Parks and Wildlife Service, Southern Zone, and the Wildlife Research and Monitoring Unit, Environment ACT. CSIRO Division of Entomology, Canberra.

considered that the Project Area warranted special attention due to its 'high profile and considerable research focus in past years'.

The previous studies include six mark-release-recapture surveys, producing estimates of population size (Cook & Edwards, 1993; Cook & Edwards, 1994; Edwards, 1994[22]; Harwood et al., 1995[23]; Rowell 2007; and Rowell, 2012), and genetic analysis of the population (Clarke & O'Dwyer, 1998). Provisional management recommendations were prepared for the Project Area (Frawley, 1995[24]; Edwards, 1995[25]), including rehabilitation of the vegetation by translocation of soil and grassland plants from a nearby area which was being developed (Davis & Hogg, 1992; Harwood et al., 1995). **Appendix 4** contains a summary of the GSM population studies to date.

2.2.4 Other Important Species

Active burrows of the uncommon Canberra raspy cricket (*Cooraboorama canberrae*) were observed in scattered locations across the site in 2007 (PB, 2008). Additionally, Anett Richter (formerly of University of Canberra) and Emma Cook (ACT Environment and Planning Directorate) observed this species during surveys in 2006 and 2007. No observations of active burrows have been made since; it is not known whether this species is absent or whether this is a function of increased biomass in post-drought conditions. This is a large wingless cricket, known only from relatively undisturbed grasslands in the lower parts of the Majura, Jerrabomberra and Molonglo valleys, and a small number of other locations in the ACT and nearby NSW (Queanbeyan-Bungendore). Much of its known habitat has been lost to housing in the ACT, and it is vulnerable to habitat fragmentation because it is flightless. It makes distinctive vertical burrows with a round cross-section, a clay and silk cap and a circle of bare soil around the entrance. Information about this cricket could be included in interpretative signage on the Project Area.

The grassland earless dragon (*Tympanocryptis pinguicolla*) is known to generally use the abandoned burrows of this species as shelter sites. This species is endangered under the EPBC Act 1999 and NC Act 2014. This species has not been recorded on site.

22 Cook, L. & Edwards, E. D. (1994) Population Monitoring of Endangered Moth *Synemon plana* 1993-94, York Park, Barton. CSIRO report to the National Capital Planning Authority.
23 Harwood, T., Narain, S. & Edwards, E. D. (1995) Population Monitoring of Endangered Moth *Synemon plana* 1994-95, York Park, Barton. CSIRO Australia. Report to the National Capital Planning Authority.
24 Frawley, K. (1995) Planning for urban native grassland conservation: York Park, Barton, ACT. *In* Management of relict lowland grasslands. Proceedings of a workshop and public seminar. September 24 and 25, 1993.
25 Edwards, E. D. (1995) Provisional Management Recommendations for York Park Moth Site. Report to the National Capital Planning Authority. CSIRO Division of Entomology, Canberra.

3.0 Maintenance Requirements

3.1 Weed Management

Weeds are recognised as one of the most significant threats to biodiversity in the ACT. They displace native species, reduce habitat quality, modify vegetation structure and alter ecological functions (TaMS, 2007[26]).

Figure 3.1 shows a vegetation map of the site, delineated into vegetation associations based on fine-scale on-site classification. Associations were determined based on dominant species, with areas considered to be exotic if they contain ≥50 per cent of exotic species cover/composition. The NTG corresponds with the best GSM habitat, and chemical weed control in this area should be undertaken with caution and sparingly, as the effect of herbicides on GSM are unknown. Areas containing Chilean needlegrass (*Nassella neesiana*) on the road verge may also contain GSM.

Several weeds of concern on the Project Area are perennial grasses. These include exotic grasses and forbs, as well as two native species which have been planted on the Project Area. These species, kangaroo grass (*Themeda triandra*) and poa tussock (*Poa labillardierei*), are not considered a useful food source for GSM larvae, and they should be prevented from spreading beyond the original areas of planting (refer to **Figure 3.1**). Despite this, it is worth noting that these species provide a useful service in their current location: the kangaroo grass reduces opportunities for weeds to establish from seeds washing off the path, and similarly, the poa tussock protects a low-lying patch which may also be susceptible to seed invasion.

The weedy area at the southern end of the Project Area results from attempted translocation of soil and native grasses from an area which was developed nearby. Historically, other weed patches have developed where trees have been removed from the Project Area, and where trees around the boundary shade the native grassland (PB, 2008), a pattern which continues to this day.

If weed management is to be undertaking during the GSM flying period, generally late October to late December, this should be completed preferably in the morning hours through careful spot-spraying. It is highly undesirable that any management practices be undertaken after 11:00 hours in order to reduce the risk of disturbing egg-laying females.

[26] TaMS (2007) Draft ACT Weeds Strategy, 2007-2017. July 2007. Department of Territory and Municipal Services, Canberra.

Figure 3.1

Current Vegetation Associations

3.1.1 Objectives

The objectives of weed management of individual species are summarised in **Table 3.1**. They include:

- Eradication: no plants of the target species remain on the Project Area.
- Suppression: reduce density of target species within the infested area and prevent infestation from spreading.
- Containment: define the boundary of the existing infestation of target species and prevent spread beyond that line.

3.1.2 Procedures

Table 3.2 summarises control methods and timing for weed species of concern. This table is indicative only, and timing can be varied to suit seasonal conditions or based on local experience of site managers. Triggers for weed management are discussed in **Section 4.1.1.1**.

The Project Area should be visited to treat weeds and assess the effectiveness of previous control in spring, summer and autumn. Attention should be paid to the plants listed **Table 3.1**.

- A record should be kept of methods, area/numbers and species of weeds treated.

3.1.2.1 Herbicide Use (spot-spray)

The following are key directions relating to the use of <u>non-residual</u> herbicides:

- operators/contractors should have significant prior experience (minimum of two years) in selective weed management in NTG, and demonstrated expertise in the identification and successful treatment of the key weed species
- the appropriate herbicide registered for use on particular species, the methods and rates of application, licensing requirements and other relevant aspects should be checked annually with ACT Territory and Municipal Services
- residual herbicides should <u>not</u> be used
- treatments should be timed to maximise results i.e. prior to seeds forming and during active growth phases
- risks to non-target species should be minimised by avoiding the spread of herbicides on footwear and equipment, using spray hoods and shields, spraying under appropriate weather (low wind) conditions etc
- woody weeds should be treated by the cut-and-paint method, and regrowth should be spot-sprayed. Roots should not be dug out in order to avoid unnecessary soil disturbance
- the effectiveness of all herbicide spraying should be monitored the following month, and follow-up spraying carried out if required.

3.1.2.2 Other Methods

Hand-pulling (the Bradley Method)

Small infestations of some weeds can be removed by hand-pulling after rain when the soil is soft, ensuring that all parts of the plant are removed. This method, also known as 'the Bradley method' (Bradley, 2002[27]) is suitable for smaller St John's wort (*Hypericum perforatum*) and Paterson's curse (*Echium plantagineum*) plants (i.e. not larger/mature ones) and can be carried out during site inspections or monitoring visits. Uprooted material should be bagged on site and removed to be disposed of appropriately.

Targeted Slashing

Wild oats (*Avena* spp.), cocksfoot (*Dactylis glomeratum*), tall fescue (*Festuca* spp.) and phalaris (*Phalaris aquatica*) can be slashed before the seed heads form. The plants often grow earlier and taller than surrounding native species, in response to soil moisture. In particular, the infestation of wild oats on the slight slope at the south end of the Project Area should be treated by high slashing (e.g. with a brush cutter/line trimmer) as required, and the slashed material removed. In particular, wild oats can have multiple flowering events per season is conditions are favourable, so this should be monitored in wetter spring periods.

If some Paterson's curse (*Echium plantagineum*) plants have begun to flower when spraying of rosettes is taking place, these flower stems also can be slashed and removed from the Project Area.

Removal of Mulch

The deciduous trees around the boundary cause dead leaf deposits to build up on parts of the Project Area at times. This is particularly prominent along the southern boundary. This mulch is likely to alter soil moisture, pH and nutrients in ways that will favour the growth of weeds, as well as smother or prevent recruitment of native grasses and forbs. The problem is most noticeable near the oak trees on National Circuit. The leaves should be removed annually, at the end of autumn, by careful raking.

Table 3.1 Main Plant Species Posing Threat to the Natural Temperate Grassland and/or Golden Sun Moth Habitat and Management Aims

Common Name	Species	WoNS[28]	Declared Pest Plant (ACT)[29]	Aim of Management
Exotic Grass Species				
wild oats	*Avena* spp.			suppression
cocksfoot	*Dactylis glomerata*			suppression
African lovegrass	*Eragrostis curvula*[1]		yes	eradicate
tall fescue	*Festuca* spp.			suppression

[27] Bradley, J. (2002) Bringing back the bush: the Bradley method of bush regeneration. Reed New Holland, Sydney.

[28] Weeds of National Significance. [http://www.weeds.org.au/WoNS/, URL Accessed 27/12/2013].

[29] Pest Plants and Animals (Pest Plants) Declaration 2009 (No 1) Disallowable instrument DI2009-67 made under the Pest Plants and Animals Act 2005, s7 (Declaration of pest plants) . [http://www.legislation.act.gov.au/di/2009-67/current/pdf/2009-67.pdf, URL Accessed 27/12/2013].

Common Name	Species	WoNS[28]	Declared Pest Plant (ACT)[29]	Aim of Management
Chilean needlegrass	*Nassella neesiana*[1]	yes	yes	eradication
serrated tussock	*Nassella trichotoma*	yes	yes	not present, requires vigilance
paspalum	*Paspalum dilatatum*			suppression
phalaris	*Phalaris aquatica*			eradication
Exotic Forb Species				
Paterson's curse	*Echium plantagineum*		yes	not present, requires vigilance
St. John's wort	*Hypericum perforatum*		yes	eradication
flatweed, cat's ear	*Hypochaeris radicata*			suppression
ribbed plantain	*Plantago lanceolata*[2]			suppression
Exotic Tree Species				
service tree	*Sorbus domestica*		yes	eradication
Native Species				
poa tussock	*Poa labillardierei*			containment
kangaroo grass	*Themeda triandra*			containment

[1] present in roadside verge on National Cct
[2] not to be confused with the native variable plantain (*Plantago varia*)

Table 3.2 Summary of Weed Control Methods and Timing

<table>
<tr><th rowspan="2">Species</th><th colspan="24">Month</th></tr>
<tr><th colspan="2">Jan</th><th colspan="2">Feb</th><th colspan="2">Mar</th><th colspan="2">Apr</th><th colspan="2">May</th><th colspan="2">Jun</th><th colspan="2">Jul</th><th colspan="2">Aug</th><th colspan="2">Sep</th><th colspan="2">Oct</th><th colspan="2">Nov</th><th colspan="2">Dec</th></tr>
<tr><td>wild oats</td><td colspan="16"></td><td colspan="7">slash and remove stems</td><td colspan="1"></td></tr>
<tr><td rowspan="2">cocksfoot</td><td colspan="16" rowspan="2"></td><td colspan="4">slash and remove stems</td><td colspan="4" rowspan="2"></td></tr>
<tr><td colspan="4">spot-spray n/s or g/s</td></tr>
<tr><td>Paterson’s curse</td><td colspan="2">hand cut and remove seedling stems</td><td colspan="6"></td><td colspan="4">spot-spray rosettes</td><td colspan="8"></td><td colspan="4">hand cut and remove seeding stems</td></tr>
<tr><td>African lovegrass</td><td colspan="4">spot-spray</td><td colspan="12"></td><td colspan="8">spot-spray</td></tr>
<tr><td rowspan="2">tall fescue</td><td colspan="16" rowspan="2"></td><td colspan="4">slash and remove stems</td><td colspan="4"></td></tr>
<tr><td colspan="8">spot-spray</td></tr>
<tr><td rowspan="2">St. John’s wort</td><td colspan="6">hand-pull small plants after rain</td><td colspan="10" rowspan="2"></td><td colspan="8">hand-pull small plants after rain</td></tr>
<tr><td colspan="6"></td><td colspan="4">spot-spray bl/s or n/s</td><td colspan="4"></td></tr>
<tr><td>Chilean needlegrass</td><td colspan="11">spot-spray</td><td colspan="4"></td><td colspan="9">spot-spray</td></tr>
<tr><td>serrated tussock</td><td colspan="4">spot-spray</td><td colspan="12"></td><td colspan="5">spot-spray</td><td colspan="3"></td></tr>
<tr><td>paspalum</td><td colspan="16"></td><td colspan="5">spot-spray</td><td colspan="3"></td></tr>
<tr><td>phalaris</td><td colspan="16"></td><td colspan="4">slash and remove stems</td><td colspan="4"></td></tr>
<tr><td>ribbed plantain</td><td colspan="8">spot-spray</td><td colspan="7"></td><td colspan="5">spot-spray</td><td colspan="4"></td></tr>
<tr><td>flatweed, cat’s ear</td><td colspan="8">spot-spray</td><td colspan="7"></td><td colspan="5">spot-spray</td><td colspan="4"></td></tr>
<tr><td>service tree</td><td colspan="24">hand-pull small plants after rain (at this stage they are only seedlings)</td></tr>
</table>

n/s = non-selective non-residual herbicides; g/s = grass-selective non-residual herbicide; bl/s = broadleaf-selective non-residual herbicide

3.2 Biomass Management

Biomass removal (defoliation) at appropriate levels and times is beneficial to many grasslands. Generally, higher levels of biodiversity are to be found at intermediate levels of disturbance and at intermediate time spans following the disturbance. It maintains an open structure, which enables native plants to flower and set seed, and allows their seedlings to become established. In natural and pastoral systems, biomass removal generally occurs through grazing or burning; at this site slashing is the only realistic option. In the Project Area, there is the additional requirement of maintaining a moderate proportion of wallaby grasses in the sward as food plants for GSM, and retaining open spaces between tussocks for basking and mating.

The Project Area has been managed by slashing for many years. The population estimate for GSM in 2006 suggested that this regime has favoured GSM, and the 2007 baseline vegetation composition data from the 20 metre x 20 metre quadrat can be used as a guide to appropriate proportions of bare ground and grasses (PB, 2008; refer to **Appendix 2**). This will vary from year to year with variations in temperature and rainfall (refer to **Section 4.0**).

Slashing on the Project Area should observe the following guidelines:

- Sward to be cut using a flail mower to mulch and spread litter and reduce windrows. Any patches of mulched material should be removed from the Project Area. The blade set height of the flail mower should be 12 centimetres; ensuring sward is not cut lower than 10 centimetres in height.
- Machinery not to be used when the ground is wet in order to avoid soil compaction and damage to the cryptogams (soil crust).
- Machinery to be washed down before entering the Project Area to remove soil and seeds. The least weedy part of the Project Area should be mown first, then the margins planted with native grasses, and the weedier areas last to avoid spreading weed seeds.
- Slashing to be carried out annually in August-September, before the emergence of adult GSM. This will help maintain the low open grassland favoured by GSM. In parts of the Project Area dominated by tall weeds (e.g. wild oats), the slashed material should be removed (by raking or use of a grass-catcher) rather than left in windrows.
- Slashing to be repeated in February if necessary (if the average vegetation height exceeds 15 centimetres. Note: average vegetation height is determined as the bulk of the grass tussock, not the seed head).

3.3 Other Management Prescriptions

3.3.1 Record Keeping

A diary of management actions and other relevant occurrences should be kept. This can be in the form of notes in the work program and management checklist (refer to **Table 3.3**).

Table 3.3 Work Program and Management Record (activities are to be undertaken annually unless otherwise indicated)

Activity	Spring	Summer	Autumn	Winter	Reporting
weed management	• Slash and remove early flowering stems of wild oats, cocksfoot, fescue and phalaris • cut-and-paint woody weeds • hand-pull smaller exotic St John's wort after rain • follow-up treatments.	• follow-up treatments • remove aerial parts of Paterson's curse (if present) • spot spray exotic perennial grasses, plantain • hand-pull smaller exotic St John's wort after rain.	• spot-spray plantain and Chilean needlegrass • cut-and-paint woody weeds.	• Spot-spray plantain and Paterson's curse (if present).	Annually: Provide weed management record to the Department of the Environment, Department of Finance, National Capital Authority and ACT Government.
weed monitoring		Assess success of management.			Annually: Provide results of monitoring to the Department of the Environment, Department of Finance, National Capital Authority and ACT Government.
biomass management	Slash to no shorter than 8 centimetres (Aug-Sept).	Slash again in February if average height >15 cm in native grassland area.			
NTG monitoring	Photographs from reference points, transects and quadrat.				Annually: provide results of monitoring to the Department of the Environment, Department of Finance, National Capital Authority and ACT Government.
GSM monitoring	• point counts and transects • every 5 years: capture-release survey for population estimation (next late 2016). ****Aim for middle of GSM flight season, assuming appropriate climatic conditions (a broader spread is preferable for capture-release****				
site inspection	Note condition, damage.	Note condition, damage.	Note condition, damage.	Note condition, damage.	
plan review	Every five years (**next review due at end of 2020**)				

3.3.2 Memorandum of Understanding

There are several key stakeholders that must be represented in the Memoranda of Understanding. These are:

- Lessor (Commonwealth)
  - interest in ongoing use of Block 3 Section 22.
- Lessee (owner)
  - role as the land manager.
- National Capital Authority
  - consent authority for development.
- ACT Government (Territory and Municipal Services)
  - management of road network and verges that adjoin Block 3, Section 22.
- ACT Government (ACT Planning and Land Authority)
  - consent Authority for development on the adjoining Block 15.
- ACT Government (Conservation, Planning and Research)
  - role in reviewing the ongoing maintenance of the conservation area.

The Memoranda should include agreement about activities such as construction, maintenance, landscaping, shading, irrigation and drainage which may affect Block 3 Section 22, and specifically the conservation area. Any proposal to extend or increase the height of the buildings in the neighbouring area (Territory land) should consider the potential impact on NTG and GSM.

3.3.3 Construction Phase

The Project Area should be protected from damage during the construction phase. It should be securely fenced, with signs on all fences stating that it is an environmentally sensitive site. There should be no activities associated with construction on the Project Area, including (but not limited to):

- vehicle or pedestrian access through the Project Area
- dumping of debris
- parking of vehicles
- storage of machinery or materials
- trenching for pipes or cables, or other earthworks.

These restrictions should be noted in the works program.

3.3.4 Rehabilitation

No soil should be brought onto the Project Area. Areas bared through control of large areas of weeds, or inadvertently damaged, should be rehabilitated using native weed-free seed or thatch collected from the Project Area (note: do not collect more than 10 per cent of a population in order to allow the majority to set seed naturally). Grasses sourced for thatch should not include kangaroo grass or poa tussock.

3.3.5 Adjacent Vegetation

Deciduous trees on the boundary of the Project Area have degraded the adjacent grassland, as well as providing perches and nest sites for birds that feed on GSM. The size and location of any trees or landscape features on the western portion of Block 3 should be such that the shadow they cast does not extend beyond the shadow of the buildings, as proposed in the Master Plan.

Landscaping should be designed to have low to nil impact on the grassland. Specifically, it should have low irrigation and fertiliser needs, and not be a significant source of mulch or seeds. Adjacent landscaping should not include non-local native grassland species or exotic grass species.

The use of pesticides on adjacent vegetation is undesirable, given the presence of rare/endangered insect species on the Project Area. In the event of this being required, a works plan should be developed with consideration of the Maintenance Plan, and reviewed by an appropriately qualified ecologist or entomologist familiar with the biology of GSM and Canberra raspy cricket.

3.3.6 Drainage

Development on the western portion of Block 3 should avoid increase in drainage onto the Project Area. Similarly, repair or replacement of the footpaths on National Circuit and Sydney Avenue should avoid an increase in drainage discharge onto the Project Area.

3.3.7 Fencing, Signs and Paths

Interpretive signs have been placed on the boundary of the Project Area. Additional fencing and signs should avoid a significant shadow and the creation of perches for birds. There should be no paths, landscaping, seating or other structures within the conservation area. Pedestrian access from the western boundary or opportunities to be used as a thoroughfare should also be prevented. If a new fence is constructed, associated materials and vehicles should be kept off-site as far as practicable during construction.

Spot cleaning of the fencing and signage should be undertaken as necessary with products that pose no risk of impacting on the NTG and the GSM.

3.3.8 Site Access and Induction Guidelines

Access to the subject area should be restricted to tasks essential for the ongoing maintenance tasks, as detailed in this Maintenance Plan. All personnel accessing the area must be appropriately inducted.

Induction Information

It is anticipated that there will be varying levels of induction, dependent on the role of the personnel to the conservation area. These groups of personnel include:

- construction and development workers during the construction phases

- require a direct induction

- facility management and associated site contractor personnel for the ongoing management of completed development
  - require a direct induction
- all building occupants
  - awareness information should be made available to this personnel group.

The intent of this information is to identify with the inductees the strategic importance of this conservation area, and ensure a level of awareness for those working on Block 3 (during construction and for the ongoing management). This information can be specifically tailored for the different levels of induction, and includes:

- the Project Area contains a population of the critically endangered GSM, whose survival relies on the protection of its NTG habitat
- although the GSM is only noticeable when the adults fly in a few weeks in late spring to early summer, it is present as eggs, larvae and pupae in the soil throughout the year
- access to the Project Area should only be for activities related to its study or maintenance, and should take place according to the restrictions prescribed the Maintenance Plan.

Conservation and Education-related Visits

As the Project Area is sensitive, very small and can be viewed from all sides, educational visits by school and university classes should be restricted to viewing of GSM and their habitat from the edge of the Project Area.

The potential need for referral and approval under the EPBC Act should be considered for any conservation activities that are not specifically nominated in this Maintenance Plan, and that the planning of such activities should first involve consultation with ACT Conservation Planning and Research (within Environment and Planning Directorate).

A licence under the *Nature Conservation Act 2014* (formerly known as a ' Permit to Take') should also be sought for all actions which interfere with the GSM, including physical handling, trapping or activities that have the potential to directly interact with adult or larval individuals. This includes the mark/recapture survey as detailed in this Maintenance Plan.

Activities should be planned to minimise foot traffic and site disturbance, and should especially avoid disturbing egg-laying females. This can be achieved by minimising activities on the Project Area after 11:00 hours during the flying period, which may take between late October and late December.

Monitoring

Monitoring should be carried out by appropriately qualified personnel, with supervisors having at least five years' experience in the assessment and management of NTG and GSM populations.

4.0 Monitoring

4.1 Methodology

4.1.1 Natural Temperate Grassland

The condition of the grassland should be monitored annually in spring.

Monitoring was previously recommended to be undertaken biennially however the benefits of increased sampling would include a reduction in the impact of data anomalies borne from infrequent observations. From a data analysis perspective, when a monitoring event in a biennial sampling regime is undertaken in conditions which are not typical of other years, it is more difficult to rationalise the variation if there is no monitoring event in a previous or following year. **Appendices 1**, **2** and **3** contain the floristic results of grassland monitoring from 2007, 2009, 2011 and 2013, 2015 and 2015.

4.1.1.1 Mapping of Vegetation Associations

Vegetation associations were previously mapped by PB (2008), Rowell (2012), Umwelt (2014) and Umwelt (2015). Annually, vegetation associations are to be mapped to determine any changes in extent as per the categories in **Table 4.1**.

Table 4.1 Vegetation Associations Present

Vegetation Association	Included Species
High quality native-dominated grassland: >75% of vegetation cover is native, dominated by tall speargrass (*Austrostipa bigeniculata*) and wallaby grasses (*Rytidosperma* spp.), with a diversity of native forbs.	Species less tolerant of disturbance such as: • rock fern (*Cheilanthes sieberi* subsp. *sieberi*) • common onion orchid (*Microtis unifolia*) • bulbine lily (*Bulbine bulbosa*) • early nancy (*Wurmbea dioica* subsp. *dioica*) • curved rice-flower (*Pimelea curviflora*) • creamy candles (*Stackhousia monogyna*) • blue devil (*Eryngium ovinum*) • lemon beauty heads (*Calocephalus citreus*).
Lower quality native-dominated grassland: >50% of vegetation cover is native, dominated by red-leg grass (*Bothriochloa macra*) and wallaby grasses, with fewer native forbs.	Disturbance-tolerant species such as: • swamp dock (*Rumex brownii*) • Australian bindweed (*Convolvulus angustissimus*) • tufted bluebell (*Wahlenbergia communis*) • fuzz-weed (*Vittadinia* spp.) • yellow buttons (*Chrysocephalum apiculatum*).

Vegetation Association	Included Species
Exotic-dominated grassland: >50% of vegetation cover is exotic.	Species of particular concern are listed in **Table 3.1**.

Annual checking of the vegetation association boundaries in spring will provide information on the effectiveness of weed control. An aim of the Maintenance Plan is to contain or reduce the exotic-dominated areas, and to maintain or enlarge the high quality native-dominated areas.

Refer to **Figure 3.1** for an updated extent of the vegetation associations in 2015.

4.1.1.2 Species List

Annually in spring, all plant species noted on the Project Area during management and monitoring activities are recorded on a cumulative annual species list (**Appendix 1**). This list records the arrival of species of weeds, or their eradication and the loss of native species. In combination with the assessments below, it will measure changes in species richness and site condition over time. A major aim of management of the Project Area is to retain native species and eliminate or contain exotic species. Any observations of fauna of interest (e.g. Canberra raspy cricket) should be recorded at the same time.

4.1.1.3 Quadrat Assessment

A 20 x 20 metre quadrat in the middle of the Project Area has been assessed in Spring 2007, 2009, 2011, 2013, 2014 and 2015 (**Appendix 2**). This sector was chosen as it had a high number of GSM captures in 2006 and even in 2015, remains the highest quality grassland area on site. An aim of the Maintenance Plan is to maintain the native plant diversity in this area.

Within the quadrat area, each species is recorded with an associated scaled cover/abundance rating as per Braun-Blanquet (1932[30]). This information is then entered into the 'Grassy Site Quality Assessment Tool' spreadsheet developed by Rehwinkel (2007[31]) to provide a 'Floristic Value Score' (FVS). Using this scoring system, each species is assigned a value ranging from one to five based on their relative rarity as determined by regional grassland assessment data. Species are categorised as follows:

- Common or increaser species, which do not add much to the value of a site
- 'Indicator species, level 1', which indicated that a site has value
- 'Indicator species, level 2', which are highly significant species; these are the rarest of grassy ecosystem species and have the highest significance scores.

The sum of values for each species within a quadrat provides a FVS. This is considered more valuable than conventional species richness scores as it provides each quadrat with a relative value score based on the presence of rare or regionally significant species that are often not present in sites of lesser quality. Additionally, it does not reward common or increaser native species which often thrive in highly disturbed sites. This scoring system is generally used to characterise grassland condition, and has been used by ACT

[30] Braun-Blanquet, J. (1932) Plant sociology. McGraw Hill, New York.

[31] Rehwinkel, R. (2007) A method to assess grassy ecosystem sites: using floristic information to assess a sites' quality. Version 2. NSW Department of Environment and Climate Change, Queanbeyan.

government to monitor the effects of macropod grazing in grassy ecosystems (Armstrong, 2013[32]; ongoing monitoring undertaken by ACT Government, no reference available).

4.1.1.4 Step-point Transects

This method assesses the relative abundance of plant species, and gives an indication of the dominant species, degree of weed invasion and amount of bare ground (see Sharp et al. 2005[33]). Two transects are surveyed along the long axis of the Project Area, starting and finishing 10 metres from the external boundary to avoid edge effects (refer to **Figure 4.1**). At each step, a long vertical wire is place ahead of the observer, and a record is made of which species touch the wire (a 'hit'). 'Hits' on rock, bare ground, cryptogams and litter are also recorded. Results of the 2007, 2009, 2011 and 2013 transects are in **Appendix 3**. The number of 'hits' may vary depending on observer stride length, and should be converted to a percentage value for each variable.

An aim of the Maintenance Plan is to maintain a balance between bare ground and vegetation, and to keep the cover of presumed GSM food plants at current or increased levels. For the life of the current Maintenance Plan, the aim is for bare ground to be kept at 5-25 per cent, the main native grasses at about 60 per cent of the vegetation cover (proportional to native forbs and exotic species) and 8-20 centimetres height, with wallaby grasses contributing 7 per cent or more of the proportional vegetation cover.

Note that these percentage figures relate to vegetation cover only, rather than total cover which includes litter, bare ground and cryptogams. While these values are important and should still be collected and analysed, they are excluded from proportional vegetation cover calculations as they can vary significantly due to slashing management, moisture conditions and other variation in prevailing weather conditions.

4.1.1.5 Photographic Record

A photographic record is to be made each spring, from the points indicated in **Figure 4.1**. The photographs from 2013 are in **Appendix 5**. They give a general indication of vegetation structure on various parts of the Project Area. In following years, photographs should be captured in accordance with **Figure 4.1** and **Appendix 5**.

Figure 4.1 shows the location of the step-point survey transects, quadrat and photographic record locations.

4.1.1.6 Weeds

Biennially, every second summer, the need for weed control should be compared with the previous year's activity, and assessed against the objectives in **Table 3.1**. This should be undertaken for individual species, and compared to previous years' activities to determine successes and failures. Successful weed management will result in eradication of some target species, suppression or containment of others, and the identification and treatment of new weed infestations. Areas where treatment has been less effective should be noted, and future treatments adjusted accordingly.

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[32] Armstrong, R. (2013) Interim analysis of relationships between vegetation condition and kangaroo density in grassy ecosystems of the northern ACT: data collected in Spring-Summer 2009/2012. A report prepared for ACT government, Environment and Sustainable Development Directorate, Canberra. February 2013.

[33] Sharp, S., Dorrough, J., Rehwinkel, R., Eddy, D. & Breckwoldt, A. (2005) Grassy Ecosystems Management Kit: A Guide to Developing Conservation Management Plans. Environment ACT, Canberra.

Figure 4.1

Location of the Step-point Survey Transects, Quadrat and Photographic Record Points

Any increase in the area of vegetation dominated by exotic species measured in the mapping exercise described above should be a trigger for an increase in weed control effort, as should repeated or continuing infestations of weeds listed for eradication, or the spread of species required to be contained (including native grass species previously planted in the Project Area).

4.1.2 Golden Sun Moth

4.1.2.1 Annual Monitoring

The Project Area is too small for standard transect surveys (e.g. Clarke & Dunford, 1999[34]) to be strictly comparable with larger sites. However, its size provides an opportunity for ongoing comparisons of observational data collection methods. Due to the small area to be surveyed and the potential for double counting, observational surveys will not give absolute numbers for a site, but provide an indication of density and activity of flying males (refer to Appendix B of Hogg, 2010[35]). Repetition of counts allows averaging to reduce the variability that can arise from changes in wind speed or sunshine intensity between short counts on the same day.

Review of the original Maintenance Plan indicates that the survey guidelines for GSM (EPBC Act Policy Statement 3.12: DEWHA, 2009[36]) are not consistent with that of the Plan. This is understandable considering the original Maintenance Plan was developed prior to the release of the GSM survey guidelines. Under the EPBC survey guidelines, survey is required to be undertaken over four (4) non-consecutive days, with optimal conditions targeted based on seasonal conditions rather than rigid timeframes outlined in the existing Plan. For instance, throughout the ACT, the flying season can vary between early November to mid-December and late November to early January. The following survey parameters should be used for selecting appropriate days to undertake monitoring:

- a warm to hot day (above 20 °C by 10:00 am)
- the warmest part the day (i.e. between 10:00 am and 2:00 pm)
- clear or mostly cloudless sky
- still or relatively still wind conditions during the survey period
- ≥ 2 days since rain
- staggered to increase the likelihood of detection given the short adult life span (1-4 days between surveys).

As per the original Maintenance Plan, the following methods are to be used to undertake GSM survey on site:

- Transect surveys: on each visit at 11:30, 12:00 and 12:30 hours, observer to walk steadily on a 100 metre transect along the long axis of the Project Area, starting and finishing 10 metres from the external boundary to avoid edge effects. All GSM seen flying ahead and on each side of the observer on

[34] Clarke, G.M. & Dunford, M. (1999) Survey of the Belconnen Naval Transmitting Station for the Endangered Golden Sun Moth, *Synemon plana*. A report prepared for Wildlife Research and Monitoring, Environment ACT.

[35] Hogg, D. (2010) A strategic approach to the conservation and environmental assessment of Golden Sun Moth sites in the Canberra area. Interim revised report. Prepared on behalf of the ACT Land Development Agency.

[36] DEWHA (2009) EPBC Act Policy Statement 3.12 - Significant Impact Guidelines for the Critically Endangered Golden Sun Moth (*Synemon plana*) Department of the Environment. [http://www.environment.gov.au/epbc/publications/pubs/golden-sun-moth.pdf, URL Accessed 27/09/2013]

each pass should be recorded on a hand- counter. Double counting of individuals to be avoided as far as possible. Results to be recorded as number of GSM per 100 metre transect.

- Point observations: to be undertaken twice on each visit in sets of ten, between the transect survey sessions. Observer to stand in centre of Project Area (in the high condition grassland area), and rotate slowly (360º in 30 seconds). All GSM seen in a radius of 25 metres during rotation to be recorded, including double counting of individuals that change track and recross the observer's visual path. Results from ten rotations to be recorded in each of the two sessions, with the range and average calculated for each session (number of GSM per 30 second rotation).

- GSM seen will be mostly flying males; any females should be recorded separately.

4.1.2.2 Five Yearly Monitoring

Population Estimate

Previous population estimation surveys have involved daily capture of males (and females in some years) throughout the flying period. The impact of this on survival and breeding of GSM is not known, although numbers were not reduced when the procedure was carried out over three consecutive seasons in the 1990s. However, it is a very intrusive procedure, and could be damaging to the population in years when numbers are already low for other reasons.

An alternative method using a nested sampling structure is outlined below (designed by Anett Richter, University of Canberra; cited in PB, 2008; Rowell, 2012). It allows population estimation with less interference, while also recording the ratio of males to females captured (recommended for larger populations only; in 2006, females were not captured to reduce interference to egg-laying). Capture, marking and release methods should be as described in Rowell (2012), although capture of females should be avoided as per the 2006 survey due to the intrusive nature of the method (A. Rowell, personal communication).

Note: mark-recapture surveys involve repeated handling of animals, and require the prior issue of a 'Permit to Take' by the Commonwealth Department of the Environment. The personnel involved in the survey should be appropriately qualified and experienced in such work, and the application for the permit should be lodged three months prior to commencement of the proposed survey.

The Robust Design

This mark-recapture method allows population estimation without daily captures. It features a nested sampling structure, timed to take account of the short life-span of adult GSM (one to four days). The first level consists of primary sampling sessions. The population experiences mortality (and potentially immigration) between primary sessions, allowing application of open population models. The secondary level of sampling involves a short mark-recapture study within each primary session. Closed population models are used at this stage to estimate the animal abundance at each primary session.

The design of the mark-recapture study (primary and secondary sampling sessions) depends on the biology of the study species. Due to the short life span of GSM (average two days), secondary sampling sessions should take place within two days. It is suggested to have at least four secondary sessions within one primary session to obtain an appropriate number of captured and recaptured individuals. To verify a closed population (no immigration, emigration, birth and deaths) four secondary sessions need to take place within two days (see design in **Figure 4.2**).

The first primary session should begin as soon as flying males are detected, and should be repeated every eight days until there are no new captures. Observational surveys of the Project Area should be undertaken weekly from late October to determine the beginning of the flying period. Analysis is to be carried out using the software package 'MARK'. The package includes the estimation of total population size of closed and open populations based on the Robust Design. It also provides estimates of daily survival rates and recapture probabilities.

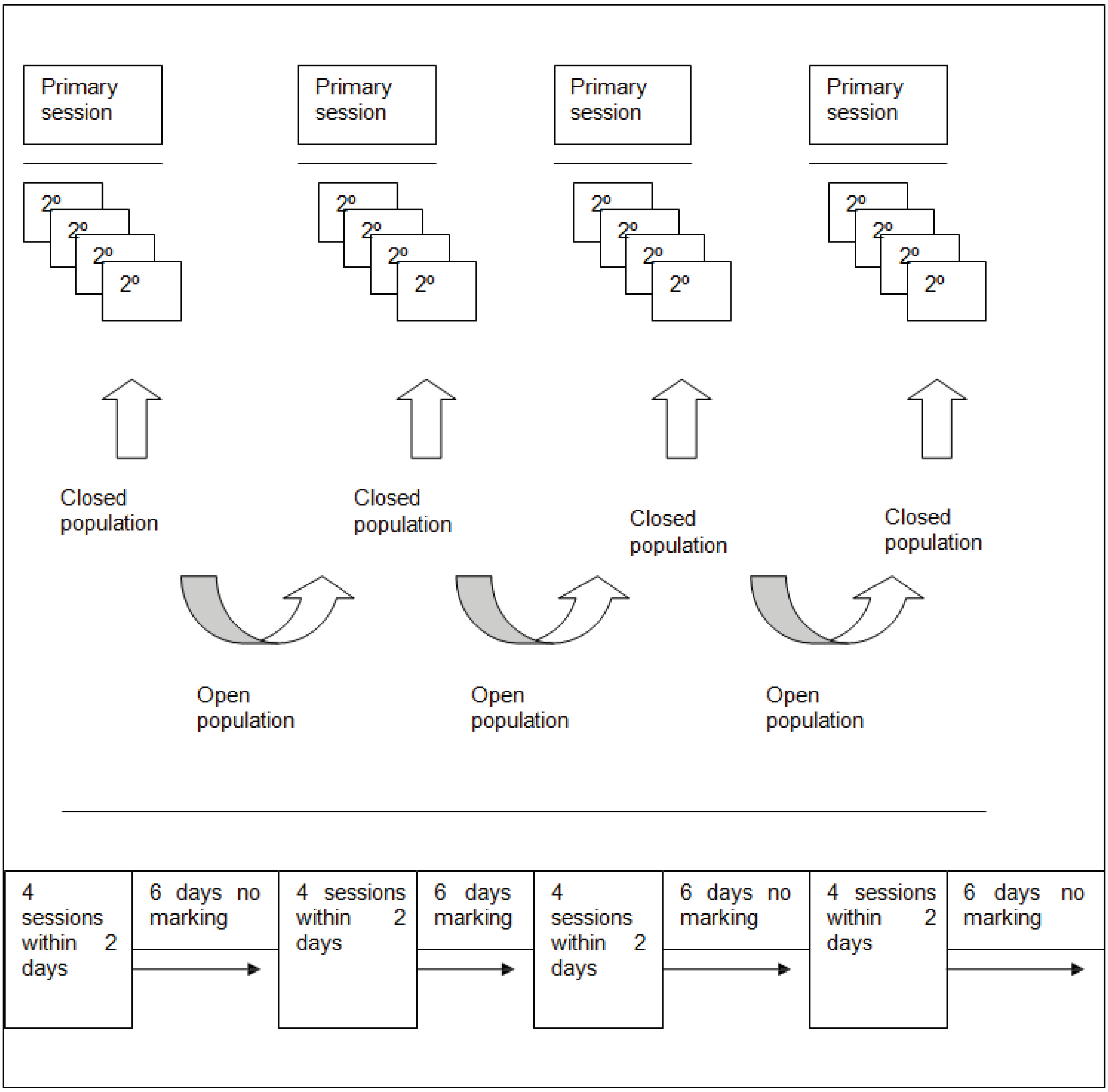


Figure 4.2

Experimental Design for Golden Sun Moth Population Estimation

Source: Anett Richter, University of Canberra, 2006 (cited in PB 2008, Rowell 2012)

4.1.3 Recording and Reporting

4.1.3.1 Management Checklist

The annotated work program and data from periodic monitoring will provide a record of management actions and outcomes that can be submitted to the lessee (National Capital Authority), the Commonwealth Department of the Environment and the ACT Government biennially or as required.

A report should be prepared in the final year of the five year Maintenance Plan, detailing the results of management and monitoring, with recommendations for variations in the reviewed Maintenance Plan.

4.2 Results and Discussion (2007-2015 Data)

4.2.1 Vegetation

4.2.1.1 Vegetation Mapping and Weed Distribution

Vegetation mapping undertaken by Umwelt (2015) was validated as part of the updated Maintenance Plan. Since this time, extent of NTG being 0.32 hectares (a reduction of 0.03 hectares since spring 2014). While changes between 2013 and 2014 were minor, it is apparent that the site has degraded in the past 12 months due to adjacent construction and general weed transfer.

Established weeds include perennial exotic grasses such as phalaris (*Phalaris aquatica*), paspalum (*Paspalum dilatatum*), tall fescue (*Festuca* sp.), Chilean needlegrass (*Nassella neesiana*) and cocksfoot (*Dactylis glomerata*). These were particularly prominent in the wetter southern third of the site, although cocksfoot and Chilean needlegrass in particular are distributed in lower abundance through native grassland areas, with Chilean needlegrass occurring outside the reject Area on the road verge along with African lovegrass (*Eragrostis curvula*).

On the bank adjacent to Sydney Avenue where disturbance from road widening and possibly replanting is evident, annual and perennial grasses were dominant. Along the western boundary, perennial exotic grasses and ribwort plantain (*Plantago lanceolata*) were abundant particularly beneath exotic deciduous trees. St John's wort (*Hypericum perforatum*) is scattered across the site.

Refer to **Figure 3.1** for updated vegetation mapping for the site.

4.2.1.2 Species List

The number of native and exotic grasses and forbs recorded since 2006 has remained relatively stable, with infrequently recorded species accounting for mild fluctuations in species richness. Prior to 2006, full-site species lists were not recorded. Notes on changes in abundance of species of interest are found in **Section 4.2.1.3**.

The species list across years since 1991 is found in **Appendix 1**.

4.2.1.3 Condition Trend Analysis

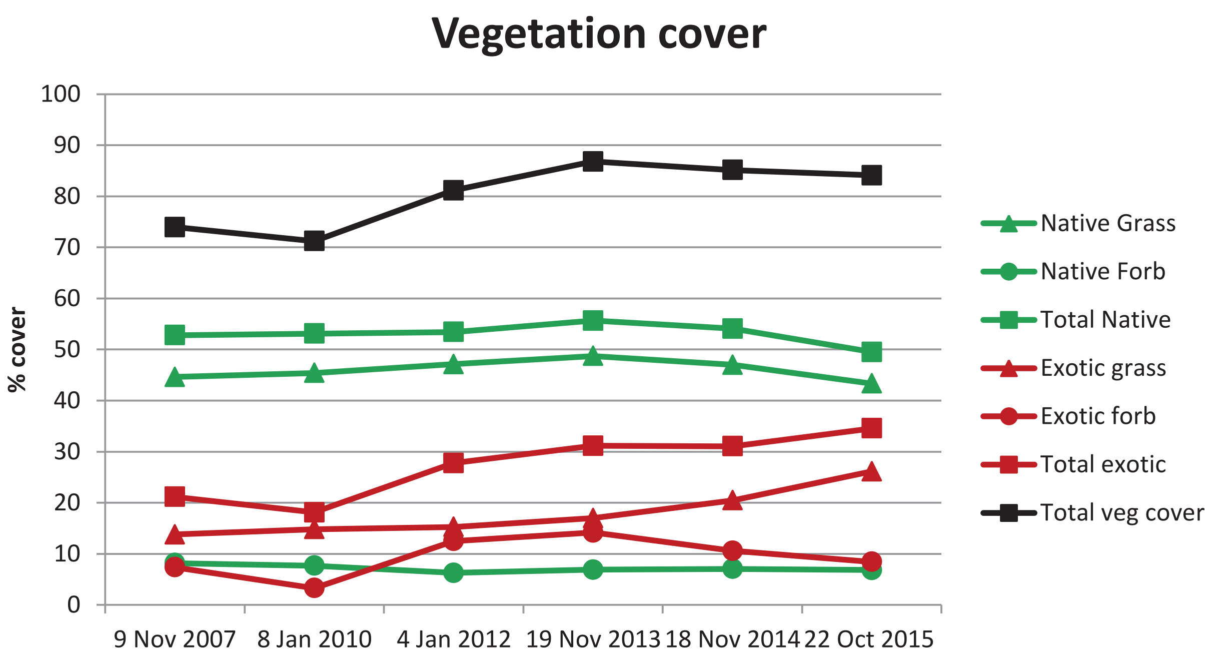
Analysis was undertaken on floristic data collected from four periods between 2007 and 2013: 9 November 2007 (late spring); 8 January 2010 (mid summer); 4 January 2012 (mid summer); 19 November 2013 (late spring); 18 November 2014 (late spring); and 22 October 2015 (mid spring).

Analysis of Step-point Transect Survey Data

A graph presented in **Graph 4.1** demonstrating changes in vegetation cover over time are based on data generated from the two step-point vegetation transects running north-south across the site (**Figure 4.1**). While step-point data is a useful means of quantifying changes in grassland composition over time, it is worth noting that even with the same observer, the exact same observation points are not sampled across years. As such, minor fluctuations in observations may not be significant; rather it is a useful way of exploring trends over time. Floristic value scores were generated from the 20 x 20 metre quadrat (location of quadrat shown in **Figure 4.1**).

As shown in **Graph 4.1**, step-point data indicates that native vegetation cover appears to be declining, with total native vegetation cover across the site currently at 50 per cent, down from 54 per cent in November 2014 and a peak of 56 per cent in November 2013.

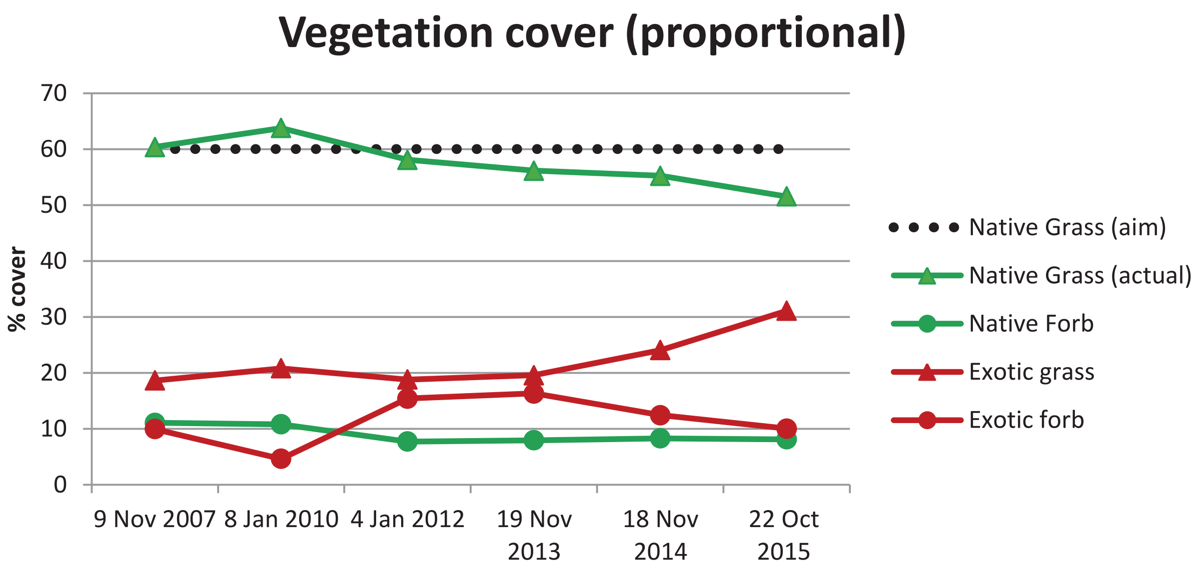
Total exotic vegetation cover has risen from 18 per cent on January 2010 to 36 per cent in October 2015, due to an increased cover of exotic grasses. During this time, exotic forb cover has decreased. This may be due to favourable rainfall conditions for exotic grass growth in the past few years, and potentially, success in control of exotic forbs through herbicide application. Each of the two step-point transect surveys cover high quality grassland areas dominated by native grasses and forbs, as well as areas dominated by exotic grasses. Without stratifying transects by vegetation condition, it is difficult to report on relative cover in native and exotic condition grasslands. However, as a guide it is estimated that native grassland areas are generally comprised of 80-90 per cent native species; similarly, areas dominated by exotic pastures are generally 80-90 per cent exotic species.



Graph 4.1

Changes in Native and Exotic Vegetation Cover over Time

A stated aim in managing the site is to retain native grasses at ≥60 per cent vegetation cover proportional to other vegetation (necessary to remove variation related to site management activities such as slashing – refer to **Section 4.1.1**). When vegetation cover is analysed independent of non-vascular cover such as litter, bare ground and cryptograms, the proportional native grass cover relative to other vegetation cover has been below this since 2012, with a cover of 52 per cent in October 2015, as shown in **Graph 4.2**. While vegetation cover on site has not reduced significantly (**Graph 4.1**), exotic grass abundance has increased and should be controlled in order to maintain grassland health and a proportional cover of ≥60% of native grasses relative to other vegetation. For further information on the increase of exotic grasses and forbs, refer to **Section 4.2.1.4** below.

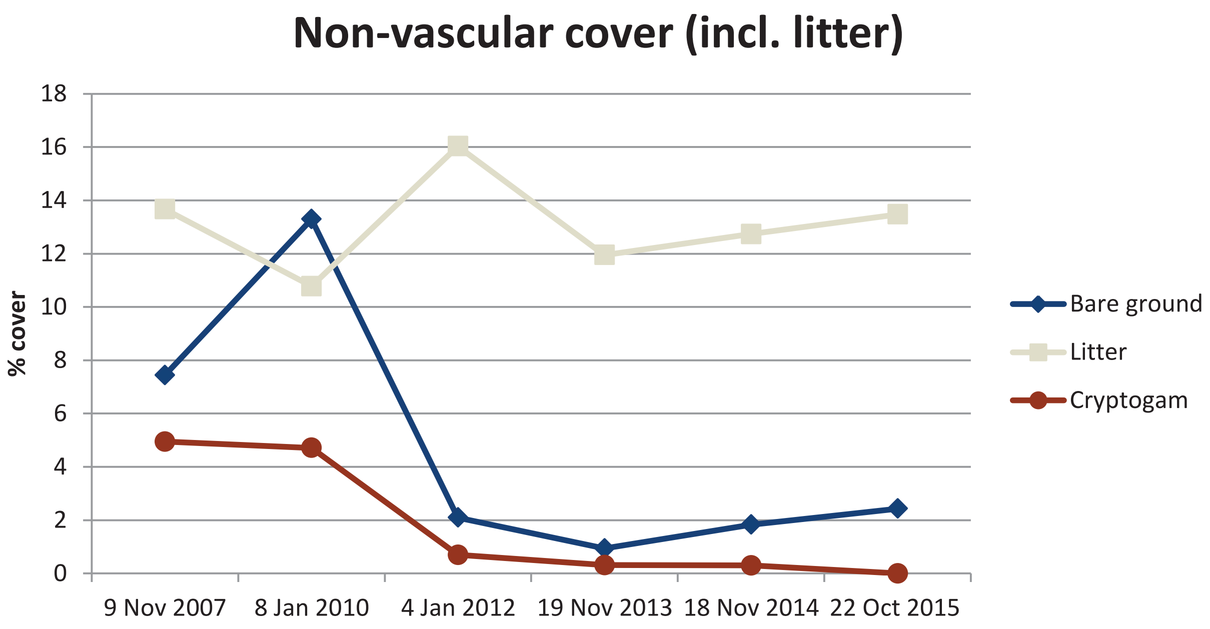


Graph 4.2

Proportional Vegetation Cover (Non-vascular Cover Excluded)

Kangaroo grass (*Themeda triandra*) that has been planted on the eastern footpath edge is gradually spreading across the site. This should be closely monitored and spot-sprayed if necessary. Kangaroo grass should be maintained along the edge of the path however, as it has formed an effective barrier to weed seed dispersal adjacent to the footpath.

Graph 4.3 demonstrates that litter cover across the site has been fluctuating between 11 per cent and 16 per cent since 2007. Significant reductions in bare ground and litter since January 2010 are likely to be as a result of spread of exotic grasses and forbs into inter-tussock spaces during favourable seasons for weed establishment.

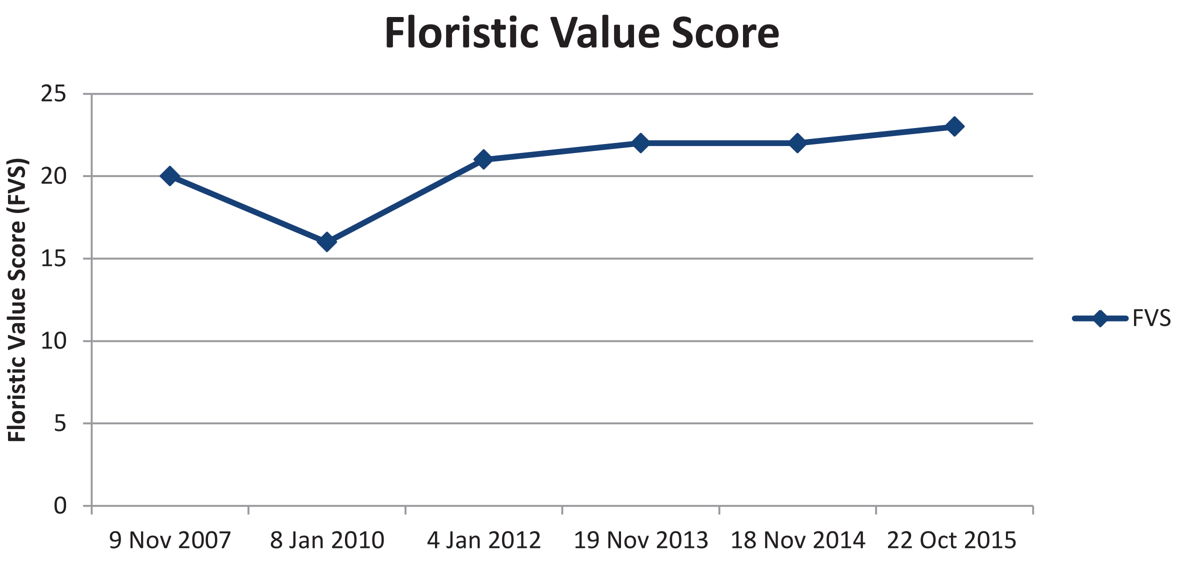


Graph 4.3

Changes in Non-vascular Cover over Time

Analysis of Quadrat Data

Within the 20 x 20 metre quadrat area, floristic values as defined by Rehwinkel (2007) have remained relatively stable over time, with a lowest value of '16' in January 2010 and a highest value of '23' in October 2015 (**Graph 4.4**). Low to moderate levels of variance using this scoring system are not considered noteworthy, as while based on the presence of 'significant' or 'indicator' species it is unlikely that floristic this information was unable to be collected in the exact same plot area as the plot corners were not permanently marked. In any case, if a 'significant' or 'important' species occurs just outside the plot it does not contribute to the floristic value score, but contributes to the overall floristic integrity of the site, which is of greater importance. However, the presence of exotic species is not factored in using this floristic value score method. Should exotic species need to be factored into the analysis in the future, data collected to-date can be used for retrospective analyses.



Graph 4.4

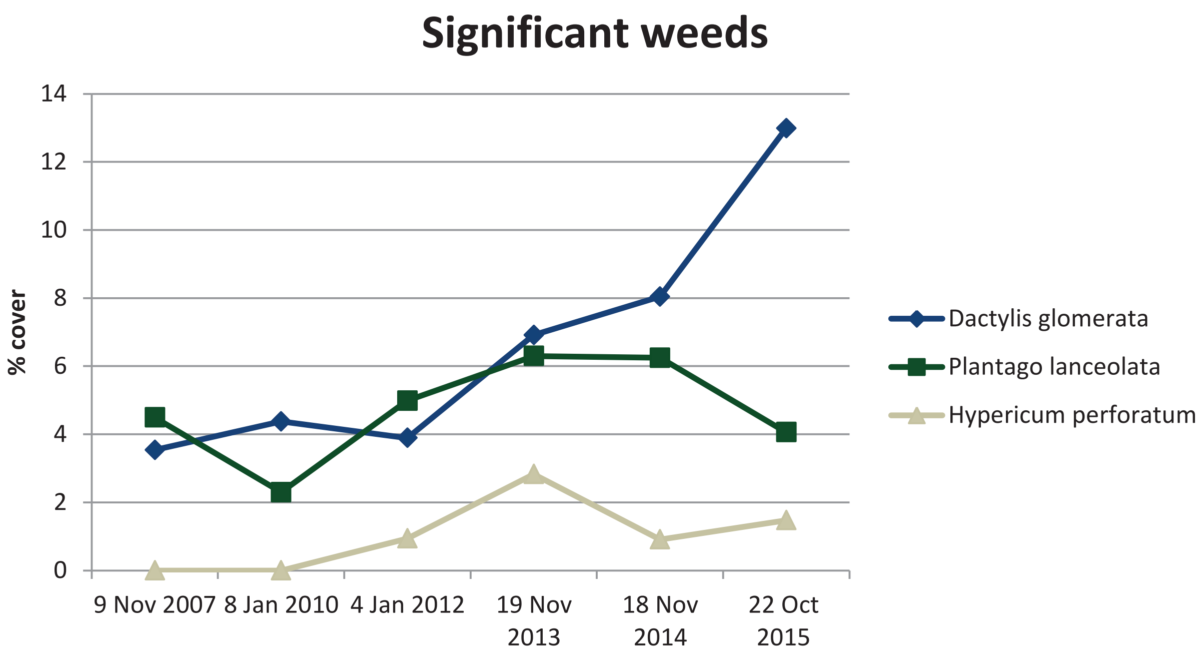
Changes in Floristic Values over Time

4.2.1.4 Changes in Weed Cover

Graph 4.5 shows the weeds of concern which have increased significantly since 2007. Generally, step-point vegetation transects record species which are of higher abundance across a site; recent observations indicate that these highly invasive weeds has increased considerably across the site in recent years.

While St. John's wort (*Hypericum perforatum*) has been known to be present on the site since 2003, it was not recorded as part of the step-point vegetation transects until January 2012. In the November 2013 survey it was observed to be scattered across the majority of the site; tis was less so in the October 2015 survey but it was still precent. Similarly, cocksfoot (*Dactylis glomerata*) and ribbed plantain (*Plantago lanceolata*) appear to be coming far more common, perhaps due to favourable growth conditions in the past few years. These species should be monitored closely in subsequent years.

Other significant weeds listed in **Table 3.1** are not shown in **Graph 4.5** as they are either considered stable, or are in a low enough abundance to not be recorded using the step-point transect survey method. Chilean needlegrass (*Nassella neesiana*), wild oats (*Avena* species), flatweed (*Hypochaeris radicata*) and tall fescue (*Festuca* sp.) appear relatively stable within the Project Area (noting that Chilean needlegrass is becoming more prevalent on the road verge), but should be controlled as they may increase after a disturbance event.



Graph 4.5

Changes in Significant Weed Cover over Time

4.2.2 Golden Sun Moth

Quantification of GSM populations at a given site is problematic due to variance in suitable flying weather and the potential for ‘double-counting’. As such, low interference ‘mark-capture-release’ methods such as that developed by Dr Anett Richter (formerly of University of Canberra) and adopted as part of five-yearly monitoring in this Maintenance Plan by Rowell (2012) are preferable in determining long term population trends.

A sustained annual monitoring effort has only recently begun at the site, with survey undertaken broadly in line with annual monitoring protocols completed in the November 2009 to January 2010 period, and again from November 2013. Exploratory analysis of this data (shown in **Table 4.2**) is not presented; assuming annual monitoring events are maintained it may be more appropriate to analyse population trends when the Maintenance Plan is up for review in 2020. In any case, analysis should be undertaken with consideration of general population trends across the ACT and Southern Tablelands to partially account for variation in larval survival based on seasonal and annual climatic variation (noting differences in this site compared with those of part of larger non-isolated remnants). Future monitoring efforts should follow guidelines as per DEWHA (2009) (refer to **Section 4.1.2.1**).

In 2015, surveys commenced during the known flight season, based on Umwelt’s prior reconnaissance and observations of GSM at nearby sites, as well as advice on observations from other ecologists.

Table 4.2 Monitoring Data for Golden Sun Moth, 2009-10 and 2013–2015

Survey Date and Time	Weather Conditions*	Observations
November 2009 to January 2010		
09/11/2009; middle of day	Temp: Max 32-35°C Rainfall: Unknown Wind: Unknown	Nil. Two male GSM observed on Sydney Ave. Median strip
25/11/2009; 1320-1350		T1 – 25; T2 – 19; T3 – 19. (ave = 21). Point observation (north) – ave = 5.5; range = 2 to 7 Point observation (south) – ave = 3.6; range = 2 to 5
08/12/2009; 1150-1220		T1 – 1; T2 – 9; T3 – 0. (ave = 3.3). Point observation (north) – ave = 0.8; range = 0 to 3 Point observation (south) – ave = 1.3; range = 0 to 4
08/01/2010; middle of day		Nil.
November to December 2013		
19/11/2013; 1130, 1200, 1230.	Temp: Max 28°C Rainfall: 0 mm Wind: Low, SSW	T1 – 4, 4, 5 (ave = 4.67); T2 – 1, 4, 1 (ave = 2). Point observation (1145) – ave = 0.7; range = 0 to 3 Point observation (1215) – ave = 0.5; range = 0 to 2
27/11/2013; 1130, 1200, 1230.	Temp: Max 29°C Rainfall: 0 mm Wind: 13km/hr, WNW	T1 – 3, 10, 5 (ave = 6); T2 – 2, 12, 9 (ave = 7.7). Point observation (1145) – ave = 0.3; range = 0 to 1 Point observation (1215) – ave = n/a; range = 0 to 0
12/12/2013; 1130, 1200, 1230.	Temp: Max 26.4°C Rainfall: 0 mm Wind: 19km/hr, WNW	T1 – 1, 0, 2 (ave = 1); T2 – 1, 5, 9 (ave = 5). Point observation (1145) – ave = 0.2; range = 0 to 1 Point observation (1215) – ave = 3.6; range = 0 to 6
November to December 2014		
18/11/2014; 1130, 1200, 1230.	Temp: 19.6°C (start); 24.3°C (max). Wind: 6km/hr WNW. Cloud cover: clear.	T1 – 0, 11, 13 (ave = 8); T2 – 1, 15, 17 (ave = 11). Point observation (1145) – ave = 0.9; range = 0 to 12. Point observation (1215) – ave = 6.2; range = 3 to 11.
18/11/2014; 1130, 1200, 1230.	Temp: 19.6°C (start); 24.3°C (max). Wind: 6km/hr WNW. Cloud cover: clear.	T1 – 0, 11, 13 (ave = 8); T2 – 1, 15, 17 (ave = 11). Point observation (1145) – ave = 0.9; range = 0 to 12. Point observation (1215) – ave = 6.2; range = 3 to 11.

Survey Date and Time	Weather Conditions*	Observations
22/11/2014; 1130, 1200, 1230.	Temp: 26.4°C (start); 31.0°C (max). Wind: 8km/hr NE. Cloud cover: clear.	T1 – 9, 17, 19 (ave = 15); T2 – 6, 12, 16 (ave = 11.3). Point observation (1145) – ave = 7; range = 4 to 11. Point observation (1215) – ave = 9.6; range = 6 to 12.
28/11/2014; 1130, 1200, 1230.	Temp: 20.4°C (start); 26.1°C (max). Wind: 1km/hr NNW. Cloud cover: clear.	T1 – 8, 20, 18 (ave = 15.3); T2 – 7, 17, 15 (ave = 13). Point observation (1145) – ave = 1.9; range = 0 to 4. Point observation (1215) – ave = 6.4; range = 4 to 11.
17/12/2014; 1130, 1200, 1230.	Temp: 22.1°C (start); 24.3°C (max). Wind: 17km/hr N. Cloud cover: clear.	T1 – 0, 2, 0 (ave = 0.7); T2 – 1, 2, 2 (ave = 1.7). Point observation (1145) – ave = 0.1; range = 0 to 1. Point observation (1215) – ave = 0.3; range = 0 to 1.
November to December 2015		
23/11/2015; 1130, 1200, 1230.	Temp: 22.5°C (start); 23.2°C (max). Rainfall: 0 mm. Wind: 19km/hr, NW. Cloud cover: clear.	T1 – 12, 20, 18 (ave = 16.67); T2 – 11, 30, 23 (ave = 21.33). Point observation (1145) – ave = 6.7; range = 3 to 12. Point observation (1215) – ave = 5.9; range = 3 to 9.
4/12/2015; 1130, 1200, 1230.	Temp: 21.5°C (start); 24.4°C (max). Rainfall: 0 mm. Wind: 9km/hr, N. Cloud cover: clear.	T1 – 2, 2, 3 (ave = 2.33); T2 – 6, 12, 6 (ave = 8.0). Point observation (1145) – ave = 2.0; range = 0 to 4 Point observation (1215) – ave = 1.1; range = 0 to 3
10/12/2015; 1130, 1200, 1230.	Temp: 19.7°C (start); 22.0°C (max). Rainfall: 0 mm. Wind: 15km/hr, NW. Cloud cover: clear.	T1 – 0, 9, 6 (ave = 5.0); T2 – 3, 5, 12 (ave = 6.67). Point observation (1145) – ave = 1.1; range = 0 to 4 Point observation (1215) – ave = 3; range = 1 to 5
24/12/2015; 1130, 1200, 1230.	Temp: 22.0°C (start); 23.2°C (max). Rainfall: 0.8 mm previous morning. Wind: 19km/hr, ENE. Cloud cover: clear.	Nil. No GSM observed throughout the transect or point observation surveys.

*In 2009-10 weather conditions were reported as a range, with all days being favourable.

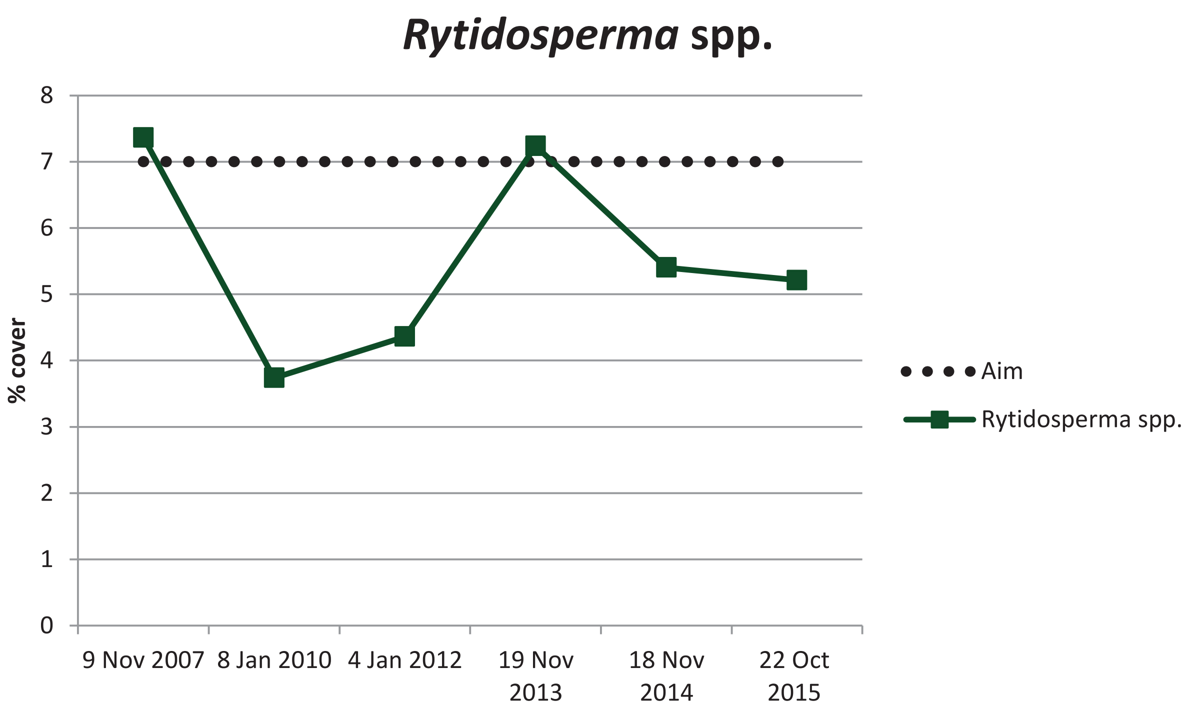
The five-year monitoring event was undertaken by Alison Rowell in December 2011 (Rowell, 2012). Across three primary capture sessions totals of 50, 32 and 12 month were achieved. Based on analysis undertaken by Dr Anett Richter, the GSM population at this time were estimated to be as shown in **Table 4.3** (from Rowell, 2012).

Table 4.3 Primary Session Golden sun Moth Population Estimates (Mark-recapture), December 2011

Primary Session	Dates	Position in Flying Season	Estimated Population Size During Session	95% Confidence Interval
1	9-10/12/2011	Mid	66	57-85
2	23-24/12/2011	Mid to late	49	39-75
3	31/12/2011-1/1/2012	Late	12*	-

*Minimum number alive, population estimate not possible due to a lack of recaptures.

At the Project Area the presence of wallaby grasses (*Rytidosperma* spp.) is important for the survival of GSM. Additionally, other C3 grasses such as tall speargrass (*Austrostipa bigeniculata*) and the exotic Chilean needlegrass (*Nassella neesiana*) provide fodder value for GSM (Richter et al. 2010). A stated aim of the Maintenance Plan is to maintain wallaby grasses at 7 per cent or more vegetation cover (proportional to vegetation only). Analysis of step-point transect survey data indicate that wallaby grasses are presently at 7.2 per cent, having ranged from 3.7 per cent to 7.4 per cent (±1.9) since November 2007 (**Graph 4.6**). As a perennial native grass in a site that is likely to be rarely subjected to macropod grazing, it is unlikely that wallaby grass cover has varied this amount since 2007. Rather, it may be a function of variance of the step-point transect survey method (noting there is probably no better way to quantify across the site), or time since slashing (which can temporarily reduce the surface area of grass tussocks).



Graph 4.6

Changes in Wallaby Grass (Rytidosperma spp.) Cover over Time

Kangaroo grass (*Themeda triandra*) has been planted on the eastern footpath edge, and it is gradually spreading across the site. Additionally, exotic pasture species such as cocksfoot (*Dactylis glomerata*) are present in all but the highest quality areas, and these species may displace C3 grasses that provide food for GSM larvae (refer to Richter et al., 2010). Rowell (2012) noted that in late 2011, grasses were longer and denser than desirable for GSM habitat, perhaps as they hadn't been mown twice in wetter years (the Plan recommends once a year with follow-up mowing in wetter years to reduce biomass). At the time of the October 2015 surveys the structure (height) was considered reasonable, perhaps due to a relatively dry spring-summer period. While inter-tussock spaces have reduced, this is more likely to vary based on climatic conditions rather than management actions such as slashing.

5.0 Review and Implementation

5.1 Review of the Maintenance Plan

The Maintenance Plan should be reviewed again at the end of five years (i.e. 2020). A new draft Plan should be prepared by an appropriately qualified person, and be presented for review and approval by the National Recovery Teams for GSM and NTG, or a committee of specialists from bodies such as ACT Government, NSW Office of Environment and Heritage, the Commonwealth Department of the Environment, University of Canberra, Australian National University, CSIRO Department of Entomology etc.

This report represents the first review of the Maintenance Plan. Review of the updated plan was undertaken by local biologist and author of the original Plan Alison Rowell, and representatives from Territory and Commonwealth Government Departments. Refer to **Section 1.2** (Acknowledgements) for further information.

5.2 Implementation of the Maintenance Plan

The leaseholder of the site will be responsible for the implementation and ongoing management of the Maintenance Plan and all associated costs.

All aspects of the Maintenance Plan should be carried out by:

- suitably qualified operators/contractors with demonstrated experience in NTG management, to be engage directly by the leaseholder of the site; or
- a recognised authority (e.g. the ACT Government), subject to an agreement, arrangement or Memorandums of Understanding with the recognised authority, with all expenses to be funded by the leaseholder.

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APPENDIX 1

Plant Species Recorded on Site

Plant species recorded at York Park
(p = present)

Species	Common Name	1991-2 WRM	1992 Davis & Hogg	1993 WRM	1994 WRM	1995 WRM	1996 WRM	1999 WRM	2000 WRM	2003 WRM	2006 Rowell	2007 Rowell	2009 Rowell	2011 Rowell	2013 Umwelt	2014 Umwelt	2015 Umwelt
Native grasses																	
Aristida ramosa	Wiregrass											p	p				
Rytidosperma auriculata	Lobed Wallaby Grass		p						p			p	p	p	p	p	p
Rytidosperma bipartitum	A Wallaby Grass										p	p	p				
Rytidosperma caespitosum	Ringed Wallaby Grass	p											p	p		p	
Rytidosperma carphoides	Short Wallaby Grass	p	p							p	p	p	p	p	p	p	p
Rytidosperma fulvum	A Wallaby Grass												p	p			
Rytidosperma laeve	Smooth Wallaby Grass	p	p								p	p	p	p	p	p	p
Rytidosperma spp.	Wallaby Grasses			p	p	p	p	p	p	p	p	p		p	p		p
Austrostipa bigeniculata	Tall Speargrass	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Austrostipa densiflora	A Speargrass			p													
Austrostipa scabra	Rough Speargrass		p									p		p	p	p	p
Bothriochloa macra	Redleg Grass	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Chloris truncata	Windmill Grass	p					p					p					
Elymus scaber	Wheatgrass	p	p	p			p	p	p		p	p	p	p	p	p	p
Eragrostis brownii	A Lovegrass	p															
Eragrostis trachycarpa	A Lovegrass					p	p						p	p			
Microlaena stipoides	Weeping Grass											p		p			
Panicum effusum	Hairy Panic Grass	p	p			p		p	p		p	p	p	p	p	p	p
Poa labillardieri	Tussock Grass										p	p		p	p	p	p
Themeda triandra	Kangaroo Grass									p	p	p	p	p	p	p	p
TOTAL		**9**	**8**	**5**	**3**	**5**	**6**	**5**	**6**	**5**	**10**	**15**	**13**	**15**	**11**	**11**	**11**
Native forbs																	
Acaena ovina	Sheeps Burr	p	p								p	p		p		p	p
Asperula conferta	Common Woodruff	p	p	p		p		p			p	p	p	p	p	p	p
Bulbine bulbosa	Golden Lily	p	p	p			p					p	p	p	p	p	p
Calocephalus citreus	Lemon Beauty Heads	p	p	p			p			p	p	p	p	p	p	p	p
Carex sp.	A sedge														p		
Chamaesyce drummondii	Caustic Weed	p															
***Cheilanthes* sp.**						p											
Cheilanthes sieberi	Rock Fern		p								p	p	p	p	p	p	p
Cheilanthes tenuifolia				p													
Chenopodium pumilio	Small Crumbweed													p			
Chrysocephalum apiculatum	Yellow Buttons	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p
Convolvulus angustissimus	Australian Bindweed	p	p		p					p	p	p	p	p	p	p	p
Crassula sieberiana	Australian Stonecrop												p			p	p
Cymbonotus lawsonianus	Bear's Ears		p														
Drosera peltata	Sundew		p														
Eryngium rostratum	Blue Devil	p	p	p			p	p			p	p	p	p	p	p	p
Euchiton sp.	A Cudweed					p		p	p								
Euchiton gymnocephalus	A Cudweed											p	p				
Euchiton sphaericus	A Cudweed													p	p		
Glycine tabacina	Vanilla Glycine										p			p			p
Gonocarpus tetragynus	Raspwort					p											
Goodenia pinnatifida	Scrambled Eggs	p	p	p	p	p	p			p	p	p	p	p	p	p	p
Hypericum gramineum	Small St John's Wort		p	p			p							p			
Juncus sp.	A Rush		p														
Lomandra bracteata	A Matrush											p	p	p	p	p	p
Lomandra filiformis	A Matrush	p	p				p				p						
Lomandra multiflora	A Matrush		p														
***Lomandra* sp.**	A Matrush			p	p	p	p	p	p		p						
Microtis unifolia	Common Onion Orchid		p										p		p	p	p
Oxalis perennans	Soursob	p	p	p	p	p	p	p	p			p		p	p	p	p
Pimelea curviflora	Curved Rice-flower		p	p		p					p	p		p	p	p	p
Plantago varia	Variable Plantain	p	p								p	p	p	p	p	p	p
Rumex brownii	Swamp Dock	p									p						

Species	Common Name	1991-2 WRM	1992 Davis & Hogg	1993 WRM	1994 WRM	1995 WRM	1996 WRM	1999 WRM	2000 WRM	2003 WRM	2006 Rowell	2007 Rowell	2009 Rowell	2011 Rowell	2013 Umwelt	2014 Umwelt	2015 Umwelt
Schoenus apogon	Bog-rush		p												p	p	p
Sebaea ovata			p														
Senecio quadridentatus	Cotton Fireweed													p			
Solenogyne dominii	Smooth Solenogyne	p	p														
Stackhousia monogyna	Creamy Candles		p					p				p			p	p	
Tricoryne elatior	Yellow Rush Lily	p	p	p	p		p	p	p	p	p	p	p	p	p	p	p
Triptilodiscus pygmaeus	Austral Sunray	p	p	p		p	p	p	p			p		p	p		p
Vittadinia muelleri	Fuzzweed									p		p		p			
Wahlenbergia sp.	A Bluebell			p	p	p	p	p						p			
Wahlenbergia communis	Tufted Bluebell	p	p								p	p	p	p	p	p	p
Wahlenbergia luteola	A Bluebell										p	p	p	p	p	p	p
Wahlenbergia multicaulis	Tadgell's Bluebell																p
Wahlenbergia stricta	A Bluebell		p														
Wurmbea dioica	Early Nancy		p														
Xerochrysum viscosum	Sticky Everlasting													p			
TOTAL		**17**	**28**	**14**	**7**	**11**	**12**	**10**	**6**	**6**	**17**	**20**	**16**	**25**	**21**	**20**	**20**
Exotic grasses																	
Aira sp.	A Hairgrass	p	p	p		p	p	p	p	p		p	p		p	p	
Aira elegantissima	A Hairgrass											p					p
Avena sp.	Wild Oats		p	p							p	p	p	p	p	p	
Avena barbata	Bearded Oats											p					p
Briza maxima	Blowfly Grass	p	p	p		p	p	p	p	p		p	p	p	p	p	
Briza minor	Shivery Grass	p	p	p		p	p	p	p	p		p	p	p	p	p	p
Bromus sp.	A Brome Grass			p	p	p	p	p	p		p						p
Bromus catharticus	A Brome Grass		p									p		p			
Bromus diandrus	A Brome Grass		p														
Bromus hordeaceus	A Brome Grass		p									p	p	p	p	p	p
Bromus mollis	Soft Brome	p															p
Cynodon dactylon	Couch			p								p		p			
Dactylis glomerata	Cocksfoot		p		p		p		p		p	p	p	p	p	p	p
Eleusine tristachya	Goose Grass							p									p
Eragrostis curvula	African Lovegrass	p														p	
Festuca sp.	A Fine-leaved Fescue		p				p				p				p		p
Festuca arundinacea	Tall Fescue								p	p	p	p		p		p	
Lolium perenne	Perennial Ryegrass											p			p		p
Lolium rigidum	Ryegrass		p	p													
Lophochloa cristata	Annual Cat's Tail											p					
Nassella neesiana	Chilean Needlegrass	p	p						p		p	p	p	p	p	p	
Nassella trichotoma	Serrated Tussock							p			p	p			p		p
Paspalum dilatatum	Paspalum			p		p	p	p	p	p	p	p	p	p	p	p	p
Phalaris aquatica	Phalaris	p	p	p		p	p					p		p	p	p	p
Vulpia sp.	Rat's-tail Fescue		p	p	p	p	p	p	p		p	p	p	p	p	p	p
TOTAL		**7**	**13**	**10**	**3**	**7**	**9**	**8**	**9**	**5**	**9**	**18**	**9**	**12**	**13**	**12**	**14**
Exotic forbs	Sorrel																
Acetosella vulgaris	Scarlet Pimpernel	p															
Anagallis arvensis	Capeweed			p													
Arctotheca calendula	Pink Stars											p					
Centaurium erythraea	Chickweed			p		p	p		p		p		p	p	p	p	p
Cerastium glomeratum	Spear Thistle		p														
Cirsium vulgare	Flax-leaf Fleabane			?			?										
Conyza bonariensis	Paterson's Curse					p	p							p	p	p	p
Echium plantagineum	Common Crowfoot											p					
Erodium cicutarium	A Bedstraw			p				p					p				
Galium divaricatum	A Cudweed					p	p										p
Gamochaeta purpurea	A Cudweed						p		p	p	p	p		p	p	p	p
Gnaphalium sp.	Hoary Mustard		p	p													
Hirschfeldia incana	St John's Wort		p									p		p	p	p	p
Hypericum perforatum	Smooth Catsear									p	p	p	p	p	p	p	p
Hypochaeris glabra	Catsear	p								p		p			p	p	p

		1991-2	1992	1993	1994	1995	1996	1999	2000	2003	2006	2007	2009	2011	2013	2014	2015			
		WRM	**Davis & Hogg**	**WRM**	**WRM**	**WRM**	**WRM**	**WRM**	**WRM**	**WRM**	**Rowell**	**Rowell**	**Rowell**	**Rowell**	**Umwelt**	**Umwelt**	**Umwelt**			
Species	**Common Name**																			
Hypochaeris radicata	Prickly Lettuce	p	p	p	p	p		p	p	p	p	p	p	p	p	p	p			
Lactuca serriola	A Peppercress						p	p		p	p	p	p	p	p	p	p			
Lepidium africanum	Common Bartsia											p								
Parentucellia latifolia	Proliferous Pink		p				p									p	p			
Petrorhagia nanteulii	Ribwort Plantain		p							p				p	p	p	p			
Plantago lanceolata	Onion Grass	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p			
Romulea rosea	Wild Sage											p				p				
Salvia verbenaca	French Catchfly		p									p								
Silene gallica	Common Sow-thistle						p					p								
Sonchus oleraceus	Salsify					p						p								
Tragopogon porrifolius	Narrow leaf Clover										p			p	p					
Trifolium angustifolium	Haresfoot Clover													p	p	p	p			
Trifolium arvense	Hop Clover		p												p	p	p			
Trifolium campestre		p	p									p	p	p	p	p	p			
Trifolium dubium	Clustered Clover		p							p							p			
Trifolium glomeratum			p													p	p			
Trifolium striatum	Clovers		p																	
Trifolium spp.				p		p	p	p												
TOTAL		**5**	**13**	**8**	**2**	**7**	**10**	**5**	**4**	**8**	**7**	**15**	**7**	**12**	**14**	**16**	**16**			
Exotic shrubs and trees	Cotoneaster																			
Cotoneaster sp.	Hawthorn											p								
Crataegus monogyna	Small-leaved Privet									p										
Ligustrum sinense	Large-leaved Privet																			
Ligustrum lucidum	Lombardy Poplar															p	p			
Populus nigra var. *italica*	Plum		p																	
Prunus sp.	Service Tree											p	p		p		p			
Sorbus domestica												p	p	p	p	p	p			
TOTAL		**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**3**	**2**	**1**	**1**	**2**	**2**			
Indicator 1 (Rehwinkel 2007)																				
Indicator 2 (Rehwinkel 2007)																				

APPENDIX 2

Cumulative Step-point Transect Survey Data

TRANSECT 1	2007	2009-10	2011-12	2013-14	2014-15	2015-16	2007	2009-10	2011-12	2013-14	2014-15	2015-16
	Hits/100 metres	Hits/100 metres	Hits/100 metres	% veg	% veg	% veg	% veg	% veg	% veg	% veg	% veg	% veg
	(% frequency)	(% frequency)	(% frequency)	(% frequency)	composition	composition	composition	composition	composition	composition	composition	composition
							(230 veg hits)	(201 veg hits)	(225 veg hits)	(158 hits)	(158 hits)	(156 hits)
Date	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**	**22-Oct-15**	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**	**22-Oct-15**
Easting start (WGS84)	**693810**											
Northing start	**6090258**											
Easting finish	**693877**											
Northing finish	**6090335**											
Bare ground	**20**	**30**	**3**		**1**	**3**	**8.7**	**14.9**	**1.3**		**0.6**	**1.9**
Litter	**30**	**21**	**40**	**19**	**23**	**20**	**13.0**	**10.4**	**17.8**	**12.0**	**14.6**	**12.8**
Cryptogam	**14**	**10**	**1**				**6.1**	**5.0**	**0.4**			
Native grasses												
Austrostipa bigeniculata	58	63	48	48	46	43	25.2	31.3	21.3	30.4	29.1	27.6
Bothriochloa macra	27	20	31	15	17	15	11.7	10.0	13.8	9.5	10.8	9.6
Rytidosperma spp.	13	4	2	8	4	6	5.7	2.0	0.9	5.1	2.5	3.8
Panicum effusum		4	5	1	2	1		2.0	2.2	0.6	1.3	0.6
Austrostipa scabra			2	1					0.9	0.6		
Elymus scaber			1	1	1	1			0.4	0.6	0.6	0.6
Themeda triandra			1	1	1				0.4	0.6	0.6	
Total native grasses	**98**	**91**	**90**	**75**	**71**	**66**	**42.6**	**45.3**	**40.0**	**47.5**	**44.9**	**42.3**
Native forbs												
Chrysocephalum apiculatum	4	1	4	6	5	6	1.7	0.5	1.8	3.8	3.2	3.8
Lomandra bracteata	1	1	1				0.4	0.5	0.4	0.0		
Tricoryne elatior	1		2				0.4		0.9			
Goodenia pinnatifida	1	1	2	2	2	2	0.4	0.5	0.9	1.3	1.3	1.3
Caocephalus citreus						4						2.6
Triptilodiscus pygmaeus	1						0.4					
Oxalis perennans			1						0.4			
Total native forbs	**8**	**3**	**10**	**8**	**7**	**12**	**3.5**	**1.5**	**4.4**	**5.1**	4.4	7.7
TOTAL NATIVES	**106**	**94**	**100**	**83**	**78**	**78**	**46.1**	**46.8**	**44.4**	**52.5**	**49.4**	**50.0**
Exotic grasses												
Dactylis glomerata	13	12	10	10	12	14	5.7	6.0	4.4	6.3	7.6	9.0
Paspalum dilatatum	8		11	4	3	5	3.5		4.9	2.5	1.9	3.2
Avena barbata	7	9	14	6	10	4	3.0	4.5	6.2	3.8	6.3	2.6
Nassella neesiana	5	3	7	7	4	3	2.2	1.5	3.1	4.4	2.5	1.9
Aira sp.	2	2					0.9	1.0				
Cynodon dactylon	1						0.4					
Bromus hordeaceus		1						0.5				
Briza maxima					1						0.6	
Briza minor		2		2		2		1.0		1.3		1.3
Vulpia sp.		6	1	1	4			3.0	0.4	0.6	2.5	
Festuca sp.					1	5					0.6	3.2
Total exotic grasses	**36**	**35**	**43**	**30**	**35**	**33**	**15.7**	**17.4**	**19.1**	**19.0**	**22.2**	**21.2**
Exotic forbs												
Plantago lanceolata	13	7	16	12	14	13	5.7	3.5	7.1	7.6	8.9	8.3
Hypochoeris radicata	8	1	13	5	3	4	3.5	0.5	5.8	3.2	1.9	2.6
Romulea rosea	2						0.9					
Hypochoeris glabra	1						0.4					
Trifolium campestre		2			1	2		1.0			0.6	1.3
Trifolium angustifolium				1	1					0.6	0.6	
Erodium cicutarium		1						0.5				
Tragopogon porrifolius			1						0.4			
Centaurium erythraea			7	3	2	1			3.1	1.9	1.3	0.6
Hypericum perforatum			1	4		2			0.4	2.5		1.3
Gamochaeta purpurea				1						0.6		
Total exotic forbs	**24**	**11**	**38**	**14**	**21**	**22**	**10.4**	**5.5**	**16.9**	**8.9**	13.3	14.1
TOTAL EXOTICS	**60**	**46**	**81**	**56**	**56**	**55**	**26.1**	**22.9**	**36.0**	**35.4**	**35.4**	**35.3**

TRANSECT 2	2007	2009-10	2011-12	2013-14	2014-15	2015-16	2007	2009-10	2011-12	2013-14	2014-15	2015-16
	Hits/100 metres	Hits/100 metres	Hits/100 metres	% veg	% veg	% veg	% veg	% veg	% veg	% veg	% veg	% veg
	(% frequency)	(% frequency)	(% frequency)	composition	composition	composition	composition	composition	composition	composition	composition	composition
							(210 veg hits)	(180 veg hits)	(210 veg hits)	(160 hits)	(165 hits)	(169 hits)
Date	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**	**23-Oct-15**	**Nov-07**	**8-Jan-10**	**10-Jan-12**	**19-Nov-13**	**18-Nov-14**	**22-Oct-15**
Easting start (WGS84)	**693810**											
Northing start	**6090258**											
Easting finish	**693877**											
Northing finish	**6090335**											
Bare ground	**13**	**21**	**6**	**3**	**5**	**4**	**6.2**	**11.7**	**2.9**	**1.9**	**3.0**	**2.4**
Litter	**30**	**20**	**30**	**19**	**18**	**21**	**14.3**	**11.1**	**14.3**	**11.9**	**10.9**	**12.4**
Cryptogam	**8**	**8**	**2**	**1**	**1**		**3.8**	**4.4**	**1.0**	**0.6**	**0.6**	
Native grasses												
Austrostipa bigeniculata	57	56	62	49	53	40	27.1	31.1	29.5	30.6	32.1	23.7
Bothriochloa macra	29	14	38	17	14	12	13.8	7.8	18.1	10.6	8.5	7.1
Rytidosperma spp.	11	6	13	12	11	7	5.2	3.3	6.2	7.5	6.7	4.1
Elymus scaber	1	1		2	3	6	0.5	0.6		1.3	1.8	3.6
Panicum effusum		3	1					1.7	0.5			
Aristida ramosa		2						1.1				
Total native grasses	**98**	**82**	**114**	**80**	**81**	**65**	**46.7**	**45.6**	**54.3**	**50.0**	**49.1**	**38.5**
Native forbs												
Chrysocephalum apiculatum	18	15	10	7	6	4	8.6	8.3	4.8	4.4	3.6	2.4
Lomandra bracteata	1	1	1		1		0.5	0.6	0.5		0.6	0.0
Tricoryne elatior	3	3		1	1	4	1.4	1.7		0.6	0.6	2.4
Goodenia pinnatifida	3		1	2	3	1	1.4		0.5	1.3	1.8	0.6
Triptilodiscus pygmeus				1		2				0.6		1.2
Asperula conferta	1	1					0.5	0.6				
Wahlenbergia luteola	1		1				0.5		0.5			
Calocephalus citreus		3	3	2	5	3		1.7	1.4	1.3	3.0	1.8
Cheilanthes sieberi		1	1					0.6	0.5			
Bulbine bulbosa		1		1				0.6		0.6		
Total native forbs	**27**	**25**	**17**	**14**	**16**	**14**	**12.9**	**13.9**	**8.1**	**8.8**	**9.7**	8.3
TOTAL NATIVES	**125**	**107**	**131**	**94**	**97**	**79**	**59.5**	**59.4**	**62.4**	**58.8**	**58.8**	**46.7**
Exotic grasses												
Dactylis glomerata	3	5	7	12	14	22	1.4	2.8	3.3	7.5	8.5	13.0
Paspalum dilatatum	1	1	6	2	1	6	0.5	0.6	2.9	1.3	0.6	3.6
Avena barbata	11	8	4	4	6	6	5.2	4.4	1.9	2.5	3.6	3.6
Nassella neesiana	7	2	6	1	1	3	3.3	1.1	2.9	0.6	0.6	1.8
Bromus hordeaceus	1	1	1	1	1	1	0.5	0.6	0.5	0.6	0.6	0.6
Aira sp.	1	5		2	4	2	0.5	2.8		1.3	2.4	1.2
Vulpia sp.				1	2	1				0.6	1.2	0.6
Cynodon dactylon	1						0.5					
Briza maxima					2	2					1.2	1.2
Briza minor				1						0.6		
Festuca sp.						1						0.6
Total exotic grasses	**25**	**22**	**24**	**24**	**31**	**44**	**11.9**	**12.2**	**11.4**	**15.0**	**18.8**	**26.0**
Exotic forbs												
Plantago lanceolata	7	2	6	8	6	4	3.3	1.1	2.9	5.0	3.6	2.4
Hypochoeris radicata	2		6	2	3	4	1.0		2.9	1.3	1.8	2.4
Tragopogon porrifolius				1						0.6		
Lactuca serriola												
Centaurium erythraea			2	2	1				1.0	1.3	0.6	
Hirschfeldia incana				1						0.6		
Hypericum perforatum			3	5	3	2			1.4	3.1	1.8	1.2
Total exotic forbs	**9**	**2**	**17**	**19**	**13**	**10**	**4.3**	**1.1**	**8.1**	**11.9**	**7.9**	**5.9**
TOTAL EXOTICS	**34**	**24**	**41**	**43**	**44**	**54**	**16.2**	**13.3**	**19.5**	**26.9**	**26.7**	**32.0**

APPENDIX 3

Cumulative Central Quadrat Data

Central quadrat data		2006	2007	2009	2011	2013	2014	2015
		Rowell	Rowell	Rowell	Rowell	Umwelt	Umwelt	Umwelt
Cover Abundance Key:	**Date**	**14 Jan 2007**	**9 Nov 2007**	**8 Jan 2010**	**4 Jan 2012**	**19 Nov 2013**	**18 Nov 2014**	**22 Oct 2015**
r: <5% and solitary (1-3 plants)*	**Easting (WGS 84)**	centre of	693832	693832	693832	693832	693832	693832
+: <5% and few (4-15 plants)*	**Northing**	site	6090303	6090303	6090303	6090303	6090303	6090303
1: <5%, common (>15 plants)	**Bare ground (CA)**	2	3	2	1	1	2	2
2: 5-25%	**Litter (CA)**	2	3	1	2	2	1	1
3: 25-50%	**Cryptogams (CA)**	1	2	1	+	+	+	
4: 50-75%	**Biomass removal**			unmown				
5: 75-100%								
*combined in 2006 survey								
Native grasses								
Anthosachne scabra	Wheatgrass	r/+	+	+		r	1	1
Austrostipa bigeniculata	Tall Speargrass	2	3	3	4	3	4	4
Austrostipa scabra	Rough Speargrass		+					
Bothriochloa macra	Redleg Grass	2	2	2	2	3	3	3
Eragrostis trachycarpa	A Lovegrass			1	r			
Panicum effusum	Hairy Panic Grass	r/+	1	1	1	+	+	
Rytidosperma auriculatum	Lobed Wallaby Grass		1	1	+	+	+	
Rytidosperma caespitosum	Ringed Wallaby Grass			+				
Rytidosperma carphoides	Short Wallaby Grass	2	1	1		+	+	2
Rytidosperma laeve	Smooth Wallaby Grass	1		1	1	1	1	
Rytidosperma spp.	Wallaby Grasses		+					2
Themeda triandra	Kangaroo Grass	r/+				r	r	2
Native forbs								
Bulbine bulbosa	Golden Lily		r	+	r	+	r	1
Convolvulus angustissimus	Australian Bindweed		+	r	+	+	1	1
Wahlenbergia communis	Tufted Bluebell	1	1	1	+	+	+	1
Calocephalus citreus	Lemon Beauty Heads	r/+	1	1	1	1	1	2
Cheilanthes sieberi	Rock Fern		1	+	1	1	1	2
Chrysocephalum apiculatum	Yellow Buttons	2	2	2	2	1	1	2
Goodenia pinnatifida	Scrambled Eggs	r/+	2	1	1	1	1	2
Lomandra bracteata	A Matrush		1	1	1	+	+	2
Pimelea curviflora	Curved Rice-flower	r/+	1		+	1	+	2
Tricoryne elatior	Yellow Rush Lily	1	1	r	1	r	+	2
Triptilodiscus pygmaeus	Austral Sunray				r			2
Wahlenbergia luteola	A Bluebell	1	+	r	r	r	r	2
Crassula sieberiana	Australian Stonecrop			r			+	
Eryngium ovinum	Blue Devil	r/+	r	r	r	r	+	
Euchiton gymnocephalus	A Cudweed			+				
Euchiton sphaericus	A Cudweed				r			
Hypericum gramineum	Small St John's Wort				r			
Lomandra filiformis	A Matrush	r/+						
***Lomandra* sp.**	A Matrush	1	1					
Oxalis perennans	Soursob				+	+	+	
Schoenus apogon						+		
Senecio quadridentatus	Cotton Fireweed		r		r			
Stackhousia monogyna						1	1	
Floristic Value Score (FVS)	Rehwinkel (2007)	**-**	**20**	**16**	**21**	**22**	**22**	
Exotic grasses								
Aira elegantissima	A Hairgrass		1					
Aira sp.	A Hairgrass			1		1	1	2
Avena sp.	Wild Oats		+		+	1	1	
Briza maxima	Blowfly Grass		1	r		1	1	2
Briza minor	Shivery Grass		1		r	1	+	1
Bromus hordeaceus	A Brome Grass		+	r	r	1	1	
Dactylis glomerata	Cocksfoot			r	+	+	1	2
Holcus lanatus	Yorkshire Fog							1
Nassella neesiana	Chilean Needlegrass					+		
Paspalum dilatatum	Paspalum			r				
Vulpia sp.	Rat's-tail Fescue	r/+	1	1	+	1	1	2
Exotic forbs								
Centaurium erythraea	Pink Stars			+	1	+	1	2
Conyza bonariensis	Flax-leaf Fleabane				1			
Echium plantagineum	Paterson's Curse		r					
Gamochaeta purpurea	A Cudweed	r/+	+		1	1	r	
Hypericum perforatum	St John's Wort	r/+	r	r	1	1	1	2
Hypochaeris glabra	Smooth Catsear		1			1	r	
Hypochaeris radicata	Catsear	1	2	1	1	1	1	2
Lactuca serriola	Prickly Lettuce	r/+		r			+	
Parentucellia latifolia	Red Bartsia						1	2
Petrorhagia nanteulii	Proliferous Pink				r	+		2
Plantago lanceolata	Ribwort Plantain	1	1	1	1	2	1	2
Romulea rosea	Onion Grass		+					
Tragopogon porrifolius	Salsify	r/+						
Triflium dubium	Yellow Suckling Clover							1
Trifolium arvense	Haresfoot Clover						+	
Trifolium campestre	Hop Clover		+	r	r		1	
Trifolium glomeratum	Clustered Clover						1	
Indicator 1 (Rehwinkel 2007)								
Indicator 2 (Rehwinkel 2007)								

APPENDIX 4

Summary of Mark-Release-Recapture Results for Male Golden Sun Moths for all Surveys

Year (period of captures)		1992 (69 days)	1993 (48 days)	1994 (45 days)	2006 (27 days)	2011 (6 days)
Number of individuals captured		317	321	375	398	94
Total captures		354	389	419	423	35
Recaptures after	1 day	25	54	30	21	After 1 session: 23 After 2 sessions: 15
	2 days	8	8	10	4	After 3 sessions: 5
	3 days	2	2	2	0	
	4 days	1	1	1	0	
	5 days	1	0	0	0	
Estimated total male population during period of captures: Fisher-Ford method MARK method JOLLY method		**524**	**456**	**736**	**440** **1230**	**Daily population est.:** 1st primary session: **66** (57-85) 2nd primary session: **49** (39-75) 3rd primary session: **12*** (* minimum number alive)

(Source: Rowell, 2012)

APPENDIX 5

Photographic Record of Site

Photo 1 (Transect 1, facing south)

Photo 2 (Transect 2, facing south)

Photo 3 (Transect 1, facing north)

Photo 4 (Transect 2, facing north)

Photo 5 (Quadrat)

Newcastle
75 York Street
Teralba NSW 2284
Ph. 02 4950 5322

Perth
PO Box 8177
Subiaco East WA 6008
33 Ventnor Avenue
West Perth WA 6005
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Attachment E

Alison Rowell (Ecologist),
Survey and Impact Assessment –
Golden Sun Moth

Survey and impact assessment at Golden Sun Moth *Synemon plana* site, Blocks 3 and 7, Section 22 Barton (York Park)

Report prepared for Parsons Brinckerhoff

by

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May 2007

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Mr Ted Edwards provided specialist advice on the biology of the Golden Sun Moth and on details of previous surveys. Ms Anett Richter of the University of Canberra performed the statistical analyses and prepared the graphs, and provided valuable technical advice and discussions during the project. Mr Arne Bishop undertook technical co-ordination and much of the moth capture work. Dr David Rowell of the Australian National University lent equipment and Tom Rowell, Cameron Summerville and Francis James provided field assistance.

Survey work carried out under Department of the Environment and Heritage (now Department of the Environment and Water Resources) Permit to Take Number E2006-0007.

Survey and impact assessment at Golden Sun Moth *Synemon plana* site, Blocks 3 and 7, Section 22 Barton

1. Background

1.1 The project

The south-eastern part of Block 3 and eastern part of Block 7, Section 22 Barton ACT contain a population of Golden Sun Moth *Synemon plana*, in about 0.5 ha of Natural Temperate Grassland dominated by species of Wallaby Grasses (*Austrodanthonia*) (ACT Government 1997, 1998, 2005). The Department of Finance and Administration, the owner of Block 3 Section 22 Barton, has appointed a Planning Consultant to develop a Master Plan to explore development opportunities for the block. Block 7 is Territory land. This part of Barton is part of an area known as 'York Park', and this term is often also applied to the Golden Sun Moth site itself.

The Golden Sun Moth is listed as Critically Endangered under Section 179 of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999,* Endangered (Schedule 1) on the NSW *Threatened Species Conservation Act 1995* (TSC Act), Endangered (Section 21) of the ACT *Nature Conservation Act 1980* and Threatened on the Victorian *Flora and Fauna Guarantee Act 1988* .

The species is found in natural temperate grasslands and grassy areas in open box-gum woodlands of south-eastern NSW, the ACT and Victoria (ACT Government 1998, DSE 2000). These plant communities are also listed as endangered under the above Acts (definitions vary). Action Plans (ACT Government 1997, 1998, 2005) and Recovery Plans (Environment ACT 2005, DCE 1992) have been prepared for the Golden Sun Moth and its habitat. A National Recovery Plan is in the final stages of preparation by Department of Environment and Conservation (NSW) and the Commonwealth Department of Environment and Water Resources.

Nationally threatened species and communities are identified as Matters of National Environmental Significance under the *EPBC Act*. Any proposed action on or near a site, which may have a significant effect on such values, must be referred by the proponent to the Minister for Environment and Heritage, for assessment as to whether the action requires approval under the Act.

For Blocks 3 and 7 Section 22 Barton, development on the currently undeveloped north-western portion of Block 3 has the potential to significantly affect the parts of Blocks 3 and 7 which contain Golden Sun Moth and Natural Temperate Grassland. Negative impacts could arise from loss of buffer area (increasing edge effects), tree planting, nutrification, run-on and altered drainage patterns. Most significantly, various building options would also result shading of the Golden Sun Moth habitat. Golden Sun Moths are generally found in flat or undulating habitats that are not subject to significant shading by hills, ridges or trees. Plants and animals in grassland communities are generally not adapted to shading, which can affect soil temperature and moisture and plant growth on a site.

1.2 Environmental values of the site

1.2.1 Natural Temperate Grassland

Status of the community
Natural Temperate Grassland of the Southern Tablelands of NSW and the Australian Capital Territory is listed as an endangered community under the *EPBC Act 1999*. The community is found between 560 and 1200 metres in valleys and broad plains. The dominant cover is native tussock grasses, with forbs such as daisies, lilies and native legumes in the intertussock spaces. It is estimated that about 5% of the original area of the community in the ACT survives in moderate to good condition, and up to about 1.5% remains in this condition over its whole previous range. Over 200 hectares of this community is reserved in the ACT, and about the same area in NSW (ESSS 2000).

Study site
The grassland on the York Park site has been given a Botanical Significance Rating of 4 (Low), and a Conservation Rating of 2 (Complementary Conservation Site). The Conservation Rating reflects that the site has only a low to moderate Botanical Significance, but contains a population of a threatened species that is considered to be viable in the medium term (ACT Government 2005).

The Natural Temperate Grassland on this site is part of a long-term grassland monitoring program being undertaken by Environment ACT, and the vegetation quality in Block 3 has been previously been assessed and mapped (Davis & Hogg 1992, ERM 2005).

1.2.2 Golden Sun Moth *Synemon plana*

Status of the species
The Golden Sun Moth is currently listed as Critically Endangered nationally, and Endangered in all the States and Territories in which it occurs. A Critically Endangered species is considered to be facing an extremely high risk of extinction in the wild in the immediate future.

Distribution
Prior to European settlement the species was widespread in native grasslands in south-eastern Australia, from near Bathurst NSW through the Australian Capital Territory and Victoria to Bordertown, SA (Edwards 1993, 1994). This distribution was correlated with grasslands dominated by low-growing Wallaby Grasses (*Austrodanthonia* species), and has contracted substantially (O'Dwyer & Attiwill 1999). The species is now only found in a few relatively small breeding areas due to habitat loss, fragmentation and degradation. Possibly less than one percent of the original habitat now remains, much of it degraded by weed invasion (Clarke & O'Dwyer 1997, O'Dwyer & Attiwill 1999, ACT Government 2005).

Description and life history

The Golden Sun Moth is a medium sized day-flying moth in the family Castniidae. The male has a wingspan of about 34 mm, the female slightly less. The upper forewings of both are grey/brown with paler patterns. The male has dark brown upper hindwings, and in the female these are bright yellow/orange edged with black spots (Figures 3 & 4).

Golden Sun Moth larvae feed on the underground parts of Wallaby Grasses (Edwards 1993, O'Dwyer & Attiwill 1999), and may sometimes feed on other native and introduced grasses (Braby & Dunford 2006). Larval development time (and thus generation time) is unknown and may vary between one and three years.

The adults live for only 1–4 days after emerging during spring, and do not feed as they have no functional mouth parts. In the middle of the day when conditions are sunny and warm, males patrol the grassland in search of the females, which have reduced hindwings and are poor fliers. The starting date and duration of the flight season vary from year to year, probably depending on spring weather conditions, with the season starting earlier in a warm dry spring (Cook & Edwards 1993).

Conservation

The Golden Sun Moth occurs in one conservation reserve in NSW, eight populations are reserved in the ACT and two in Victoria (ACT Government 2005, DEC unpublished). Four of the larger habitat areas in the ACT have been given a High Conservation Value rating (ACT Government 1998). Six ACT populations in small areas of habitat (0.1 to 3 ha) have been identified as being of doubtful long-term viability, even under optimum conditions. The limited flight ability of the female moths adds to the species' vulnerability to extinction on small sites, and makes natural re-colonisation from other sites unlikely.

Study site

The York Park (current study) site, although small, has received a Moderate Conservation Value rating, increased because of the previous scientific work carried out on the site (ACT Government 1998). Clarke (1998) also considered that this site warranted special attention due to its 'high profile and considerable research focus in past years'.

The area of the Golden Sun Moth habitat on this site is about 5600m². The Golden Sun Moth population has been intensively surveyed in the past. The previous studies include three mark-release-recapture surveys producing estimates of population size (Cook & Edwards 1993 & 1994, Edwards 1994, Harwood *et al.* 1995), and genetic analysis of the population (Clarke & O'Dwyer 1998). Provisional management recommendations have also been prepared for the site (Frawley 1995, Edwards 1995). These included rehabilitation of the vegetation by translocation of soil and grassland plants from a nearby area which was being developed (Davis & Hogg 1992, Harwood *et al.* 1995).

2. Aim

The brief for this project requires an assessment of environmental factors for Block 3 Section 22 Barton, with a comprehensive study of the Golden Sun Moth *Synemon plana*, ‘including a Capture-Mark-Release study for the 2006-07 season’. Mark-release-recapture methods require that individuals from a population be captured, marked and released. Sampling the population on subsequent occasions allows the determination of the proportion of the population carrying marks and hence an estimate of the number of individuals in the population.

It was recognised that survey data from a single season can only reliably detect large changes in the population, as numbers of flying male Golden Sun Moths vary considerably from year to year, probably affected by seasonal conditions. However, repeating the surveys carried out 14-16 years ago allows broad comparison of the population estimates, and provides some information on the effects of site management and environmental conditions on the population in the intervening period.

The mark-release-recapture survey required for this site was recognised as having the potential to damage individual animals and disrupt their behaviour throughout the breeding period. A Permit to Take under Section 201 of the *EPBC Act 1999* was therefore sought and obtained from the Department of Environment and Heritage (now Department of the Environment and Water Resources). This permit (E2006-0007) allowed up to 400 Golden Sun Moths to be handled and marked, and during the survey was amended to allow more moths to be handled.

Figure 1. Male Golden Sun Moth after capture and numbering.
(Photograph: Anett Richter)

3. Methods

3.1 Golden Sun Moth survey

The methods employed in the current mark-release-recapture survey differed slightly from those used in the 1992-1995 surveys, for several reasons. The previous surveys did not use exactly the same methods each year, so the methods selected for 2006 were a combination of past methods. The earlier surveys also covered almost the whole flying period of the Golden Sun Moth at the site, but the date of issue of the 2006 Permit to Take meant that the 2006 survey did not include the first 2 to 3 weeks of adult moth activity. Both male and female moths were captured in the earlier surveys, but captures and recaptures of females were so low that the data could not be used in estimating the population. It was therefore decided not to capture females in 2006, to reduce interference to mating and egg-laying.

The Permit to Take was issued on 16 November 2006. A trial of methods was conducted on 17 November, and adult male Golden Sun Moths were sampled daily from 18 November to 19 December. The site was divided into 9 equal sectors (3 x 3, see Figure 7). Collection was undertaken for one hour (excluding handling and marking time), generally between 1030 and 1230 hours (Eastern Daylight Saving Time). This was before the peak activity period, to reduce disruption to mate-seeking and mating. Moths were captured from all parts of the site with 40cm butterfly nets, and marked with a number on the underside of the hindwing, using a quick-drying xylene-free metallic ink pen (Artline 999XF Silver) (Figure 1). The mark number, location of capture and condition of each moth were recorded on a daily data sheet (see following page). Sightings of females were also noted (see Photograph 2).

After marking, moths were kept in the shade in a mesh-sided holding cage with a cloth cover, to reduce damage from fluttering (Figure 2). All moths were released in the centre of the site (Sector 5, Figure 7) at the end of the collection period each day.

The capture and recapture data were analysed by Ms Anett Richter (University of Canberra) using appropriate open-capture models in the programs MARK and JOLLY, and estimates of the male population were produced. An open population is one which is subject to changes due to birth (emergence), death, immigration and emigration during the sampling period. The previous method of analysis (Fisher-Ford) was not used due to technical difficulties, but the methods chosen were suitable for populations with low survival and recapture rates.

YORK PARK GOLDEN SUN MOTH SURVEY, 2006

Date:	**Start time:**	**Finish time:**

Weather conditions:

Cloud/8:	**Cloud density:**	**Wind speed:** **Direction:**

Temp. during survey:	**Daily temp. range:**

Surveyors:

Sector	**Number (today)**	**Mark**	**Condition**	**Comments**

Comments:

Long grass area and fence **North**

7	**4**	**1**
8	**5**	**2**
9	**6**	**3**

National Circuit

Condition

1: Upperwing markings clear, wing margins intact
2: Markings less distinct, wing margins intact
3: Markings obscure, wing margins worn

3.2 Habitat assessment

Three 20 metre by 20 metre vegetation quadrats were surveyed in the Golden Sun Moth habitat area in March 2007 (Appendix 3). The quadrats were placed centrally in sectors 2, 5 and 8. Species composition and percentage cover were recorded. Notes were also made on the vegetation of the unmanaged portion of Block 3, and on the vegetation of the median strip of Sydney Avenue, east and west of National Circuit.

3.3 Assessment of shading effects

Diagrams showing the extent of shading of the subject site at different times of the day in various seasons were produced by Colin Stewart Architects. These were examined to assess the potential effect of shading on the Golden Sun Moth habitat.

Figure 2. Male Golden Sun Moths in temporary mesh holding cage.
(Photograph: Anett Richter)

Figure 3. Female Golden Sun Moth showing upperwing pattern.
(Photograph: A Rowell)

Figure 4. Female Golden Sun Moth, ventral view.
(Photograph: A Rowell)

4. Results

4.1 Golden Sun Moth survey

4.1.1 Flying season and captures of males

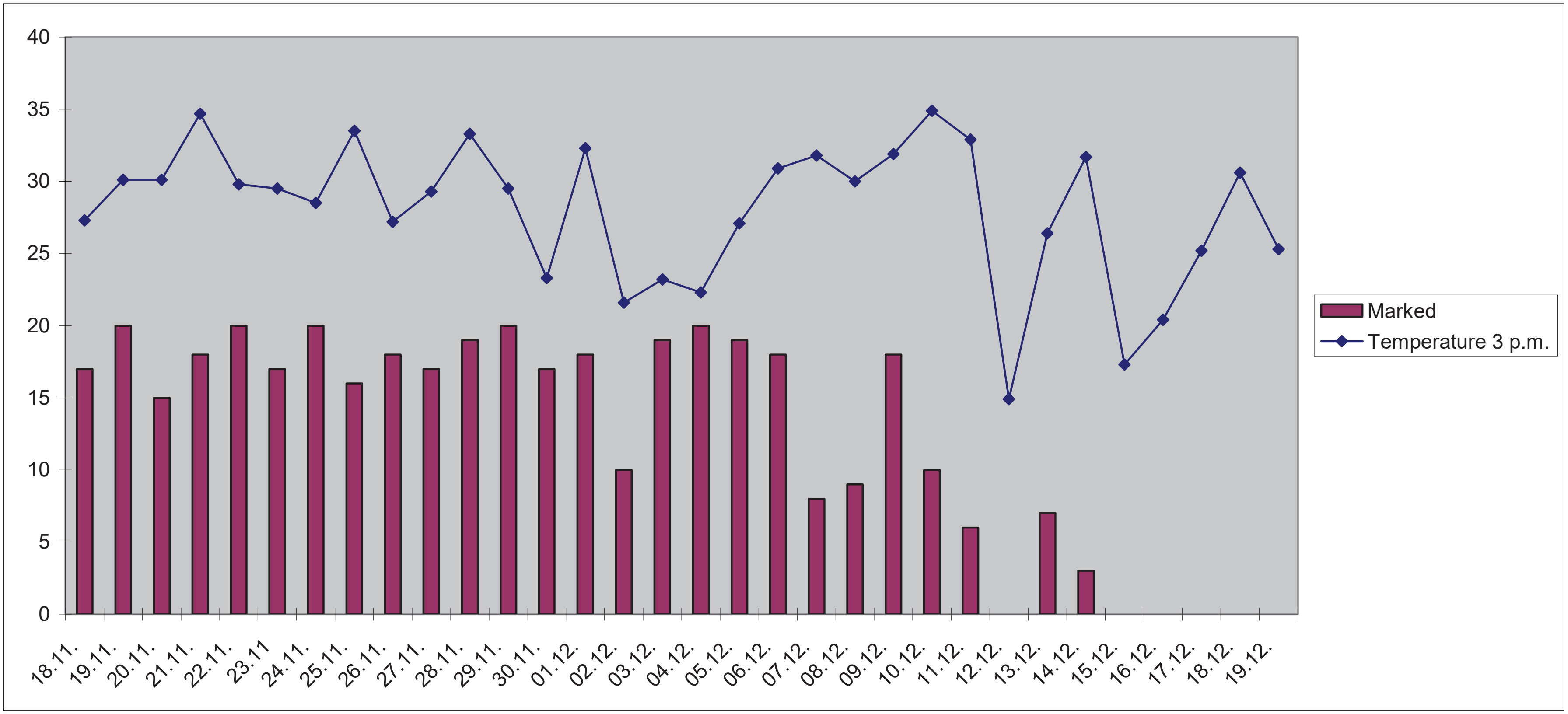
The first report of flying male Golden Sun Moths in the district in 2006 was at Mulligans Flat in the north of the ACT on 16 October (Steven Holliday, pers. comm.). This is exceptionally early, and probably a result of the unusually warm conditions in early spring 2006. Male moths were first observed flying at the York Park site on 30 October by Ms Anett Richter, a PhD student from the University of Canberra who is studying grassland invertebrates in the ACT. Reasonable numbers were flying on this date, so the date of first appearance in 2006 is likely to have been earlier. The dates on which males were first seen flying on this site in previous years were 23, 16 and 17 November.

The Permit to Take was issued on 16 November 2006, the trial of methods was conducted on 17 November, and capture sessions were undertaken daily from 18 November to 19 December. 419 male Golden Sun Moths were captured and marked between 17 November and 14 December. No moths were seen or captured on 12 December, when the temperature during the collection period was 11-12 degrees Celsius. Only one moth was seen between 15 and 19 December, and none were captured in this period. When no moths had been captured for 5 days despite suitable conditions, it was decided that the breeding season had ended (see Figure 5).

398 of the moths captured were used in the population study. The 21 males excluded from the population study were those handled in the trial of methods, and others caught after the end of the capture period on the first three days of the study (due to miscalculation of capture period). Seven female Golden Sun Moths were observed during the survey. No moths were killed during handling and marking, and all marked moths were able to fly away from the holding cage at the end of the daily survey period.

From the 398 individual male moths captured and marked, there were 25 recaptures. 21 of the recaptures were on the day following first capture, and 4 recaptures were 2 days after first capture. No moths were captured more than 2 days after marking.

Figure 5. Daily first captures of male Golden Sun Moths at York Park, spring 2006.
(Graph by Anett Richter)



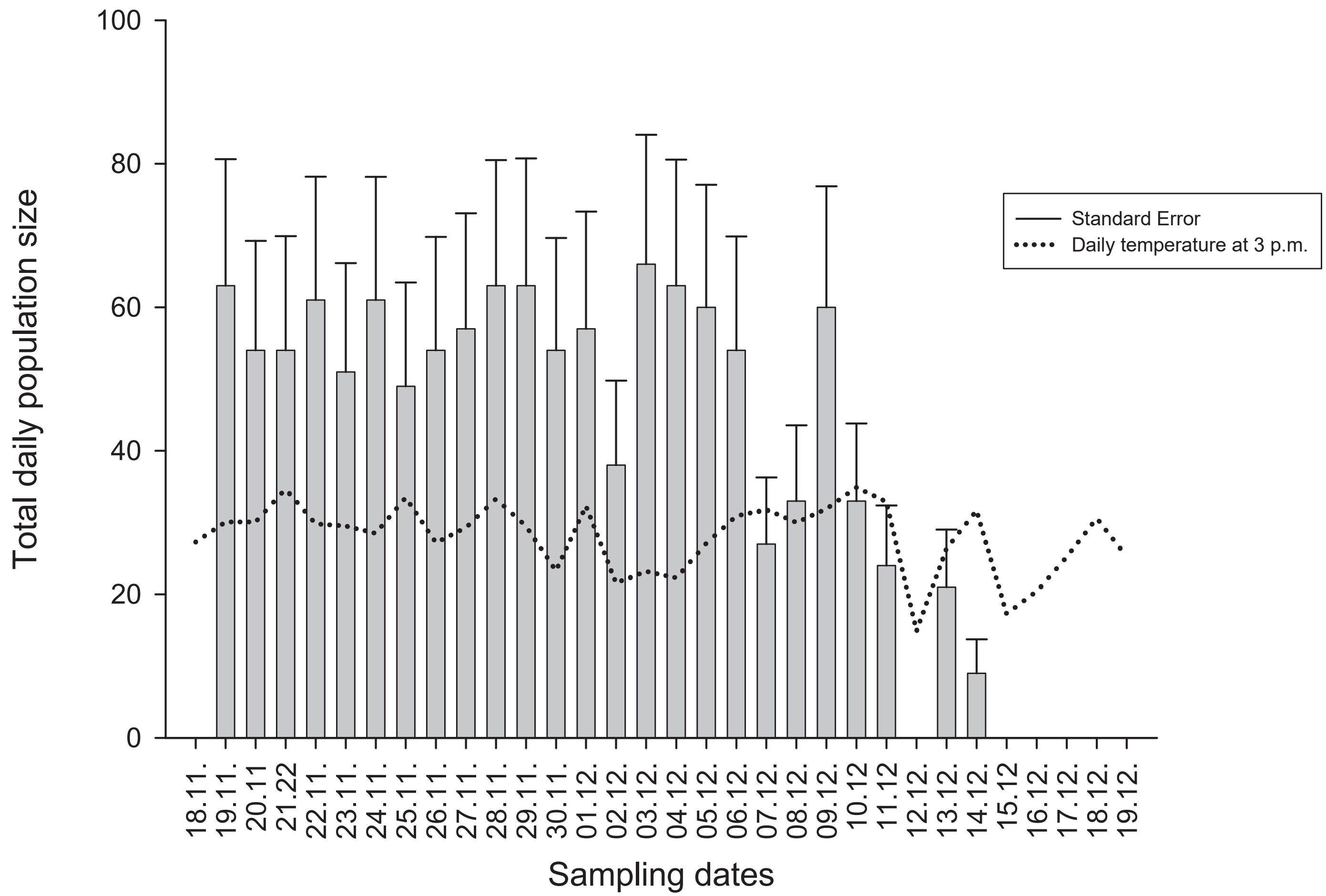


Figure 6. Estimated daily male population size at York Park, Barton, spring 2006.
(Jolly-Seber model D). (Graph by Anett Richter)

4.1.2 Distribution and movements

As observed in previous seasons, captures were made in all sectors (see Figure 7), but the distribution of captures changed over the survey period, with more moths captured in the central and northern sectors in November, and greater numbers in the southern sectors in December (Table 1). This pattern also appeared in the sightings of female moths. In the previous surveys it was also suggested that changes in the capture sites of the males may reflect a change in the distribution of females during the season (Cook & Edwards 1993, 1994).

Noting the sector of capture enabled some observations to be made of movements of male moths around the site. Moths could be recaptured in the same sector, or could move one or two sectors (laterally and/or diagonally) away from the site of previous capture. 16% of recaptures were made in the same sector as the previous capture, 60% were made in an adjacent sector (ca 15 to 40 metres away), and 24% of recaptures were two sectors from the previous capture site (ca 30 to 80 metres away). This suggests that the males are not attached to particular parts of the site over time.

All 423 releases (new captures plus recaptures) at the end of the daily survey period were made in the central sector. Recaptures could then be made in the same sector as release, or in an adjacent sector. 24% of the 25 recaptures were made in the sector of release (sector 5). A similar figure of 21% of total captures were made in sector 5, suggesting that recaptured animals were not much more likely to be found in this sector than other individuals were, i.e. releasing animals in the middle of the site did not skew recapture results towards this sector.

Male moths were observed to fly from the study site to degraded vegetation on the median strip of Sydney Avenue. Many males were seen flying over this median strip, both east and west of National Circuit, but no females were seen there. Some males were seen to fly through the wire fence into the weedy long grass west of the site, but these usually returned quickly to the mown area.

Male moths were seen circling over or landing near stationary females. Males performed the same manoeuvres around pieces of amber glass, which occasionally led to more than one being captured with a single sweep of the net.

Figure 7. Sectors of the Golden Sun Moth survey site.

National Circuit

3	**6**	**9**
2	**5**	**8**
1	**4**	**7**

Sydney Ave

Table 1. Change in distribution of captures of male Golden Sun Moths during survey period.

Sector	Captures for whole survey period	Captures in November	Captures in December	Change over survey period
1	33 (8%)	22 (9%)	11 (6%)	↓
2	28 (7%)	15 (6%)	13 (7%)	≈
3	14 (3%)	10 (4%)	4 (2%)	↓
4	116 (27%)	67 (28%)	49 (27%)	≈
5	89 (21%)	66 (27%)	24 (13%)	↓↓
6	19 (5%)	13 (5%)	6 (3%)	↓
7	37 (9%)	14 (6%)	23 (13%)	↑↑
8	69 (16%)	29 (12%)	40 (22%)	↑↑
9	17 (4%)	8 (3%)	9 (5%)	↑

4.1.3 Moth condition

Condition of captured male moths was assessed as follows:

- Condition 1 - Upperwing markings clear, wing margins intact
- Condition 2 - Markings less distinct, wing margins intact
- Condition 3 - Markings obscure, wing margins worn

Condition 1 moths had probably emerged on the morning of capture. Their fine wing markings were clear because most of the wing scales were intact. These scales rub off with activity and wear, and the markings become less distinct. Condition 3 moths had lost many of their wing scales, and the margins of their wings were worn or damaged. These moths had probably emerged on a previous day. Condition 2 moths could have emerged early on the day of capture, or on a previous day.

Handling and marking of moths caused loss of wing scales, but did not generally damage the wing margins. This meant that moths captured as Condition 1 were often released as Condition 2. This did not appear to impair their ability to fly after release. All recaptures were either Condition 2 or Condition 3.

The proportion of first-capture moths in Condition 1 each day was 25-80%, while Condition 3 moths made up 0-53% of first captures each day. This result supports the interpretation that Condition 3 moths are older animals, with their numbers declining through mortality. A possible cohort effect could sometimes be seen, with relatively high numbers of Condition 1 moths on one day being followed by relatively high numbers of Condition 3 moths on the two subsequent days.

Some variation in the size of the male moths was also noted. A few Condition 1 individuals were recorded as being unusually large or small, but this was not confirmed by measurement. Condition 3 moths often appeared smaller due to loss of wing area.

4.1.4 Predation

Several species of birds were seen to take Golden Sun Moths, mainly from the ground. These were Common Starling, Magpie-lark and Black-faced Cuckoo-shrike. The Magpie-larks were nesting nearby, and feeding moths to their young. Australian Magpies and Common Mynahs also frequented the site, and probably took Golden Sun Moths. No instances were seen of predation by Robber Flies or Dragonflies, although this has been a common occurrence on this and other sites in previous years (Cook & Edwards 1993 & 1994, Edwards 1994, Harwood *et al.* 1995, A. Rowell pers. obs.). Invertebrate numbers have been generally low in local grasslands in the last year (pers. obs., Anett Richter pers. comm.), presumably due to the prolonged drought.

4.2 Population estimates

The data set of 398 encounter histories was initially analysed by Ms Anett Richter (University of Canberra) using open-capture models in the software MARK (Windows 95). A set of models was developed, analysed and ranked following analysis. The best fitted model for open populations was the POPAN model, which includes constant parameters for apparent daily survival rate, (re)capture probability and probability of entry to the population.

The data were re-analysed by Ms Richter using the program JOLLY, calculating daily population estimates with an open population model that assumes the survival rate and capture probability to be constant per unit time (Figure 6). This model was considered to give a more accurate total population estimate than the model used in MARK. The details of both analyses are attached as Appendix 1 and Appendix 2.

A summary of these analyses are shown with the results from previous surveys in Table 2. The MARK analysis gives a male population slightly lower than previous estimates, and the JOLLY analysis gives an estimate two to three times higher. It should be noted that the population estimates are of the number of male moths present during the capture period, and that this period was both shorter in 2006 and a smaller proportion of the total flying season. Sampling was carried out for almost the entire flying season in the earlier surveys, while up to two weeks (or one third) of the flying season was missed in 2006. This means that both population estimates for 2006 underestimate the total numbers of males emerging on the site in that season, and that the male population was almost certainly larger in 2006 than in 1992-95.

It is not known whether being captured once reduces the chances of a moth being captured again, either through increased morbidity/mortality or increased wariness. If this were the case, the reduced recapture results would result in an overestimate of the population. This could be expected to affect the population estimates from all years in a similar way, as the methods used are essentially the same.

It would be advantageous if the data from all seasons could be analysed using the same programs, and to this end efforts are being made to obtain the raw data from the earlier surveys for re-analysis.

No attempt was made to capture females in 2006, and care was taken to avoid disturbing them. In 1992-1995, both males and females were captured, and the observed male:female sex ratios were 9:1, 36:1 and 38:1. The ratio of males (captured) to females (observed during surveys) was 57:1 in 2006, but this figure cannot be compared to the earlier ratios, due to the difference in methods. After the earlier surveys it was assumed that the behavioural differences between the sexes partially explained the variation in numbers caught, with the sampling method favouring the capture of males. However, the possibly skewed sex ratio was still considered to be of concern, with the number of reproductive females being critical to population viability (Harwood *et al.* 1995).

Table 2. Summary of mark-release-recapture results for male Golden Sun Moths for all surveys.

Year (period of captures)	**1992** (69 days)	**1993** (48 days)	**1994** (45 days)	**2006** (27 days)
Number of individuals captured	317	321	375	398
Total captures	354	389	419	423
Recaptures after 1 day	25	54	30	21
2 days	8	8	10	4
3	2	2	2	0
4	1	1	1	0
5	1	0	0	0
Estimated total male population during period of captures:				
Fisher-Ford method	**524**	**456**	**736**	
MARK method				**440**
JOLLY method				**1230**

4.3 Habitat assessment

4.3.1 Vegetation

The 0.56 ha of Golden Sun Moth habitat on this site is defined by the fenced and mown area, and includes native pasture (adjacent to Sydney Avenue) and Natural Temperate Grassland (0.4 ha). The verges and median strips of the adjacent roads provide a degraded grassland buffer, which has the potential to become auxiliary habitat if rehabilitated.

Previous descriptions of habitat for this species have suggested that a minimum density of 40% Wallaby Grass *Austrodanthonia* cover is required to sustain a Golden Sun Moth population (*e.g.* Dear 1997 in ACT Government 2005, O'Dwyer & Attiwill 1999). Wallaby Grass cover can vary considerably on a site over a year, being affected by factors such as heavy grazing and low summer growth rates. Recent surveys in the ACT have found Golden Sun Moths on sites which have much lower cover of Wallaby Grasses, but the condition and population trends of the Golden Sun Moth populations on these sites is not known (Braby & Dunford 2006, Rowell 2005). Recent detailed studies at a Victorian site found that Wallaby Grass cover at Golden Sun Moth sites varied from 0% to 37%, and did not find a strong correlation between numbers of flying males and Wallaby Grass cover (Gibson 2006).

Five species of Wallaby Grass were recorded on the study site, the most common being Short Wallaby Grass *Austrodanthonia carphoides* and *A. laevis*. Three 20 metre x 20 metre vegetation quadrats in the north, centre and south of the site were assessed. Wallaby Grasses were present in all quadrats, but none had cover greater than 25% (see Appendix 3 and Figures 9 to 11). More moths were captured in the central sector which had lower cover of Tall Speargrass *Austrostipa bigeniculata*, higher cover of forbs (non-grass species) and more open ground than the other two sectors where the vegetation was surveyed.

The unmown part of Block 3, west of the study site, was dominated by exotic species such as Phalaris *Phalaris aquatica*, Hoary Mustard *Hirschfeldia incana* and Wild Oats *Avena* species. It also contained scattered native grasses, including Wallaby Grasses *Austrodanthonia laevis* and *A. bipartita*, which is an uncommon species in the ACT (Isobel Crawford pers. comm.). This part of Block 3 is very disturbed, and may have received fill during the construction of the R G Casey Building (to the west). It is not considered to be Golden Sun Moth habitat, and it is currently a source of weeds for the habitat area (Figure 8).

The vegetation on the Sydney Avenue median strips was also dominated by exotic species, the most common being Chilean Needlegrass *Nassella neesiana*. This exotic grass was recently found to be the dominant species on a floodplain of Ginninderra Creek where Golden Sun Moths occur, and it has been suggested that it is a possible food plant of Golden Sun Moth larvae, but this has not been confirmed (Braby & Dunford 2006). Wallaby Grasses made up less than 5% of the vegetation cover on the median strips, and no evidence was found that Golden Sun Moths had emerged there, nor were any females observed there (Figure 12).

Figure 8. Disturbed vegetation in Block 3, west of Golden Sun Moth habitat. Dominated by Phalaris, with scattered Wallaby Grass *Austrodanthonia bipartita.*

Figure 9. Vegetation in Sector 2 (Block 7) of Golden Sun Moth site. Low quality Natural Temperate Grassland, low diversity of native grasses with some common forbs.

Figure 10. Vegetation in Sector 2 (centre of Block 3) of Golden Sun Moth site. Moderate quality Natural Temperate Grassland, moderate diversity of native grasses and forbs, patches of bare ground.

Figure 11. Vegetation in Sector 8 (south end Block 3) of Golden Sun Moth site. Native pasture, low diversity of native grasses and exotic species, few native forbs.

Figure 12. Median strip of Sydney Avenue, east of National Circuit. Dominated by exotic species, low cover of native grasses, much bare ground.

4.3.2 Canberra Raspy Cricket *Cooraboorama canberrae*

Active burrows of the uncommon Canberra Raspy Cricket *Cooraboorama canberrae* were found scattered across the site. This is a large wingless cricket, known only from relatively undisturbed grasslands in the lower parts of the Majura, Jerrabomberra and Molonglo valleys, and a small number of other locations in the ACT and nearby NSW (Queanbeyan-Bungendore). Much of its known habitat has been lost to housing in the ACT, and it is vulnerable to habitat fragmentation because it is flightless. It makes distinctive vertical burrows with a round cross-section, a clay and silk cap and a circle of bare soil around the entrance (Figures 13 & 14). The endangered Grassland Earless Dragon is known to use the abandoned burrows of this species as shelter sites. Information about this animal could be included in interpretative signage on the site.

Figure 13. Capped burrow of Canberra Raspy Cricket.

Figure 14. Female Canberra Raspy Cricket.
(5mm grid)

4.4 Assessment of shading effects of building options

The features of the building design options (Colin Stewart Architects) are summarised in Tables 3 and 4, and their potential effect on the Golden Sun Moth population is discussed below.

Table 3. Building design options.

Design option	**Building height**	**Setback from reserve**	**Time shadow enters habitat area on 21 June**	***Portion of habitat shaded on 21 June at 1500 hrs (EST)**
1	5 storeys	28 metres	ca 1330 hours	ca 47%
2	5 storeys	40	1415	26%
3a	4 storeys	24	1400	25%
3b('wings')	4 storeys	24	1300 (wing)	26%

* assumes access road to Block 7 is not constructed north of Block 3.

Table 4. Details of shading by Option 3b.

Date	**Time shadow enters habitat (EST)**	**Portion of habitat shaded at time**
21 June	1300 hrs	1500 hrs: 27.0%
21 March/23 September	1400 hrs	1500 hrs: 4.4% 1600 hrs: 32.0%
22 December	1700 hrs	1800 hrs: 8.4%

4.4.1 Option 1 (November building design)

This building has 5 levels and a 40 m frontage to Sydney Avenue. It is set back 28 m from the current grassland reserve boundary.

The effect of shading on the grassland and Golden Sun Moth habitat by this building is likely to be significant. The shadow enters the site by 1330 hrs in winter, and 47% is shaded by 1500 hrs. In spring and autumn the building shadow enters the grassland at about 1430 hrs. In summer the effect is less, and the building shadow has not reached the grassland boundary by 1600 hrs.

This level of shading will reduce soil temperatures and increase soil moisture, particularly between autumn and spring. This is likely to favour weed species over the native grasses and forbs, which are not adapted to shading. This could reduce the density of Wallaby Grasses, the roots of which are thought to be the primary food for the moth.

4.4.2 Option 2 (January building design)

This building has a 35 m frontage to Sydney Avenue. It has 5 levels with the uppermost level being set back from the edge nearest the reserve. It is placed closer to Windsor Walk than Option 1, and set back about 40 m from the boundary of the grassland reserve.

Reducing the profile and footprint of the building and moving it further from the reserve boundary reduces the amount of shading of the grassland reserve. The building shadow does not enter the site until about 1430 hrs in winter, and by 1500 hrs about 26% of the site is shaded.

This building design is likely to have a lesser effect on the activity of adult Golden Sun Moths during their breeding period in early summer, and reduces the daily number of hours of shading from autumn to spring.

4.4.3 Option 3a (February Building Design)

This building causes slightly more shading of the Golden Sun Moth site at the winter solstice than Option 2. The building is lower than the other two options, but is closer to the reserve boundary than Option 2.

4.4.4 Option 3b, with 'wings' (March Building Design)

This option results in slightly more shading of the site than Options 2 and 3. The small shadow of the 'wings' enters the site earlier, and the main building shadow enters at the same time as for Option 3a.

4.4.5 Access road to Block 7

The construction of this road and its associated landscaping would destroy or negatively affect about 21% of the existing natural temperate grassland and Golden Sun Moth habitat in Section 22.

5. Discussion

5.1 Significance of the York Park Golden Sun Moth population

5.1.1 Species conservation status

In 2002, the conservation status of the Golden Sun Moth was raised from Endangered to Critically Endangered under the *EPBC Act 1999.* A Critically Endangered species is considered to be facing an extremely high risk of extinction in the wild in the immediate future. Many new populations of this species have been discovered in recent years (Clarke & O'Dwyer 1998, Clarke 2000, Clarke 2001, A. Rowell pers. obs., Mark Dunford pers. comm.), but many are small and relatively few are in reserves. Eight populations in the Canberra-Queanbeyan area are currently reserved.

5.1.2 Genetic status

Genetic analysis of Golden Sun Moth populations across its entire range in the ACT, NSW and Victoria has identified five distinct population groups based on genetic variation and diversity (Clarke & O'Dwyer 1998, revised in Clarke 2000 and 2001). The genetic distance between groups corresponds with geographic separation, and it was recommended that the groups be treated as separate units for conservation management. It was also recommended that a minimum of two populations from each genetically defined cluster should be considered for priority conservation management, with the aim of conserving and maintaining as much genetic diversity and variability as possible within the species. Selection of priority sites for conservation is based on the genetic variation and diversity of the population, as well as site size, quality and tenure.

The most recent genetic analysis (Clarke 2001) puts the York Park population in a genetic sub-group (within a larger ACT/NSW group) that includes large populations at the Belconnen Naval Station, Majura Valley East, Mulanggary Grassland Reserve and Jerrabomberra Reserve (Woden) in the ACT and Letchworth Reserve in NSW, and smaller sites at Black Street in Yarralumla, Mulligans Flat Reserve and Campbell Park paddocks in the ACT. Four of the ten populations in this group have been given a High Conservation Value rating by the ACT Government, and four are already in reserves. A large part of the decommissioned Belconnen Naval Station (High Conservation Value site) is likely to be incorporated into a reserve in the future, and the Campbell Park site is also likely to become part of the Canberra Nature Park. On current information it appears that the genetic characteristics of the group containing the York Park population are reasonably well protected.

5.1.3 Population trends

Numbers of males at this site appear to be stable or increasing, but the sex ratio still appears skewed. A refinement of survey methods would be necessary to determine the actual sex ratio, which is relevant to the long-term viability of the population. The length of the larval period is still uncertain. A larval period longer than one year could mean that there is a lag between events that have an impact on the population and the detection of that impact by surveys of adult abundance.

As noted previously, the York Park population has been given a Moderate Conservation Rating by the ACT Government, and is considered to warrant special attention due to its long research history. The life history of the Golden Sun Moth is still poorly known, and apart from genetic studies, little biological and ecological research has been undertaken on the species. The previous population surveys carried out at the York Park site are the only such detailed studies carried out on the species so far.

To obtain information necessary for the recovery of the species, it is important to undertake long-term monitoring of Golden Sun Moth populations and their habitat, to determine population trends and the viability of populations. The results of such monitoring can be used in the refinement of management guidelines for the species.

With four seasons of mark-release-recapture surveys already undertaken between 1992 and 2006, there is a database of information on medium-term population trends at this site that is unmatched elsewhere. Baseline genetic data has also been collected (Clarke & O'Dwyer 1998), and future genetic surveys can test this small isolated population for continued viability and to find if it is affected by inbreeding or genetic drift. This information is important in setting conservation priorities for other small populations, and in predicting the effect of fragmentation of populations.

5.1.4 Educational opportunities

Education and community involvement are also important in the recovery of threatened species. The location of this site in the central Canberra area makes it ideal for educating local people and visitors about the biology and conservation of the Golden Sun Moth and Natural Temperate Grassland. Access is good, and the two street frontages provide the opportunity for interpretative signage and viewing areas that do not damage the habitat.

5.2 Potential impacts of proposed development

5.2.1 General effects of shading

There is little specific data on the effect of shading on Golden Sun Moth populations, but the available information (summarised below) suggests that it would be deleterious for the moths and for the Natural Temperate Grassland, as it would reduce soil temperature and increase soil moisture.

More adult moths tend to emerge after a dry winter (Edwards 1995), suggesting that higher soil moisture between autumn and spring has a negative effect on the survival of larvae and pupae. Soil changes caused by shading could affect larval development directly, change the proportion of food plants in the grassland and encourage weed growth. Ongoing reduced larval survival could lead to the extinction of the Golden Sun Moth population on this site.

The 2006 Golden Sun Moth survey at York Park found that the moths were more numerous at (and possibly emerged from) the central to northern part of the site early in the season, and the southern end of the site later on. This has been noted in previous surveys on the site (Cook & Edwards 1993, 1994, Harwood *et al.* 1995), and is probably due to the effect of soil conditions on the timing of larval development and/or adult emergence, as the northern part of the site is better drained. Changes in the distribution of moth activity during the flying season has also been noted at larger local sites (Braby 2005, Clarke & Dunford 1999), probably indicating the effects of aspect and slope on soil temperature and moisture.

Small populations of Golden Sun Moth are known from a few sites in Canberra containing remnants of native grassland with exotic tree plantings (M. Dunford, Environment ACT pers. comm., A. Rowell pers. obs.). Few of these urban sites are subject to significant shading, being sparsely planted with small trees and/or containing deciduous trees which minimise winter shading. A small (0.9 ha) site near Dudley Street Yarralumla (ACT Government 1998) has mature radiata pines to the south-east and north-west. In November/December 2006 it was noticeable that the male moths were not flying near the north-western group of pines. The shade from these trees was associated with an area of denser vegetation, with more weeds and less Wallaby Grass than the sunnier parts of the site (A. Rowell pers. obs.). A very small site (<0.05ha) discovered in the suburb of Griffith in November 2006 (A. Rowell pers. obs.) is subject to some shading from buildings and evergreen hedges, but nothing is known about the size and viability of the Golden Sun Moth population on this site.

5.2.2 Natural versus artificial shading

All of the building designs subject the site to more shading than it currently receives, and provide more than the natural shading of known Golden Sun Moth habitats in the district. For instance, a site on Ginninderra Creek in West Macgregor ACT (Braby 2005) includes a steep slope, which rises 20 metres over a distance of 150 metres, west of known habitat. This hillslope would cause loss of sunlight to the lower habitat area earlier in the afternoon than a site with a flatter topography would experience, but the shading would be less than that caused by all the building options for Section 22, which are a similar height but much closer to the habitat.

5.2.3 Assessment of building options

Option 1 shades the Golden Sun Moth habitat to an unacceptable degree. This is likely to change environmental conditions on the site to the extent that the composition and structure of the grassland are altered, and the continued survival of the Golden Sun Moth population is put at risk.

Option 2 reduces the potential for such effects on the natural temperate grassland and the Golden Sun Moth habitat, but the long term effect of shading by this option on the Golden Sun Moth population on this small site is unknown.

Options 3a and 3b would have slightly more impact on the reserve than Option 2.

Access road

The construction of the access road through the narrow extension of Block 7 at the northern end of the grassland reserve is inadvisable, due to the damage it is likely to cause to the Golden Sun Moth population. The loss of 21% of an already small area of habitat would greatly increase the risk of the extinction of the species on this site. Six other ACT sites ranging from 0.1 to 3 ha in area are rated as being so small that the continued survival of their moth populations is in doubt (ACT Government 1998).

Associated structure

All options include paved areas and landscaping between the building and the reserve. This area can be managed in a way that limits its impact on the grassland and Golden Sun Moth habitat (run-off, run-on, nutrification, shading etc). The natural contours of the site prevent run-on from the west at the moment, and this situation should be maintained.

Landscaping between the building and the Golden Sun Moth habitat should be designed to minimise shading and weed incursion. Trees should be lower than the building shadow. It would be desirable to plant a buffer zone between the carpark/road and the habitat with non-invasive ground covers that do not require irrigation. This zone could also be planted with native grasses and mown, to provide a ‘soft edge’ to the habitat. If this were done, it would be essential to use seed or other propagation material sourced from the central Canberra area. Wallaby Grasses (*Austrodanthonia* species) native to the site could provide an extension of the habitat area.

6. Recommendations

Blocks 3 and 7 Section 22 Barton contain a population of the Golden Sun Moth *Synemon plana*, which is listed as a critically endangered species under the *EPBC Act 1999.* This population:

- has proved to be viable in the medium term
- is located in an endangered vegetation community
- is of scientific value due to its research history
- and may suffer adverse impacts from development of the adjacent part of Block 3.

Therefore, the following recommendations are made:

- Proposed development on or adjacent to Block 3 Section 22 Barton should be the subject of a referral to the Department of Environment and Water Resources under the *EPBC Act 1999.*
- The Golden Sun Moth habitat on Block 7 (Territory land) should be treated as an integral part of the habitat.
- If development takes place on or adjacent to Block 3 Section 22 Barton, the site should be protected as far as possible during and after construction from impacts to the site from shading by buildings or trees, vehicle and pedestrian traffic, soil compaction and disturbance, dumping, weed invasion, run-on of water and nutrients etc. The present log fence at the National Circuit side of the site has portions that have been lifted out to allow vehicles unauthorised access to the site.
- Fencing on three sides would reduce through traffic and protect the site from damage, while allowing access for education, maintenance and research activities. A fence which discourages perching by predatory birds and allows passage of moths is desirable.
- The site should be used for interpretation and education activities related to the Golden Sun Moth and the Natural Temperate Grassland. This could include signs and viewing platforms suitable for school groups and bus tours, incorporation of stylised moth and plant designs into the fence etc. Local grassland plants (particularly Wallaby Grasses) could be used in landscaping in buffer areas, to extend the existing habitat. If this is done, it would be preferable to source the seed from the existing site.
- Future management of the site should follow the guidelines previously laid down (Edwards 1995).

- The existing database of population estimates should be built on. Future surveys on the site should use the Robust Design every 4-5 years, and a standard monitoring protocol should be used to develop an index of abundance based on observation for use in both capture-survey years (for calibration) and in the intervening years. Robust Design uses mark-recapture methods in a nested sampling structure, which removes the necessity to capture animals every day. Primary sampling sessions are undertaken at fixed intervals, with mortality and immigration taking place between primary sessions, so that open population models apply at this level. The second level of sampling has a short mark-recapture study within each primary session, and closed population models are then used to estimate the species abundance at each primary session.

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APPENDIX 1
MARK ANALYSIS
Method
The data set of 398 encounter histories was analysed with the open-capture models in MARK (White & Burnham 1999). A set of a priori models was initially developed, analysed and then ranked by the AICc (Akaike's information criterion) values following analysis in the program MARK. The model with the lowest AIC's criteria is the best fitted model and was used to analyse N (super population size), phi (apparent survival), p ((re)capture probability) and pent (probability of entry).

Results

The best approximating model for open populations used for this analysis was the POPAN model (included in the program MARK). Constant parameters for "apparent survival (phi)"; "recapture (probability of capture p)" and "probability of entry (pent)" are included in this model that provides a parameterization of the Jolly Seber model (Schwarz and Arnason 1996). We used the "POPAN" model rather then the "Jolly Seber" model because the likelihood function better converged with "POPAN".

Estimation of real Function Parameters of Phi(.) p(.) pent(.) N(.)

			95% Confidence Interval	
Parameter	Estimate	Standard Error	Lower	Upper
1:Phi	0.0660405	0.0118929	0.0462169	0.0935331
2:p	0.9044230	0.0489270	0.7573096	0.9663250
3:pent	1.0000000	0.4294350E-07	0.9999999	1.0000001
4:**N**	**439.57621**	**24.782598**	**412.10894**	**520.51671**

The very low survival probability (phi) results from the extremely low life expectancy for *S. plana* males. The maximum life span was estimated as 2.0 days, where as the average life span of males was estimated as 1.08 days (n=24, SE= 0.057). The total population size was estimated with 440 individuals varying between 412 and 520.

Reference

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APPENDIX 2

```
                        P R O G R A M    J O L L Y
                         =============    =========
                         LAST REVISED :   01/21/98
```

Program JOLLY output contains analyses for as many as 5 different capture-recapture models.

Model A is the standard Jolly-Seber model for open populations (Jolly 1965; Biometrika 52: 225-241).

Model A' is the "Death But No Immigration" model of Darroch (1959: Biometrika 46: 344-349) and
Jolly (1965; Biometrika 52: 241-242).

Model 2 is the capture-resighting model of Brownie and Robson (1983; Biometrics 39:437-453) permitting an effect
of initial capture and tagging on first period survival rate.

Model B is the Jolly-Seber model with survival rate assumed constant per unit time
and time-specific capture probability.

Model D is the Jolly-Seber model with both survival rate and capture probability assumed constant per unit time.

Model AX is equivalent to model A except it includes between-period resighting data.
The following capture-history codes have been added:
3 - not captured in time i, resighted between i and i+1,
4 - captured in time i, resighted between i and i+1.

```
 ******** Definitions and Notation
*******************************************************

   M(i)         = Estimated number of marked animals in the population at time i.

   p(i)         = Estimated probability that an animal alive at time i is captured in the
i-th sample

   N(i)         = Estimated population size at time i

   PHI          = Estimated probability that an animal alive at time i survives to time
i+1

   PHI*         = Estimated probability that an animal caught for the first time in sample
i
              survives to time i+1 (Model 2 only)

   B(i)         = Estimated number of new animals recruited during the interval i to i+1
              and alive at time i+1 (Recruitment includes birth and immigration)

   SE(x)        = Standard error of parameter x including non-sampling error terms

   SE'(x)       = Standard error of parameter x excluding non-sampling error terms

   COV(X(i,j))  = Covariance between estimates X(i) and X(j).

   r(i)         = Number of animals caught in sample i, and recaptured later

   z(i)         = Number of animals caught before and after sample i, but not caught in
sample i

   z'(i)        = z(i) + animals caught for the first time subsequent to sample i
```

Notes: Estimates of PHI,N,M,and B under models A and A' are computed using bias corrected formulae of Seber (1973:204; The Estimation of Animal Abundance and Related Parameters, Griffin, London) except when z(i)=0;then N(i)= Number caught in sample i.

95% Confidence intervals are computed using the standard error which includes sampling variation (SE(x)).

Estimates which cannot be computed due to poor data (m(i),r(i),z(i),... = zero) are denoted by "Div/0". (Means do not include these values.)

```
 INPUT==>TITLE=GSM TEST RUN
 CONTROL RECORD:TITLE=
 GSM TEST RUN
 INPUT==>NUMBER OF PERIODS=32
 CONTROL RECORD:PERIODS= 32
 INPUT==>FIRST=2006
 CONTROL RECORD:FIRST= 2006
 INPUT==>INTERVALS=1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1
 INPUT==>  1.  1.  1.  1.  1.  1.  1.  1.  1.  1.  1.  1.  1.  1.  1.  1.  1.
  1.  1.  1.  1.  1.  1.  1.  1.  1.  1.  1.  1.  1.  1.
 INPUT==>FORMAT=(32(I1),I1)
 INPUT==>10000000000000000000000000000000 1;
```

```
 JOLLY (Ver:01/21/98)  GSM TEST RUN
4/13/07  10:52

 Number of sampling periods =    32
 Input format         = (32(I1),I1)
 Max iterations       =    100
 Convergence criterion = 0.1000E-03

 Time period interval lengths =
   1.00000000   1.00000000   1.00000000   1.00000000   1.00000000   1.00000000
1.00000000   1.00000000   1.00000000   1.00000000
   1.00000000   1.00000000   1.00000000   1.00000000   1.00000000   1.00000000
1.00000000   1.00000000   1.00000000   1.00000000
   1.00000000   1.00000000   1.00000000   1.00000000   1.00000000   1.00000000
1.00000000   1.00000000   1.00000000   1.00000000
   1.00000000
 Data type:CAPTURE HISTORY (1)  -
 (32(I1),I1)

    404 Input records read


 Data summarized in "B-Table" format (See Leslie, Chitty and Chitty 1953; Biometrika
40:137-169).

 Time of !
    last !          Time of recapture
 capture ! 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037
 ------------------------------------------------------------------------------------
----------------------
    2006 !    0    1    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2007 !    0    0    3    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2008 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2009 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2010 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2011 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2012 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2013 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2014 !    0    0    0    0    0    0    0    0    0    2    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2015 !    0    0    0    0    0    0    0    0    0    0    2    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2016 !    0    0    0    0    0    0    0    0    0    0    0    1    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2017 !    0    0    0    0    0    0    0    0    0    0    0    0    1    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2018 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    1
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2019 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    2
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2020 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
1    2    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2021 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2022 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    1    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2023 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2024 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    1    0    0    0    0    0    0    0    0    0    0    0    0
    2025 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    2    0    0    0    0    0    0    0    0    0    0    0
```

```
    2026 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    2    0    0    0    0    0    0    0    0    0    0
    2027 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    1    0    0    0    0    0    0    0    0    0
    2028 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    2    0    0    0    0    0    0    0    0
    2029 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2030 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2031 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2032 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2033 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2034 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2035 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2036 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
    2037 !    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0

 Marked   !    0    1    3    0    0    0    0    0    0    2    2    1    1    0    3
1    2    1    0    1    2    2    1    2    0    0    0    0    0    0    0    0
 Unmarked!   17   20   15   18   20   17   20   16   18   17   19   20   17   18   10
19   19   19   18    8    9   18   10    6    0    7    3    0    0    0    0    0
 Caught   !   17   21   18   18   20   17   20   16   18   19   21   21   18   18   13
20   21   20   18    9   11   20   11    8    0    7    3    0    0    0    0    0
 Released!   17   21   18   18   20   17   20   16   18   19   21   21   18   18   13
20   21   20   18    9   11   20   11    8    0    7    3    0    0    0    0    0

 Other summary stats:

 R(i)     !    1    3    0    0    0    0    0    0    2    2    1    1    1    2    3
0    1    0    1    2    2    1    2    0    0    0    0    0    0    0    0    0
 z(i)     !    0    0    0    0    0    0    0    0    0    0    0    0    0    1    0
2    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
 z'(i)    !  381  361  346  328  308  291  271  255  237  220  201  181  164  147  136
119   98   79   61   53   44   26   16   10   10    3    0    0    0    0    0    0


JOLLY (Ver:01/21/98)  GSM TEST RUN
4/13/07  10:52
```

Model D - Constant survival rate per unit time, constant capture probability.

```
  Parameters: PHI = Estimate of survival rate
              p   = Capture probability


  Definitions:
    THETA  = Vector of parameters
    1-X(i) = Probability that an animal alive just after period i is subsequently
recaptured
    T(i)   = Time units between periods i and i+1


 Starting values of THETA :           0.1810      0.8765

 Final values after     35 iterations:


                                      Standard
 Parameter                 Variance    error        95% confidence interval
Covariance(P,PHI)
 ------------------------------------------------------------------------------------------
---------
```

```
     PHI     0.1599     0.00079606   0.0282            0.1046 -  0.2153          -
0.00177829

     p       0.3300     0.00510956   0.0715            0.1899 -  0.4701
 ------------------------------------------------------------------------------
```

Period	M	Variance	Standard error	95% confidence interval	
2007	2.71	4.8039	2.19	-1.59 -	7.00
2008	8.12	15.7044	3.96	0.35 -	15.88
2009	0.00	0.0000	0.00	0.00 -	0.00
2010	0.00	0.0000	0.00	0.00 -	0.00
2011	0.00	0.0000	0.00	0.00 -	0.00
2012	0.00	0.0000	0.00	0.00 -	0.00
2013	0.00	0.0000	0.00	0.00 -	0.00
2014	0.00	0.0000	0.00	0.00 -	0.00
2015	5.41	9.9915	3.16	-0.78 -	11.61
2016	5.41	10.1798	3.19	-0.84 -	11.66
2017	2.71	4.9071	2.22	-1.64 -	7.05
2018	2.71	4.8609	2.20	-1.62 -	7.03
2019	2.71	4.8566	2.20	-1.61 -	7.03
2020	8.12	15.7234	3.97	0.35 -	15.89
2021	8.12	16.0097	4.00	0.27 -	15.96
2022	5.41	10.3056	3.21	-0.88 -	11.70
2023	2.71	4.9138	2.22	-1.64 -	7.05
2024	0.00	0.0000	0.00	0.00 -	0.00
2025	2.71	4.8095	2.19	-1.59 -	7.00
2026	5.41	10.0911	3.18	-0.81 -	11.64
2027	5.41	10.1940	3.19	-0.85 -	11.67
2028	2.71	4.9080	2.22	-1.64 -	7.05
2029	5.41	10.1114	3.18	-0.82 -	11.64
2030	0.00	0.0000	0.00	0.00 -	0.00
2031	0.00	0.0000	0.00	0.00 -	0.00
2032	0.00	0.0000	0.00	0.00 -	0.00
2033	0.00	0.0000	0.00	0.00 -	0.00
2034	0.00	0.0000	0.00	0.00 -	0.00
2035	0.00	0.0000	0.00	0.00 -	0.00
2036	0.00	0.0000	0.00	0.00 -	0.00
2037	0.00	0.0000	0.00	0.00 -	0.00
MEAN	2.44	11.2803	3.36	-4.14 -	9.03

Period	N	Variance	Standard error	95% confidence interval	
2007	63.32	311.9989	17.66	28.70 -	97.94
2008	53.57	232.4437	15.25	23.69 -	83.46
2009	54.55	253.8202	15.93	23.32 -	85.78
2010	60.61	295.7702	17.20	26.90 -	94.32
2011	51.52	229.0995	15.14	21.85 -	81.18
2012	60.61	295.3599	17.19	26.93 -	94.29
2013	48.49	208.6926	14.45	20.17 -	76.80
2014	54.55	250.3096	15.82	23.54 -	85.56
2015	56.93	259.1699	16.10	25.38 -	88.48
2016	62.99	307.4358	17.53	28.62 -	97.36
2017	63.32	314.8583	17.74	28.54 -	98.09
2018	54.22	245.2944	15.66	23.53 -	84.92
2019	57.25	267.0851	16.34	25.22 -	89.29
2020	38.42	138.7512	11.78	15.33 -	61.51
2021	65.70	325.8699	18.05	30.31 -	101.08

2022	62.99	309.1549	17.58	28.53 - 97.45
2023	60.29	291.3501	17.07	26.83 - 93.74
2024	54.55	251.7103	15.87	23.45 - 85.64
2025	26.95	86.3764	9.29	8.73 - 45.17
2026	32.69	111.5742	10.56	11.98 - 53.39
2027	59.96	284.2105	16.86	26.92 - 93.00
2028	33.01	116.8001	10.81	11.83 - 54.19
2029	23.59	70.0911	8.37	7.19 - 40.00
2030	0.00	0.0000	0.00	0.00 - 0.00
2031	21.21	64.2895	8.02	5.50 - 36.93
2032	9.09	22.3381	4.73	-0.17 - 18.36
2033	0.00	0.0000	0.00	0.00 - 0.00
2034	0.00	0.0000	0.00	0.00 - 0.00
2035	0.00	0.0000	0.00	0.00 - 0.00
2036	0.00	0.0000	0.00	0.00 - 0.00
2037	0.00	0.0000	0.00	0.00 - 0.00
MEAN	39.69	2331.2585	48.28	-54.95 - 134.32

Period	B	Variance	Standard error	95% confidence interval
2007	38.96	146.5820	12.11	15.23 - 62.69
2008	49.68	207.3209	14.40	21.46 - 77.90
2009	54.76	237.7612	15.42	24.54 - 84.99
2010	45.02	178.3026	13.35	18.85 - 71.19
2011	55.09	240.5426	15.51	24.69 - 85.49
2012	41.99	162.0113	12.73	17.04 - 66.94
2013	49.35	204.8482	14.31	21.30 - 77.40
2014	45.67	182.4908	13.51	19.19 - 72.15
2015	52.06	221.0530	14.87	22.92 - 81.20
2016	54.44	235.0296	15.33	24.39 - 84.49
2017	45.02	178.3026	13.35	18.85 - 71.19
2018	49.03	202.4254	14.23	21.14 - 76.91
2019	24.46	83.6935	9.15	6.53 - 42.39
2020	54.33	240.4888	15.51	23.94 - 84.73
2021	51.41	215.9484	14.70	22.61 - 80.21
2022	51.41	215.9484	14.70	22.61 - 80.21
2023	48.38	197.7292	14.06	20.82 - 75.94
2024	18.40	63.2230	7.95	2.81 - 33.98
2025	24.68	80.6233	8.98	7.08 - 42.28
2026	51.63	223.2035	14.94	22.34 - 80.91
2027	24.46	83.6935	9.15	6.53 - 42.39
2028	14.94	46.9778	6.85	1.50 - 28.37
2029	-1.95	3.4785	1.87	-5.60 - 1.71
2030	21.21	64.1906	8.01	5.51 - 36.92
2031	6.82	22.2835	4.72	-2.43 - 16.07
2032	-0.97	1.5150	1.23	-3.39 - 1.44
2033	0.00	0.0000	0.00	0.00 - 0.00
2034	0.00	0.0000	0.00	0.00 - 0.00
2035	0.00	0.0000	0.00	0.00 - 0.00
2036	0.00	0.0000	0.00	0.00 - 0.00
MEAN	32.34	1112.3485	33.35	-33.03 - 97.71

JOLLY (Ver:01/21/98) GSM TEST RUN
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	Test of model D vs model A		Test of model B vs model A		Test of model D vs modelB	
Per	T1	T2	T1	T2	T1	T2
2006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2007	1.4549	0.0000	0.0000	0.0000	0.0000	0.0000
2008	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2010	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2012	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2014	4.2943	0.0000	0.0000	0.0000	0.0000	0.0000
2015	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2016	0.1815	0.0000	0.0000	0.0000	0.0000	0.0000
2017	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2018	0.0430	0.0000	0.0000	0.0000	0.0000	0.0000
2019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2020	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2021	1.3892	0.0000	0.0000	0.0000	0.0000	0.0000
2022	0.0000	0.5109	0.0000	0.0000	0.0000	0.0000
2023	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2024	0.6745	0.0000	0.0000	0.0000	0.0000	0.0000
2025	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2026	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2027	3.1217	0.0000	0.0000	0.0000	0.0000	0.0000
2028	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2029	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2030	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2031	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2032	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2033	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2034	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2035	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

```
  2036           0.0000           0.0000           0.0000           0.0000
0.0000           0.0000

 Total          11.1591           0.5109           0.0000           0.0000
0.0000           0.0000

     Total chi-square   =      11.6701     Total chi-square   =       0.0000     Total
chi-square   =       0.0000
     Degrees of freedom =        6         Degrees of freedom =      -32         Degrees
of freedom =      -31
     Probability        =       0.0697     Probability        =       1.0000
Probability        =       1.0000

 Likelihood-Ratio test of model A versus model 2:

   Hypothesis: Survival rate of newly captured animals =  survival rate of previously
captured animals.

               Chi-square =     0.0000 with   0 degrees of freedom (Probability =
1.0000)

 Goodness-of-fit tests:

 Model   Chi-square     DF    Probability
 -----   ----------     --    -----------
   A        0.0000       0      1.0000

   2        0.0000       0      1.0000
```

APPENDIX 3
VEGETATION ASSESSMENT
QUADRANT 1

Site No.	Block 3(part), Block 7(part), Section 22 Barton	**Date**	14-Jan-07	**Recorder**	A. Rowell
AMGE		**Location**	York Park Golden Sun Moth site, NW corner of National Circuit and Sydney Avenue intersection. In sector 5 (centre of site).		
AMGN					

Veg type	grassland	**Groundlayer**	NTG
G'layer diversity	Moderate	**G'layer structure**	high
Rocky	0	**Fallen timber**	0
Bare ground	3	**Topography**	footslope
Litter	3	**Moss/lichen**	2

Notes

20 metre x 20 metre quadrat. Dominant species *Austrodanthonia/Bothriochloa/Austrostipa/Chrysocephalum*.
Flush of summer growth in response to storms. *Austrostipa bigeniculata, Tricoryne, Goodenia, Chrysocephalum, Wahlenbergia* flowering.

Native species	f code
Austrodanthonia laevis + A. carphoides	3
Bothriochloa macra	3
Austrostipa bigeniculata	3
Chrysocephalum apiculatum	3
Wahlenbergia communis	2
Wahlenbergia luteola	2
Tricoryne elatior	2
Lomandra sp.	2
Goodenia pinnatifida	2

Exotic species	f code
Hypochaeris radicata	2
Plantago lanceolata	2
Gnaphalium americanum	1
Hypericum perforatum	1
Vulpia sp.	1
Lactuca serriola	1
Tragopogon porrifolius	1

1 - <5% u
2 - <5% c
3 - 5-25%
4 - 25-50%
5 - 50-75%
6 - >75%

Calocephalus citreus	2
Panicum effusum	1
Themeda triandra	1
Lomandra filiformis var. *filiformis*	1
Eryngium ovinum	1
Pimelea curviflora	1
Elymus scaber	1

More species on back (y/n)	n

QUADRANT 2.

Site No.	Block 3(part), Block 7(part), Section 22 Barton	**Date**	14-Jan-07	**Recorder**	A. Rowell
AMGE		**Location**	York Park Golden Sun Moth site, NW corner of National Circuit and Sydney Avenue intersection. In sector 8 (southern end of site).		
AMGN					

Veg type	grassland	**Groundlayer**	NTG/NP
G'layer diversity	L/M	**G'layer structure**	medium
Rocky	0	**Fallen timber**	0
Bare ground	2	**Topography**	footslope
Litter	3	**Moss/lichen**	2

Notes

20 metre x 20 metre quadrat. Dominant species *Austrostipa bigeniculata/Austrodanthonia*.
Disturbance in quadrat, large tree roots, stump hole? + rabbits? Active holes of Canberra Raspy Cricket *Cooraboorama canberrae,* Wolf Spiders

Native species	f code
Austrostipa bigeniculata	4
Austrodanthonia laevis (+ *A. bipartita*)	3
Bothriochloa macra	2
Goodenia pinnatifida	2
Wahlenbergia communis	2
Wahlenbergia luteola	2
Eryngium ovinum	2
Asperula conferta	2
Lomandra (2 species)	1
Chrysocephalum apiculatum	1
Rumex brownii	1

Exotic species	f code
Plantago lanceolata	3
Dactylis glomeratum	3
Paspalum dilatatum	2
Nassella neesiana	2
Avena sp.	1
Bromus sp.	1
Festuca arundinacea	1
Hypochaeris radicata	1
Lactuca serriola	1
Tragopogon porrifolius	1
Festuca sp.	1

1 - <5% u
2 - <5% c
3 - 5-25%
4 - 25-50%
5 - 50-75%
6 - >75%

Glycine tabacina	1
Convolvulus erubescens	1
Acaena sp.	1
Calocephalus citreus	1

More species on back (y/n)	n

QUADRANT 3

Site No.	Block 3(part), Block 7(part), Section 22 Barton	**Date**	14-Jan-07	**Recorder**	A. Rowell
AMGE		**Location**	York Park Golden Sun Moth site, NW corner of National Circuit and Sydney Avenue intersection. In sector 2 (northern end of site).		
AMGN					

Veg type	grassland	**Groundlayer**	NTG
G'layer diversity	medium	**G'layer structure**	medium
Rocky	0	**Fallen timber**	0
Bare ground	2	**Topography**	footslope
Litter	3	**Moss/lichen**	2

Notes

20 metre x 20 metre quadrat. Dominant species *Austrostipa bigeniculata/Bothriochloa/Austrodanthonia.*
Less diverse than Quadrat 1, less weedy than Quadrat 2.

Native species	f code
Austrostipa bigeniculata	4
Austrodanthonia laevis + *A.* species	3
Bothriochloa macra	3
Chrysocephalum apiculatum	2
Wahlenbergia communis	2
Lomandra filiformis var. *filiformis*	2
Wahlenbergia luteola	1
Tricoryne elatior	1
Plantago varia	1
Goodenia pinnatifida	1
Panicum effusum	1

Exotic species	f code
Hypochaeris radicata	2
Plantago lanceolata	2
Paspalum dilatatum	1
Centaurium erythraea	1
Nassella trichotoma	1

1 - <5% u
2 - <5% c
3 - 5-25%
4 - 25-50%
5 - 50-75%
6 - >75%

More species on back (y/n)	

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OFFSET ANALYSIS REPORT

Block 3 Section 22 and Proposed Offset Sites

FINAL

January 2016

Australian Government
Department of Finance

OFFSET ANALYSIS REPORT

Block 3 Section 22 and Proposed Offset Sites

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Department of Finance

Project Director: Peter Cowper
Project Manager: Rob Armstrong
Report No. 8018C/R06/V1
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Appendices

1.0 Introduction

Umwelt Australia Pty Ltd (Umwelt) was commissioned by the Commonwealth Department of Finance ('Finance') to develop an offset analysis report for the proposed Development of Block 3 Section 22 Barton (the proposed development area) relation to the requirements of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The objective of this offset analysis report is to assess the relative magnitude of impacts to matters of national environmental significance (MNES) occurring on proposed development area, and determine whether either or both of two potential offset sites will adequately compensate for potential impacts at the proposed development area. The potential offset sites are both on Wallaroo Road however occur in the ACT and NSW respectively and are described as:

- Registered Rural Block 48 in Hall, ACT, and
- Lot 1 DP1144979 in Wallaroo, NSW.

MNES directly impacted at the proposed development area include:

- 0.3 hectares of 'Natural Temperate Grassland of the Southern Tablelands of New South Wales and the Australian Capital Territory' (NTG), and endangered ecological community under the EPBC Act, and
- 0.3 hectares of a high density golden sun moth (GSM; *Synemon plana*) population, listed as Critically Endangered under the EPBC Act.

It is understood that as a consequence of the proposed divestment of the proposed development area, all natural values including MNES would be removed. This scenario provides the basis for assessing the appropriateness of either Block 48 or Lot 1 as offset sites.

2.0 Current Values

Studies undertaken by Umwelt (2016a[1]; 2016b[2]; 2016c[3]; 2016d[4]; 2016e[5]; 2016f[6]) have determined that MNES are present in proposed development and potential offset areas as outlined in **Table 2.1**. The location of these MNES are shown in **Figure 2.1**, **Figure 2.2** and **Figure 2.3** respectively.

All NTG information is sourced from Umwelt (2016a; 2016b; 2016c; 2016d; 2016e), with GSM information derived from Umwelt (2016c; 2016f). Additional information required for determining habitat quality is presented in **Section 3** in relation to the EPBC Act offset policy.

Table 2.1 Summary of MNES Values within Proposed Development and Potential Offset Areas.

MNES	Area (hectares)	Stocking Rate*
Potential Development: Block 3 Section 22 Barton		
Natural temperate grassland	0.3 hectares	N/A
Golden sun moth	0.3 hectares	156/hectare
Potential Offset 1: Block 48, Hall		
Natural temperate grassland	2.3 hectares	N/A
Golden sun moth	3.1 hectares	9.2/hectare
Potential Offset 2: Lot 1 DP1144979 Wallaroo		
Natural temperate grassland	17 hectares, including 15.9 hectares in low condition and 1.1 hectares in moderate condition.	N/A
Golden sun moth	0.7 hectares	15.4/hectare

* For GSM only, calculated as the 'highest day density' / hectares.

Results of previous studies undertaken within the proposed development and offset areas were considered as part of the Umwelt (2016a; 2016b; 2016c; 2016d; 2016e; 2016f) assessments; please refer to these documents for further information.

[1] Umwelt (2016a) Vegetation Management Plan: Block 48 Wallaroo Road. Draft Report prepared for Department of Finance, January 2016.

[2] Umwelt (2016b) Vegetation Management Plan: Lot 1 Wallaroo Road. Draft Report prepared for Department of Finance, January 2016.

[3] Umwelt (2016c) Golden Sun Moth and Natural temperate Grassland Vegetation Management Plan. Block 3 Section 22 Barton. Draft Report prepared for Department of Finance, January 2016.

[4] Umwelt (2016d) Year 2 / Baseline Vegetation Condition Monitoring Report. Block 48 Wallaroo Road. Draft Report prepared for Department of Finance, January 2016.

[5] Umwelt (2016e) Year 2 / Baseline Vegetation Condition Monitoring Report. Lot 1 Wallaroo Road. Draft Report prepared for Department of Finance, January 2016.

[6] Umwelt (2016f) Golden Sun Moth Survey Results, Lot 1 and Block 48 Wallaroo Road. Briefing Note prepared for Department of Finance, January 2016.

Image Source: Google Earth - DigitalGlobe (2015)

0 10 25 50m
1:1 000

Legend

Project Area (Block 3)
Natural Temperate Grassland / Golden Sun Moth Habitat (2015)

FIGURE 2.1

MNES Block 3 Section 22 Barton

Image Source: Google Earth - DigitalGlobe (2015), CNES / Astrium (2015)

0 100 250 500m
1:10 000

Legend

- Project Area (Block 48)
- State Boundary
- Golden Sun Moth Habitat (2015)
- Natural Temperate Grassland

FIGURE 2.2

MNES Block 48 Wallaroo Road

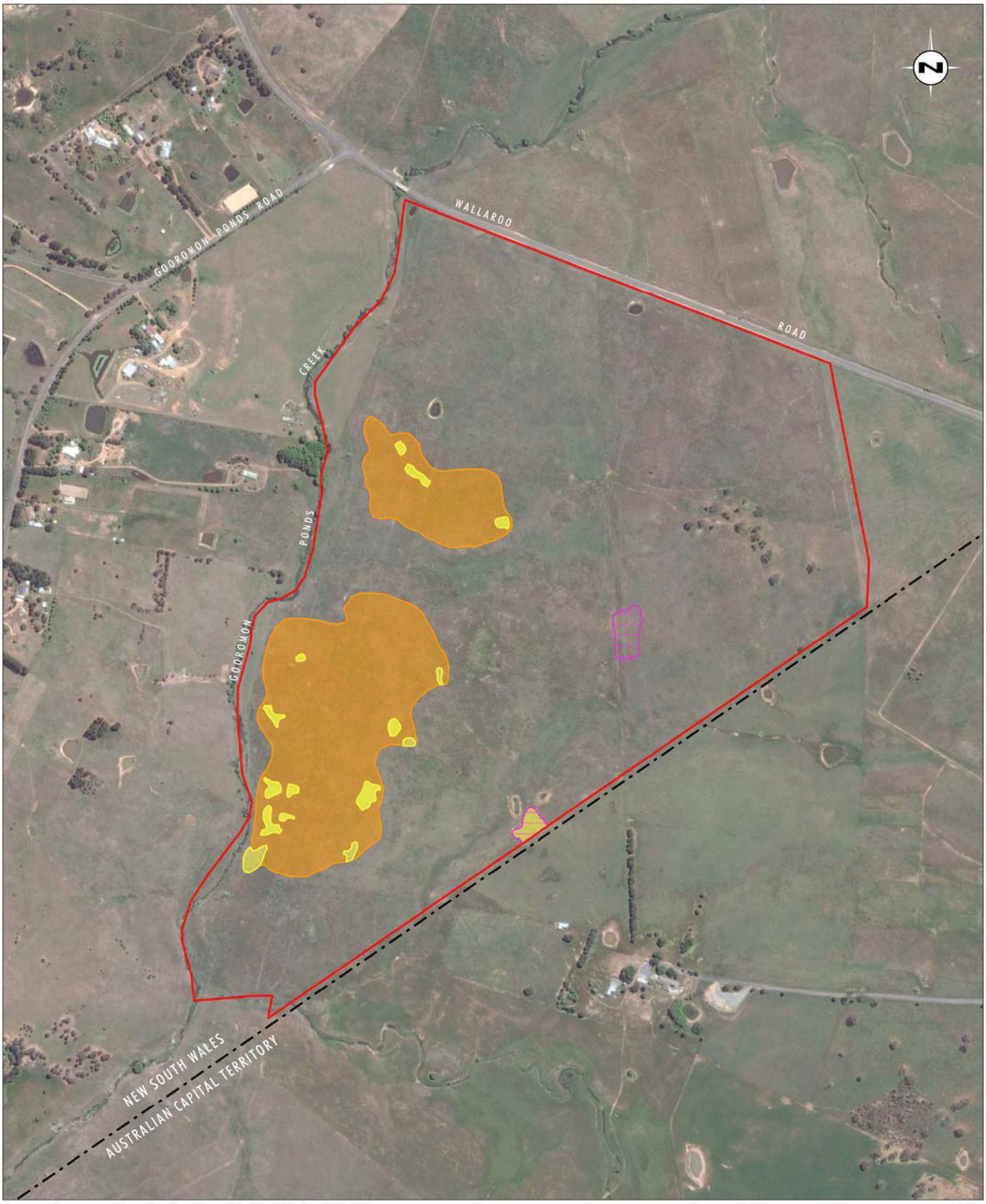


Image Source: Google Earth - DigitalGlobe (2015)

0 100 250 500m
1:10 000

Legend

- Project Area (Lot 1)
- State Boundary
- Golden Sun Moth Habitat (2015)
- Low Quality Natural Temperate Grassland
- Moderate Quality Natural Temperate Grassland

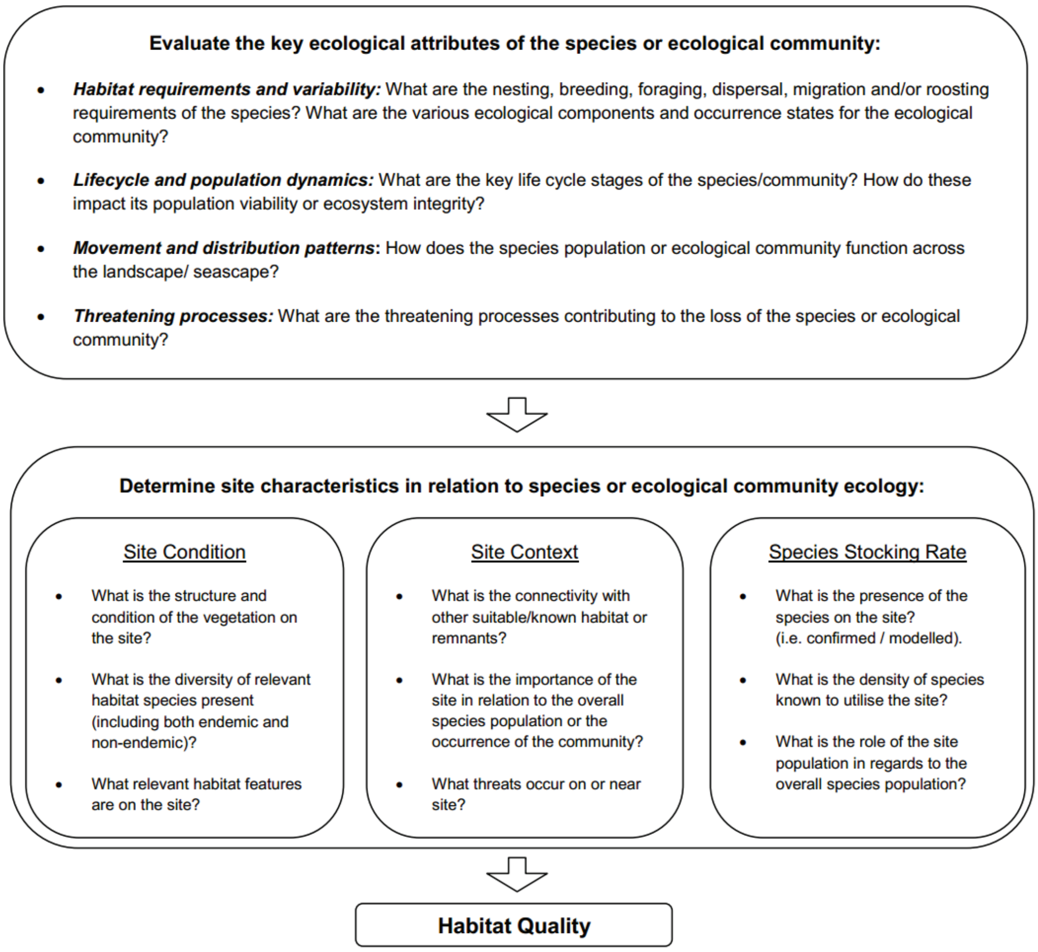
FIGURE 2.3

MNES Lot 1
Wallaroo Road

3.0 Offset Calculations

The 'offsets assessment guide' under the Environmental Offsets Policy (Australian Government 2012[7]) was used to determine appropriate offsets for actions that result in significant impacts to MNES under the EPBC Act. The associated 'how to' document provides guidance through suggesting that determining habitat quality requires an understanding of key ecological attributes, and subsequent consideration of site characteristics in relation condition, context and species stocking rate (**Figure 3.1**). Notwithstanding this, not all components are relevant to each MNES; for example, some threatened flora may persist irrespective of disturbance, patch size or other higher site condition and species stocking rate is not necessarily relevant to ecological communities. The habitat quality score for each species or ecological community should be considered in the context of other examples within the region or across its known distribution as far as practicable and incorporate consideration of criteria pertaining to why the entity is threatened.

For ecological communities (in this case NTG), site condition and site context are important. For species such as GSM, site condition, site context and species stocking rate are all important.



Source: 'how to' supplement: Australian Government (2012)

Figure 3-1 Key Considerations in Determining the Quality of Threatened Species and Ecological Community Habitat

[7] Australian Government (2012) *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy. Department of Sustainability, Environment, water, Population and Communities, October 2012.

3.1 Methodology and Calculations

Umwelt has developed transparent habitat quality scoring systems to determine relative impacts of removal of habitat on MNES. This approach has been progressively developed and implemented successfully by Umwelt in other projects. It is a repeatable and reliable method for scoring important aspects of an ecological community or species ecological requirements with respect to habitat quality. The process involved the following:

1. Developing transparent habitat quality scores through consideration of relevant factors pertaining to site condition, site context and/or species stocking rate. Detail on how transparent habitat quality scores were developed is shown in Section **3.1.1** for NTG, and Section **3.1.2** for GSM.

2. Entering habitat quality and/or population data as relevant into the 'offset assessment guide' calculator:

    a. Entering impact (area of community/habitat/number of individuals as relevant) into the 'Impact Calculator', and

    b. Entering and adjusting 'start' and 'future with offset' values as relevant to ensure that a balanced offset calculation is reached. Assumptions for each MNES are outlined in relevant sections below.

Further detail on this as it applies to each MNES is provided below.

3.1.1 Natural Temperate Grassland

In order to transparently quantify the habitat quality score of NTG in the context of existing remnants occurring in the ACT lowlands, a range of existing data consideration of landscape context variables were reviewed. Selected data from NTG surveys undertaken by and ACT Conservation Planning and Research (Armstrong 2013[8]) formed the basis for this review.

Using 20 x 20 metre quadrat data, the following values were examined to determine variability in floristic values:

- Native species richness
- FVS (as per Rehwinkel (2007[9]))
- Exotic species richness (weeds), and
- Significant weeds (as per Rehwinkel (2007)).

[8] Armstrong RC (2013) Interim Analysis of Relationships Between Vegetation Condition and Kangaroo Density in Grassy Ecosystems of the Northern ACT: Data Collected Spring-Summer 2009/2012. A Report Prepared for ACT Government, Environment and Sustainable development Directorate, Canberra. February 2013.

[9] Rehwinkel R (2007) A Method to Assess Grassy Ecosystem Sites: Using Floristic Information to Assess a Site's Quality. NSW Department of Environment and Climate Change. November 2007, Version 2.

Habitat quality (Q) for NTG was determined to be a function of site condition (C) and site context (X). For an ecological community, the concept of species stocking rate is not relevant and accordingly this measure was not applied. As a result, Quality (Q) is expressed by **Equation N1**.

Equation N1: $Q = fn(C + X)$

3.1.1.1 Site Condition

Site condition was considered to be a function of the Floristic Value Score (FVS) and native species richness (R) as the positive influencers and the exotic species richness (w) and number of 'significant' weeds (W) as the negative influencers. In deriving the final result however a number of transformations of the data was necessary to give appropriate weightings to each of the components and account for the fact that this formula relies on both raw data (R, W and w) and derived values (FVS). Accordingly, site condition (C) can be described by **Equation N2**.

Equation N2: $C = fn(R' + FVS') - fn(w' + W')$

Values for each component were transformed to a score out of 10 (note that *Equation N2* applies transformed values, not raw values). The transformation was based on comparison to other data that was selected to represent the range of conditions in which NTG is known to occur within the ACT. This provided an ability to compare the Project Area to other occurrences of the community and allocate condition scores appropriately. The relevant data from six reference sites described by Armstrong (2013) are presented in **Table 3.1**; these formed the basis for comparison.

Table 3.1 Reference Site Data for Natural Temperate Grassland in the ACT region*

Quadrat	Native species richness (R)	Floristic Value Score (FVS)	Exotic species richness (w)	'Significant' weeds (W)
BN01	22	16	19	1
CR02	30	40	9	1
JW02	30	24	11	2
MU03	38	49	14	1
NT01a	23	27	14	1
YA01	8	4	18	1

Source: Armstrong (2013).

* these reference sites were subjectively selected based on a range of known floristic values.

Data collected as part of the Umwelt surveys at potential development and offset sites in late 2015 (Umwelt 2016c; 2016d) are summarised in **Table 3.2.**

Table 3.2 Source Data for Natural Temperate Grassland in potential Development and Offset Areas

Quadrat	Native species richness (R)	Floristic Value Score (FVS)	Exotic species richness (w)	'Significant' weeds (W)
Potential Development: Block 3 Section 22 Barton				
B1	18	23	14	1
B2	13	19	14	1
Mean				
N/A	15.5	21	14	1
Potential Offset 1: Block 48 Hall[1]				
H_5	14	14	18	0
H_6	20	17	16	0
Mean				
N/A	17	15.5	17	0
Potential Offset 2: Lot 1 DP1144979 Wallaroo				
W_1	15	11	15	2
W_2	9	3	14	0
W_3	13	4	19	2
W_4	14	9	16	1
W_5	13	2	21	2
W_6	9	8	19	1
W_7	20	18	19	2
W_8	19	18	21	0
W_9	18	14	24	2
W_10	6	3	17	1
Mean				
N/A	13.6	9	18.5	1.3

[1] eight (8) additional quadrats were assessed in derived native grassland (derived from Box Gum Woodland).

Transformation of the values was based on the look-up tables in **Appendix 1** which identifies the scores allocated to each component based on the values in **Table 3.2** above. Once these scores had been allocated, from the tables in **Appendix 1**, the final scores were converted to a score out of 10. This resulted in the derived values for R', FVS', w' and W' as described above.

In order to reflect the relative importance of each component, weightings were also applied to each of the values (**Table 3.3**). These again were converted to a score out of a possible maximum 10. In calculating the value of the condition (C), and to account for factors determining the presence of NTG, the negative influencers were permitted to only reduce the total possible score by no more than 20 per cent. Effectively, this would mean a perfect site would score 10, indicating excellent native species richness and an associated FVS with no weeds. If however the same site were to be infested with a substantial weed component that included numerous 'significant' weeds but retained its native biodiversity, the maximum score would be 8. This approach is appropriate as the presence of the community is not defined by the absence of weeds but by the presence and diversity of certain native species, the weeds only serve to reduce quality, and are an indication of environmental stress and threatening processes.

Table 3.3 Weightings for Condition Components

Influencer	Component	Weightings	Justification
Positive (80 per cent)	Native species richness	25 per cent	While native species richness is important, floristic value scores are given a higher rating due to the recognition of significant species such as grazing sensitive herbs.
	Floristic value score	75 per cent	
Negative (20 per cent)	Exotic species richness	50 per cent	Significant weeds as defined by Rehwinkel (2007) include some noxious weeds and some common invaders. As there are additional weeds which fall into this category but are not attributed as a significant weed by Rehwinkel (2007), equal weighting was given to both weed variables.
	Number of 'significant' weeds	50 per cent	

Based on these weightings and considering mean values of each proposed development and offset area, the values for condition (C) were derived as follows in **Table 3.4**.

Table 3.4 Derived Values for Site Condition (C)

R'	FVS'	w'	W'		$fn(R' + FVS')$	$fn(w' + W')$	C
Potential Development: Block 3 Section 22 Barton							
4	7	8	2		6.68	4.75	5.73
Potential Offset 1: Block 48 Hall							
4	6	5	0		5.93	2.50	5.43
Potential Offset 2: Lot 1 DP1144979 Wallaroo							
3	5	5	3		4.82	3.80	4.06

3.1.1.2 Site Context

With regard to the ecological and other biophysical characteristics that are important for the viability of NTG, also with reference to the listing/conservation advice for the community, the following were selected to describe site context (X). All components were considered to be equally important and were each scored out of a maximum of 3.

- *Shape (a)*. This component rewarded patches with a more regular shape such that a round remnant would score more highly than rectangular remnant which in turn would score more highly than an irregular shaped area. Criteria adopted were as follows:
  - 'linear' or with edge to area ratio of 8:1 or worse; score = 1
  - 'rectangular' or with edge to area ratio of 2:1 or worse; score = 2, and
  - 'round' or 'square' or with edge to area ratio of less than 2:1; score = 3
- *Size (b).* This component rewarded larger remnants over smaller remnants and was based on the approximate normal size range of remnants in the ACT. Ranges adopted were as follows:
  - 0-0.49 Ha; score = 1
  - 0.5-1.99 Ha; score = 2, and
  - 2+ Ha; score = 3
- *Adjacent vegetation (c).* This component rewarded patches with more than 50 per cent of their edge being a common boundary with other native vegetation
- *Adjacent tenure (d).* This component rewarded patches that are contiguous with an existing nature reserve
- *Threatening processes (e).* This component rewarded patches that were not subject to significantly threatening processes, for example, this might include an adjacent, upslope weed plume which had a

real possibility of invading the patch. This component is reliant on the site assessment and experience of the observer.

For each of the latter three components, a ‘true’ response was awarded a score of 3, while a ‘false’ response was awarded a score of 0.

Site context was calculated as the sum of all contributing components and then converted to a score out of a possible maximum of 10. This is explained by the following **Equation N3**.

$$\textbf{Equation N3}: X = \frac{(a+b+c+d+e)}{15} \times 10$$

The derived values for site context (X) are presented in **Table 3.5**.

Table 3.5 Derived Values for Site Context (X)

Shape (a)	Size (b)	Adjacent NV (c)	Adjacent tenure (d)	Threats (e)	X
Potential Development: Block 3 Section 22 Barton					
3	1	0	0	0*	2.67
Potential Offset 1: Block 48 Hall					
3	3	3	0	0*	6.00
Potential Offset 2: Lot 1 DP1144979 Wallaroo					
3	1[1]	3	0	0*	4.67

[1] made up of two small patches of 0.42 and 0.22 hectares respectively.

*each site has active threatening processes to a degree, however it is assumed that as they are all subject to current vegetation management plans that these are being managed.

3.1.1.3 Determining Habitat Quality

As identified in **Equation 1**, site condition is a function of the sum of site condition (C) and site context (X). In deriving this final value, site condition was weighted to be 80 per cent of the total score reflecting information presented in the community’s listing/conservation advice. The derived values were then rounded to the nearest integer in order to arrive at a final value for habitat quality (Q) for NTG. These figures are presented in **Table 3.6**. Values for condition (C) are taken from **Table 3.4** while values for context (X) are taken from **Table 3.5**.

Table 3.6 Habitat Quality Scores for Natural Temperate Grassland within Potential Development and Offset Areas

Condition (C)	Context (X)	Weighted Total	Quality (Q)
Potential Development: Block 3 Section 22 Barton			
5.73	2.67	5.12	**5**
Potential Offset 1: Block 48 Hall			
5.43	6.00	5.54	**6**
Potential Offset 2: Lot 1 DP1144979 Wallaroo			
4.06	4.67	4.18	**4**

3.1.2 Golden Sun Moth

The parameters used to determine the habitat quality score for GSM were based on the three site characteristics defined in the EPBC Act Offset Guide: Site Condition, Site Context, and Species Stocking Rate (see **Figure 3.2**). Each of these Characteristic Scores has been broken down into sub-scores, the parameters of which are based on the key ecological attributes of GSM. These have been selected as being representative of the issues facing GSM; however additional variables could be added with further analysis or available data. These parameters and the role they play in determining GSM habitat are discussed in detail in the following sections.

Each score is based on current available information for the site (Umwelt, 2016c; 2016f) and reflects the site quality at the time of assessment. The quality of these habitats may change over time, in response to climatic influences.

3.1.2.1 Site Condition

The Site Condition Characteristic Score has been separated into three component sub-scores: vegetation structure, vegetation condition, and forage species diversity. Relevant habitat features (as noted under 'site condition' in **Figure 3.1**) is not included as a specific sub-score as habitat features important to GSM (e.g. inter-tussock space and presence of forage species) are incorporated in the vegetation structure and species diversity sub-scores. This is in part an indication of the limitations to knowledge of this species and further research may identify habitat features (such as soil moisture, soil structure, etc.) that are important indicators of the suitability and condition of a site for GSM.

Vegetation structure is a reflection of the habitat type (i.e. grassland or open woodland) and the amount of inter-tussock space available (i.e. rank or open grassland). GSM typically occupies grassland, therefore grassland structures score higher than woodland. This is important for sites that were originally woodland form but through habitat modification exist as derived grassland into which GSM have migrated. For such sites, there is often a sparse shrub or remnant tree component in addition to a soil seed bank that if left unmanaged would result in the area reverting to a woodland overtime. This noted however, habitat structure as with all site characteristics is assessed on what is observable in the present and includes no consideration of possible future states as these are subject to future management decisions which are not certain.

The species also requires inter-tussock space in which the females bask to attract males during breeding (i.e. flying) season, therefore open grassland scores higher than rank grassland (Australian Government 2009a[10]). The range of vegetation structure scores is shown in **Table 3.7**. Any vegetation type that does not fit into one of these categories is not considered to be GSM habitat from a structural perspective and is highly unlikely to support the species.

Table 3.7 Vegetation Structure Sub-Scores for Golden Sun Moth

Score	Rationale
1	Grassy open woodland or shrubland. Is the least suitable of habitats that are occupied by golden sun moth.
2	Rank (i.e. overgrown) grassland.
3	Open grassland. Provides optimal habitat structure.

The vegetation condition sub-score considers the proportion of exotic to native species and the availability of GSM forage species at the site. Scores are determined based on dominance to give an overall impression of the types of grass species that occur. Exotic species dominance is ranked lowest as it is considered to be a sign of poor ecosystem health and a detriment to biodiversity as a whole. It is noted that some exotic species (namely Chilean needle-grass) also provide habitat for GSM (Australian Government 2016[11]). Often in such circumstances the population of GSM within these exotic pastures is much higher than native communities. That aspect however is considered by the Species Stocking Rate Characteristic Score and is not a relevant consideration in the vegetation condition sub-score. This decision is justified on the basis that the ability for a weed species to provide habitat for one species (albeit critically endangered) should not be valued over the detriment such species pose to native ecosystems as a whole.

Sites with mixed dominance, or dominance of native non-forage species (e.g. kangaroo grass) are given an equal score. This is considered appropriate as it is believed that the presence (not dominance) of forage species is enough to provide habitat for GSM in some circumstances. Despite this, sites with a dominance of forage species are ranked the highest as they provide the most habitat resources for GSM and are considered to be of a higher quality (Australian Government 2016). The range of habitat vegetation scores that may be assigned is shown in **Table 3.8**.

Table 3.8 Vegetation Condition Sub-Scores for Golden Sun Moth

Score	Rationale
1	Dominated by exotic species (e.g. Chilean needle-grass).
2	Mixed exotic and native forage species dominance.
3	Dominated by native forage species (e.g. short wallaby grass and spear grasses).

[10] Australian Government (2009a) Significant Impact Guidelines for the Critically Endangered Golden Sun Moth (*Synemon plana*), Nationally Threatened Species and Ecological Communities EPBC Act Policy Statement 3.12, Department of Environment, Water, Heritage and the Arts, Canberra.

[11] Australian Government (2016) Protected Matters Search Tool, Department of the Environment, Canberra, (last updated: January 2014), accessed online (January 2016): http://www.environment.gov.au/epbc/pmst/index.html.

The forage species diversity sub-score demonstrates the species richness (i.e. the number of species present at a site) and the evenness of the percentage cover for each species. It is important to note the difference between species richness (total number of species present) and species diversity (a function of species richness and abundance). Ideally, this score would be based on forage species diversity, however this information has not been available for all GSM habitats within the Project Area, and as such a general habitat diversity score has been applied to ensure consistency in the assessment. The range of scores presented here is outlined in **Table 3.9**.

Table 3.9 Forage Species Diversity Sub-Scores for Golden Sun Moth

Score	Rationale
1	Low species diversity.
2	Medium species diversity.
3	High species diversity.

3.1.2.2 Site Context

The Site Context Characteristic Score is a more complex component of habitat quality and is considered for the purpose of GSM to be a function of the following sub-scores: site connectivity, site importance, and threats.

For the purpose of this offset strategy, site connectivity is considered to be a function of the size of a habitat area, the distance between habitat areas, and the ability for individual GSMs to traverse this distance (termed 'permeability' herein).

Before a discussion of the range of values that may be assigned for connectivity, the concept of isolation must be articulated as it relates to GSM. This species is known to be limited in its ability to disperse. Females are not able to traverse over any non-habitat substrate due to their inability or poor flying ability (ACT Government, 2005[12]), and as such any break in habitat connectivity is considered an absolute barrier that females cannot cross. The distance that males will traverse depends upon the substrate they are travelling over. A substrate that consists of non-habitat grassland will be permeable for male GSMs up to a distance of 200 metres (ACT Government, 2005); whilst a substrate of concrete, water, bare ground or the like is taken on the basis of observation to be permeable up to a distance of 15 metres. Beyond this distance they are considered absolute barriers and male moths will not cross. In addition, features such as trees, shrubs, or buildings are an absolute barrier for male GSM (Australian Government, 2009b[13]). Effectively, any structure at the flying height of moths (up to 1.5 metres) will obstruct movement.

The connectivity sub-score expands the scale of analysis to a landscape level. For the purposes of this next calculation, all known occupied GSM habitats that are not isolated by absolute barriers are considered a single patch. **Figure 3.2** presents a conceptual scenario where 'patch 1' is being assessed. In this scenario, the primary connections to proximate patches are considered for the purpose of the calculation. Assuming 'patch 2' is within 200 metres of 'patch 1' and the intervening space is unoccupied grassland/pasture, these two patches would be considered as one but with an internal connectivity affected by the distance and

[12] ACT Government (2005) Action Plan No. 28: A Vision Splendid of the Grassy Plains Extended, ACT Lowland Native Grassland Conservation Strategy, Environment ACT, Canberra.

[13] Australian Government (2009b) Background Paper to EPBC Act Policy Statement 3.12 – Nationally Threatened Species and Ecological Communities Significant Impact Guidelines for the Critically Endangered golden Sun Moth (Synemon plana), Department of the Environment, Water, Heritage and the Arts, Canberra.

nature of the intervening space. 'Patch 3' being a secondary connection to 'patch 1' is not included despite being within 200 metres of 'patch 2'. This approach seeks to minimise the complexity of the model for the purpose of this assessment however, there would be no limitation to the number of patches that might be considered should the information be available.

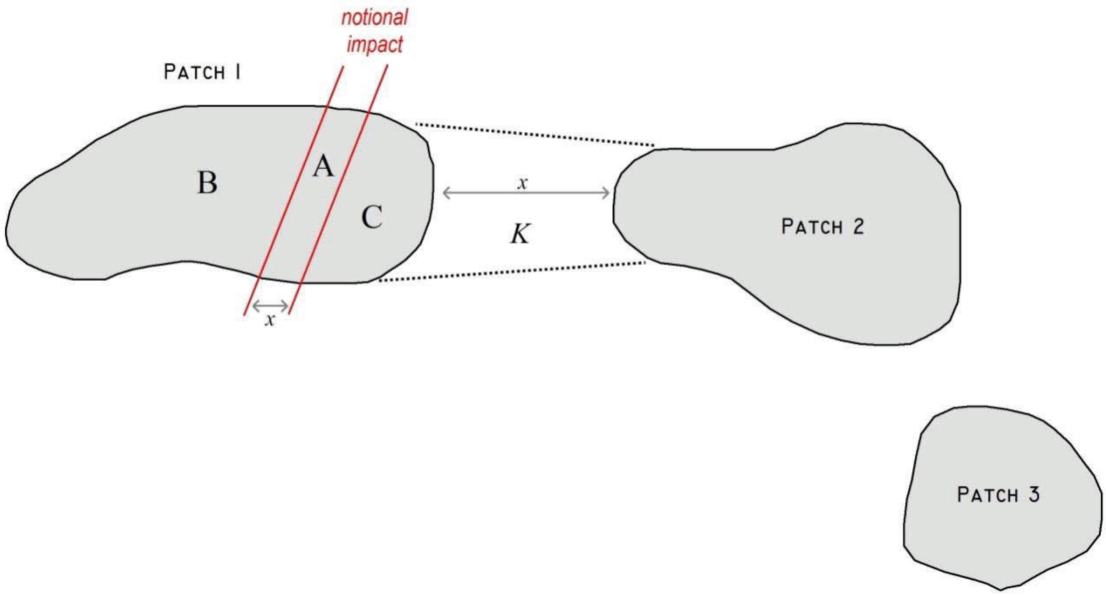


Figure 3-2 **Habitat Connectivity Concept for Golden Sun Moth (not to scale)**

Using this definition of a patch, all sub-patches are considered connected and GSM movement between them is possible. However, as the distance between patches varies, the ease with which this may occur also varies. To assess the ease of movement between patches, the concept of permeability is used. Permeability is considered a function of distance and substrate, whereby the greater the distance between sub-patches, the less permeable the non-habitat substrate between them becomes.

Permeability across different non-occupied (potential) or non-habitat grassland is determined using **Equation G1**. This equation is applied to different scenarios but with different values for X_{max} depending on the nature of the area across which permeability is being assessed. This calculation is completed for the shortest distance between all sub-patches that are not isolated ('X_n' values in **Figure 3.2**).

Equation G1: $P_{gsm} = 1 - (\frac{X}{X_{max}})$

Where:

P_{gsm} = the permeability score for golden sun moth

X = the smallest distance (metres) between two sub-patches, or the width of the impact area at its narrowest point through the patch

Constants for golden sun moth X_{max}:

Unoccupied grassland X_{max} = 200 metres

Non-habitat (eg. road) X_{max} = 15 metres

The scenario presented in **Figure 3.2** indicates a notional impact area (labelled 'A') which in the pre-development stage would have a permeability of 100 percent meaning there is no limitation to movement. In the post-development scenario described by **Figure 3.2** (assume a road), the permeability will be a function of the width of the non-habitat substrate (road and shoulders) and the relevant X_{max} constant value. Should the width of the road in this hypothetical scenario exceed 15 metres, the resultant permeability would be zero meaning that it is an absolute barrier.

For a patch that contains an absolute barrier within a permeable substrate, such that GSM are able to move around the barrier (e.g. a patch of trees or a building surrounded by grassland), the permeability score for the area containing the building will be zero. The permeability score of the permeable substrate would be calculated using the methods described above.

The permeability score for the entire patch is taken as the average of all permeability scores applicable to that patch.

The connectivity sub-score of a patch is determined by applying the patch permeability score to the total area of permeable non-habitat substrate within the patch and adding this to the total area of habitat, per **Equation G2**. This gives a weighted average of the permeability of a patch based on area by assigning a permeability of 1 to the habitat sub-patches.

Equation G2: $C = \sum_{1 \to n} (A_i \times P_i)$

Where:

C = connectivity raw score

A_i = area of each discrete patch

P_i = permeability score for each discrete patch

By calculating connectivity in this way, the maximum score will be achieved when the entire patch contains GSM habitat. Patches will score lower depending upon the proportion of GSM habitat to permeable substrate within it and the level of permeability of the substrate.

The site importance matrix is based on two inputs: size class of the affected patch (e.g. Patch 1 in **Figure 3.2**) and residual permeability for the impacted area (e.g. sub-patch 'A' in **Figure 3.2**). The range of scores presented has been based on a general risk assessment matrix where the combination of area and permeability gives a score for importance for use in the calculation. This describes the importance of the affected area to the population and indicates that a large impact to permeability (low number on X-axis) will be very important in a small patch but of only minor importance to a big patch. It assumes that very large patches are highly resilient to any impacts while the smaller patches are increasing susceptible to more substantial impacts.

The size class is determined based on the categories outlined in **Table 3.10**, noting that this is the patch size, not necessarily the area of GSM habitat. The reasons for this are explained below.

Table 3.10 Patch Size Score for Golden Sun Moth

Score	Patch Size (ha)
1	0 – 14.9
2	15 – 74.9
3	75 – 124.9
4	125 – 159.9
5	160 and greater

The range of the size classes are determined using existing knowledge of occupied GSM habitats in the ACT. Action Plan 28 identifies the areas of lowland grasslands known to contain GSM populations. The areas of these grasslands were graphed in size order from smallest to largest, and a logarithmic curve fitted to the data (refer to **Figure 3.3**). This curve was used to define the size classes such that an equal weight was given to small or moderate size habitat patches, and higher scores given to the larger patches to reflect the pattern of habitat size distribution in the ACT.

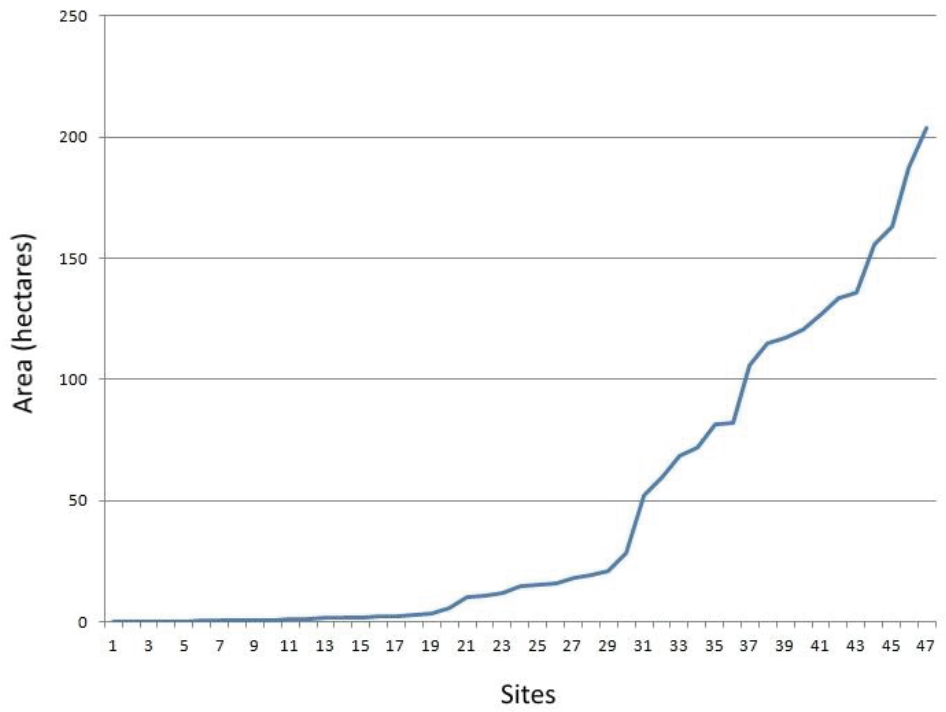


Figure 3-3 **Size of Golden Sun Moth Patches in Action Plan 28**

This system is based on the general assumption that bigger habitat areas are better than smaller ones. However it is unknown what the minimum thresholds are for habitat size in relation to GSM population viability. In future, pending further scientific investigation, a minimum patch size may be incorporated into this scoring system to reflect the minimum habitat size that can host a viable GSM population. The same may be said for larger patches, and identifying the point (if any) after which patch size does not affect the viability or size of a GSM population.

The key limitation of this methodology is that the data set used is ten years old, and since this time many more GSM populations have been identified in Canberra (Mulvaney, 2012[14]). This data is also based on the size of the grasslands, and this does not necessarily reflect the total area of GSM habitat present. Due to the variety in reporting methods for the species, it is difficult to access data in the same format. It is therefore most likely that these areas have all been overestimated, however the effect of this on the Habitat Quality Score is considered negligible, given that it applies to all data being utilised for the GSM habitat quality assessments.

The threats sub-score is based on the presence and intensity of the threats identified in the Commonwealth species profile for GSM. The Commonwealth GSM Conservation Advice (Australian Government, 2013[15]) noted six types of threats: habitat loss, habitat fragmentation, isolation of populations, habitat degradation, agricultural practices, and weed invasion. Given the considerable overlap and multiple drivers of these threats, they were narrowed into five specific threats for the purposes of this offset calculation:

- weed invasion (i.e. non-forage species, not necessarily exotic plants)
- under or over grazing
- pesticide use
- inappropriate fire, and
- fertiliser use.

It should be noted that both grazing and fire may be used as management tools without being considered a threat to GSM as long as they occur within the tolerance thresholds of the species.

Each of the five threats above is assigned a score out of 2 based on the presence and intensity of threats at the site, the criteria for which is outlined in **Table 3.11**. The overall threat sub-score is the sum of scores for each threat and has a maximum of 10.

Table 3.11 Threat Intensity Scores for Golden Sun Moth

Score	Rationale
0	Threat absent.
1	Low intensity threat.
2	High intensity threat.

3.1.2.3 Species Stocking Rate

The Species Stocking Rate Score is an estimate of the number of GSM that occupies a site. For the purpose of this assessment, this score has been separated into three sub-scores: species presence, species density, and role of site.

[14] Mulvaney, M. (2012) The Extent and Significance of Gungahlin's Biodiversity Values, Technical Report 24, prepared for Environment and Sustainable Development Directorate, Canberra.

[15] Australian Government (2013) Approved Conservation Advice for *Synemon plana* (Golden Sun Moth). Approved by the Delegate of the Minister on 17 December 2013.

The species presence sub-score is a simple three-tiered scoring system (**Table 3.12**) that scores highest when GSM are known to occupy a site.

Table 3.12 Species Presence Scores for Golden Sun Moth

Score	Rationale
0	Golden sun moth are absent from the site.
1	Models predict that golden sun moth might occupy a site.
2	The presence of golden sun moth at the site has been confirmed.

Species density has been scored based on the following six tiered system. This sub-score is somewhat subjective given the variability of GSM observations between and during survey efforts and the lack of objective methods to determine the species density at a site. The justification for the score given will be provided. The sub-score values are presented in **Table 3.13**.

Table 3.13 Species Density Scores for Golden Sun Moth

Score	Rationale
0	No golden sun moth present.
1	Very low numbers of golden sun moth observed during surveys.
2	Low numbers of golden sun moth observed during surveys.
3	Low to moderate numbers of golden sun moth observed during surveys.
4	Moderate numbers of golden sun moth observed during surveys.
5	High numbers of golden sun moth observed during surveys.

The role of site sub-score relates to the importance of the population from a national perspective. The aim of this is to reflect the role of the site in population dynamics of the species and thus provide higher scores to populations that play a larger role in this regard, regardless of their density. The scores are assigned based on the number of important population criteria that are met, as defined in the Significant Impact Guidelines in relation to species listed as vulnerable under the EPBC Act. Criteria for an 'important population' are:

- key source population for either breeding or dispersal
- population that is necessary for maintaining genetic diversity, and
- population that is near the limit of the species range.

These criteria are considered appropriate as they are established in policy and although intended to be applied to an impact assessment for vulnerable species, they describe characteristics of populations that are ecologically important. Where these criteria are applied for assessment of a vulnerable species, should a population meet any criterion it would be considered as being 'important' for the purpose of impact assessment. As the intention of the assessment under the offset calculation is to determine relative importance, it is appropriate to recognise a population meeting all three criteria as being of greater importance that a population meeting only one criterion.

Scores are assigned based on the system defined in **Table 3.14**.

Table 3.14 Role of Site Sub-Score for Golden Sun Moth

Score	Rationale
0	None of the important population criteria met.
1	1 important population criterion met.
2	2 important population criteria met.
3	3 important population criteria met.

3.1.2.4 Determining Habitat Quality

As the EPBC Act Guide requires integer scores out of 10, each of the above raw scores was transformed prior to being combined for the final Habitat Quality Score. The transformation is described by **Equation G3.**

$$\textbf{Equation G3}: X' = bX$$

Where:

X' = transformed score

$$b = \frac{maximum\ transformed\ score}{maximum\ raw\ score}$$

X = raw score

For the purpose of this calculation, all components of the Habitat Quality Score were considered equal. As such, the final Habitat Quality Score is an equally weighted average of the transformed component scores, rounded to the nearest integer.

Despite each sub-score being weighted equally, due to the raw score range of some of the scores being different, it is noted that a single step change in some individual components will have a larger effect on the overall habitat quality score than others.

Table 3.15 Habitat Quality Scores for Golden Sum Moth within Potential Development and Offset Areas

Variable	Potential Development	Potential Offset	
	Block 3 Section 22 Barton	Block 48 Hall	Lot 1 DP1144979 Wallaroo
Site Condition			
Structure	3	3	3
Condition	3	2	2
Species Diversity	3	1	1
Site Context			
Connectivity	0	0	0
Importance	1	1	1
Threats	0.5	1.5	1.5
Species Stocking Rate			
Presence	2	2	2
Diversity	5	2	2
Population Importance	1	1	1
Habitat Quality			
	7	**5**	**5**

3.1.3 Offset Scenario Parameters

The following parameters were used to geode offset calculations using the Commonwealth Environmental Offsets Policy:

- risk-related time horizon was set at 20 years as this is appropriate for an action for which the impacts are permanent
- time until ecological benefit was set at three (3) years. This was applied based on the assumption that the predicted improvement in quality on the offset site under standard conservation management practices in grassy ecosystems will generally take effect by this time
- Note that habitat quality scores may easily be set as variable scores for start, future with and future without values based on quantified assessment of identified offset sites, and identification of potential improvements (e.g. control of significant weed species)

- the risk of loss (per cent) without offset was set at 10 per cent. This is based on the low potential for habitat to be degraded under current management under a vegetation management plan, and the Finance's obligation under divestment to any party to maintain MNES. The risk of loss (per cent) with offset was set at 5 per cent based on a slightly higher level of certainty of maintenance of ecological condition in a managed conservation area; a small risk was still allocated due to the potential for stochastic events or climate change to alter floristic composition and site condition
- given the precautionary approach outlined in the above points, the confidence in result was set at 90 per cent, and
- It is assumed that habitat quality in proposed offset areas would decrease by '1' if no additional management actions are undertaken, and increase by '1' if additional management actions are undertaken.

3.2 Results

Calculating the value of the offset results in a score that describes the proportion of the offset that is achieved under a given scenario. The minimum that needs to be achieved through is 90 percent. In such a scenario the remaining 10 percent must be made up of other compensatory measures, formerly described as 'indirect' offsets and may take the form of research.

3.2.1 Natural Temperate Grassland

Based on the transparent habitat quality scoring system developed through comparative analysis of plot data within the Project Area and at selected sites across the ACT, habitat quality scores for proposed development and offset areas are shown in **Table 3.6** (**Section 3.1.1.3**).

Table 3.16 shows impact and offset calculations for NTG. Through incorporating current knowledge on values (**Section 2**) and habitat quality (**Section 3.1.1.3**) and applying scenario parameters outlined in Section **3.1.3**, both potential offset sites are considered to offset impact values for the development of Block 3 Section 22 Barton. As indicated in **Table 3.16** both potential offset sites substantially exceed the minimum 90 percent and required 100 percent of offset values.

Full calculations are shown in **Appendix 2**.

Table 3.16 Impact and Offset Scenarios for Natural temperate Grassland

Impact (Block 3 Section 22 Barton)			Potential Offset			
Area (ha)	Habitat Quality	Adjusted Area	Name	Area (ha)	Habitat Quality	Impact Offset
0.32	5	0.16	Block 48	2.3	6	255%
			Lot 1	17	4	1,810%

3.2.2 Golden Sun Moth

Based on the transparent habitat quality scoring system developed through comparative analysis of GSM species richness and condition plot data within the Project Area and at selected sites across the ACT, habitat quality scores for proposed development and offset areas are shown in **Table 3.15** (**Section 3.1.2.4**).

Table 3.17 shows impact and offset calculations for GSM. Through incorporating current knowledge on values (**Section 2**) and habitat quality (**Section 3.1.2.4**) and applying scenario parameters outlined in Section **3.1.3**, only Block 48 Hall is considered a suitable site to offset impact values for the development of Block 3 Section 22 Barton. Lot 1 in Wallaroo only achieves 59 percent of the required value as an offset for golden sun moth.

Full calculations are shown in **Appendix 3**.

Table 3.17 Impact and Offset Scenarios for Golden Sun Moth

Impact (Block 3 Section 22 Barton)			Potential Offset			
Area (ha)	Habitat Quality	Adjusted Area	Name	Area (ha)	Habitat Quality	Impact Offset
0.32	7	0.22	Block 48	3.1	5	207%
			Lot 1	0.7	5	47%

4.0 Conclusion

The EPBC Act Environmental Offsets Policy (Australian Government, 2012) outlines the Australian Government's approach to the use of offsets under the EPBC Act, aiming to provide transparency around how the suitability of offsets is determined. While the approach provides guidance as to how to calculate habitat quality, variables within this (site condition, site context and/or species stocking rate) should be considered based on an appreciation of the suite of values and threats of the MNES as it occurs in nature. This consideration should also occur across its ecological range, or at a minimum, broad regional or metapopulation scale.

Guidance is provided on determining associated parameters in the 'offsets assessment guide' such as time over which loss is averted, time until ecological benefit, risk of loss (per cent), and confidence in result (per cent). There is considerable sensitivity in calculations depending on how these are applied. For example the difference between 60 per cent, 70 per cent and 80 per cent confidence will have a significant bearing on offset requirements. While there is no apparent way to apply these parameters consistently, associated parameter values should be determined in a transparent and justifiable manner, based on evidence as far as possible.

The methodology used to develop parameters for offset calculations for this offset analysis report are outlined in **Section 3.1**, with the results in **Section 3.2**. Through consideration of applicable ecological factors in determining habitat quality, and justification in the application of associated parameters, a transparent foundation for offset calculations has been provided.

The proposed development of Block 3 Section 22 Barton may be offset for with respect to impacts on NTG by either Block 48 or Lot 1 Wallaroo. However, impacts to GSM populations may only be offset by Block 48 Hall.

5.0 References

ACT Government (2005) Action Plan No. 28: A Vision Splendid of the Grassy Plains Extended, ACT Lowland Native Grassland Conservation Strategy, Environment ACT, Canberra.

Armstrong RC (2013) Interim Analysis of Relationships Between Vegetation Condition and Kangaroo Density in Grassy Ecosystems of the Northern ACT: Data Collected Spring-Summer 2009/2012. A Report Prepared for ACT Government, Environment and Sustainable development Directorate, Canberra. February 2013.

Australian Government (2009a) Significant Impact Guidelines for the Critically Endangered Golden Sun Moth (*Synemon plana*), Nationally Threatened Species and Ecological Communities EPBC Act Policy Statement 3.12, Department of Environment, Water, Heritage and the Arts, Canberra.

Australian Government (2009b) Background Paper to EPBC Act Policy Statement 3.12 – Nationally Threatened Species and Ecological Communities Significant Impact Guidelines for the Critically Endangered golden Sun Moth (Synemon plana), Department of the Environment, Water, Heritage and the Arts, Canberra.

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Rehwinkel R (2007) A Method to Assess Grassy Ecosystem Sites: Using Floristic Information to Assess a Site's Quality. NSW Department of Environment and Climate Change. November 2007, Version 2.

Umwelt (2016a) Vegetation Management Plan: Block 48 Wallaroo Road. Draft Report prepared for Department of Finance, January 2016.

Umwelt (2016b) Vegetation Management Plan: Lot 1 Wallaroo Road. Draft Report prepared for Department of Finance, January 2016.

Umwelt (2016c) Golden Sun Moth and Natural temperate Grassland Vegetation Management Plan. Block 3 Section 22 Barton. Draft Report prepared for Department of Finance, January 2016.

Umwelt (2016d) Year 2 / Baseline Vegetation Condition Monitoring Report. Block 48 Wallaroo Road. Draft Report prepared for Department of Finance, January 2016

Umwelt (2016e) Year 2 / Baseline Vegetation Condition Monitoring Report. Lot 1 Wallaroo Road. Draft Report prepared for Department of Finance, January 2016.

Umwelt (2016f) Golden Sun Moth Survey Results, Lot 1 and Block 48 Wallaroo Road. Briefing Note prepared for Department of Finance, January 2016.

APPENDIX 1

Transformation Tables for Natural Temperate Grassland

Table A1.1 – Native Species Richness

Native Species Richness Score (R’)	Raw Data Range	
	min	max
1	1	5
2	6	10
3	11	15
4	16	20
5	21	25
6	26	30
7	31	-

Table A1.2 – Floristic Value Score

Floristic Value Score (FVS’)	FVS Range	
	min	max
1	1	1
2	>1	2
3	>2	4
4	>4	8
5	>8	12
6	>12	18
7	>18	24
8	>24	32
9	>32	40
10	>40	-

Table A1.3 – Exotic Species

Exotic Species Richness Score (w’)	Raw Data Range	
	min	max
0	0	0
1	1	5
2	6	10
3	11	15
4	16	-

APPENDIX 2

Offset Calculations for Natural Temperate Grassland

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	NTG
EPBC Act status	Endangered
Annual probability of extinction Based on IUCN category definitions	**1.2%**

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	Yes	Block 3 Section 22 Barton	Area	0.32	Hectares	Umkwelt (2016)
			Quality	5	Scale 0-10	
			Total quantum of impact	0.16	Adjusted hectares	
Threatened species habitat						
Area of habitat	No		Area			
			Quality			
			Total quantum of impact	0.00		

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source
Number of features e.g. Nest hollows, habitat trees	No				
Condition of habitat Change in habitat condition, but no change in extent	No				
Threatened species					
Birth rate e.g. Change in nest success	No				
Mortality rate e.g Change in number of road kills per year	No				
Number of individuals e.g. Individual plants/animals	No				

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	Yes	0.16	Adjusted hectares	Block 48 wallaroo Road	Risk-related time horizon (max. 20 years)	20	Start area (hectares)	2.3	Risk of loss (%) without offset	10%	Risk of loss (%) with offset	5%	0.12	90%	0.10	0.08	0.41	255.06%	Yes		
									Future area without offset (adjusted hectares)	2.1	Future area with offset (adjusted hectares)	2.2									
					Time until ecological benefit	5	Start quality (scale of 0-10)	6	Future quality without offset (scale of 0-10)	5	Future quality with offset (scale of 0-10)	7	2.00	90%	1.80	1.70					
Threatened species habitat																					
Area of habitat	No				Time over which loss is averted (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset		Risk of loss (%) with offset										
									Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0									
					Time until ecological benefit		Start quality (scale of 0-10)		Future quality without offset (scale of 0-10)		Future quality with offset (scale of 0-10)										

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Number of features e.g. Nest hollows, habitat trees	No															
Condition of habitat Change in habitat condition, but no change in extent	No															
Threatened species																
Birth rate e.g. Change in nest success	No															
Mortality rate e.g Change in number of road kills per year	No															
Number of individuals e.g. Individual plants/animals	No															

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	0				$0.00		$0.00
Area of community	0.16	0.41	255.06%	Yes	$0.00	N/A	$0.00
					$0.00	**$0.00**	**$0.00**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	NTG
EPBC Act status	Endangered
Annual probability of extinction Based on IUCN category definitions	1.2%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	Yes	Block 3 Section 22 Barton	Area	0.32	Hectares	Umkwelt (2016)
			Quality	5	Scale 0-10	
			Total quantum of impact	0.16	Adjusted hectares	
Threatened species habitat						
Area of habitat	No		Area			
			Quality			
			Total quantum of impact	0.00		

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact	Units	Information source
Number of features e.g. Nest hollows, habitat trees	No				
Condition of habitat Change in habitat condition, but no change in extent	No				
Threatened species					
Birth rate e.g. Change in nest success	No				
Mortality rate e.g Change in number of road kills per year	No				
Number of individuals e.g. Individual plants/animals	No				

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	Yes	0.16	Adjusted hectares	Block 48 wallaroo Road	Risk-related time horizon (max. 20 years)	20	Start area (hectares)	17	Risk of loss (%) without offset	10%	Risk of loss (%) with offset	5%	0.85	90%	0.76	0.60	2.90	1809.91%	Yes		
									Future area without offset (adjusted hectares)	15.3	Future area with offset (adjusted hectares)	16.2									
					Time until ecological benefit	5	Start quality (scale of 0-10)	4	Future quality without offset (scale of 0-10)	3	Future quality with offset (scale of 0-10)	5	2.00	90%	1.80	1.70					
Threatened species habitat																					
Area of habitat	No				Time over which loss is averted (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset		Risk of loss (%) with offset										
									Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0									
					Time until ecological benefit		Start quality (scale of 0-10)		Future quality without offset (scale of 0-10)		Future quality with offset (scale of 0-10)										

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)	Start value	Future value without offset	Future value with offset	Raw gain	Confidence in result (%)	Adjusted gain	Net present value	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Number of features e.g. Nest hollows, habitat trees	No															
Condition of habitat Change in habitat condition, but no change in extent	No															
Threatened species																
Birth rate e.g. Change in nest success	No															
Mortality rate e.g Change in number of road kills per year	No															
Number of individuals e.g. Individual plants/animals	No															

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	0				$0.00		$0.00
Area of community	0.16	2.90	1809.91%	Yes	$0.00	N/A	$0.00
					$0.00	**$0.00**	**$0.00**

APPENDIX 3

Offset Calculations for Golden Sun Moth

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Synemon plana
EPBC Act status	Critically Endangered
Annual probability of extinction Based on IUCN category definitions	6.8%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	York Park	Area	0.32	Hectares	Umwelt (2016)
			Quality	7	Scale 0-10	
			Total quantum of impact	0.22	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	No				Risk-related time horizon (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset		Risk of loss (%) with offset										
									Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0									
					Time until ecological benefit		Start quality (scale of 0-10)		Future quality without offset (scale of 0-10)		Future quality with offset (scale of 0-10)										
Threatened species habitat																					
Area of habitat	Yes	0.22	Adjusted hectares	Block 48 wWllaroo Road	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	3.1	Risk of loss (%) without offset	10%	Risk of loss (%) with offset	5%	0.16	90%	0.14	0.04	0.46	206.58%	Yes		
									Future area without offset (adjusted hectares)	2.8	Future area with offset (adjusted hectares)	2.9									
					Time until ecological benefit	2	Start quality (scale of 0-10)	5	Future quality without offset (scale of 0-10)	4	Future quality with offset (scale of 0-10)	6	2.00	90%	1.80	1.58					
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**		**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																				
Condition of habitat Change in habitat condition, but no change in extent	No																				
Threatened species																					
Birth rate e.g. Change in nest success	No																				
Mortality rate e.g Change in number of road kills per year	No																				
Number of individuals e.g. Individual plants/animals	No																				

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($)		
					Direct offset ($)	Other compensatory measures ($)	Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	0.224	0.46	206.58%	Yes	$0.00	N/A	$0.00
Area of community	0				$0.00		$0.00
					$0.00	**$0.00**	**$0.00**

Offsets Assessment Guide

For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999*
2 October 2012

This guide relies on Macros being enabled in your browser.

Matter of National Environmental Significance	
Name	Synemon plana
EPBC Act status	Critically Endangered
Annual probability of extinction Based on IUCN category definitions	6.8%

Key to Cell Colours
User input required
Drop-down list
Calculated output
Not applicable to attribute

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community	No		Area			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat	Yes	York Park	Area	0.32	Hectares	Umwelt (2016)
			Quality	7	Scale 0-10	
			Total quantum of impact	0.22	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No					
Condition of habitat Change in habitat condition, but no change in extent	No					
Threatened species						
Birth rate e.g. Change in nest success	No					
Mortality rate e.g Change in number of road kills per year	No					
Number of individuals e.g. Individual plants/animals	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)		% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																					
Area of community	No				Risk-related time horizon (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset		Risk of loss (%) with offset										
									Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0									
					Time until ecological benefit		Start quality (scale of 0-10)		Future quality without offset (scale of 0-10)		Future quality with offset (scale of 0-10)										
Threatened species habitat																					
Area of habitat	Yes	0.22	Adjusted hectares	Lot 1 Wallaroo Road	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	0.7	Risk of loss (%) without offset	10%	Risk of loss (%) with offset	5%	0.03	90%	0.03	0.01	0.10	46.65%	No		
									Future area without offset (adjusted hectares)	0.6	Future area with offset (adjusted hectares)	0.7									
					Time until ecological benefit	2	Start quality (scale of 0-10)	5	Future quality without offset (scale of 0-10)	4	Future quality with offset (scale of 0-10)	6	2.00	90%	1.80	1.58					
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**		**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																				
Condition of habitat Change in habitat condition, but no change in extent	No																				
Threatened species																					
Birth rate e.g. Change in nest success	No																				
Mortality rate e.g Change in number of road kills per year	No																				
Number of individuals e.g. Individual plants/animals	No																				

Summary

Protected matter attributes	Quantum of impact	Net present value of offset	% of impact offset	Direct offset adequate?	Cost ($): Direct offset ($)	Cost ($): Other compensatory measures ($)	Cost ($): Total ($)
Birth rate	0				$0.00		$0.00
Mortality rate	0				$0.00		$0.00
Number of individuals	0				$0.00		$0.00
Number of features	0				$0.00		$0.00
Condition of habitat	0				$0.00		$0.00
Area of habitat	0.224	0.10	46.65%	No	$0.00	#DIV/0!	#DIV/0!
Area of community	0				$0.00		$0.00
					$0.00	**#DIV/0!**	**#DIV/0!**

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Australian Government
Department of Finance

YEAR 2 / BASELINE VEGETATION CONDITION MONITORING REPORT

Block 48 Wallaroo Road, Hall ACT

FINAL

January 2016

Australian Government
Department of Finance

YEAR 2 / BASELINE VEGETATION CONDITION MONITORING REPORT

Block 48 Wallaroo Road, Hall ACT

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Department of Finance

Project Director:	Peter Cower
Project Manager:	Rob Armstrong
Report No.	8018C/R04/V1
Date:	January 2016

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Figures

Appendices

1.0 Introduction

1.1 Background

Umwelt (Australia) Pty Ltd (Umwelt) was commissioned by the Commonwealth Department of Finance ('Finance') to undertake 'Year 2' vegetation condition monitoring for Block 48 Wallaroo Road, Hall, ACT (the 'Project Area').

The Project Area is approximately 66 hectares. As determined by Umwelt (2016[1]), it contains approximately 14 hectares of White Box – Yellow Box – Blakely's Red Gum Grassy Woodland (Box Gum Woodland), an ecological community listed as critically endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and endangered under the ACT *Nature Conservation Act 2014* (NC Act). The Project Area also contains approximately 2.3 hectares of the ecological community 'Natural Temperate Grassland of the Southern Tablelands of NSW and the ACT' (NTG) (Umwelt, 2016), listed as endangered under the EPBC Act and the NC Act.

A Vegetation Management Plan (VMP) was developed for the Project Area by Kellogg Brown & Root Pty Ltd (KBR) in 2014 (KBR, 2014[2]), updated by Umwelt (2016). The VMP stipulates the need for monitoring of fixed vegetation quadrats, the locations of which were determined during the 2013 Vegetation Condition Assessments.

This report presents the following:

- The methodology and results of baseline monitoring using methods outlined in the ACT Vegwatch manual (Sharp and Gould, 2014[3]) and the Floristic Value Scores method (Rehwinkel, 2007[4]).
- The methodology and results of Year 2 monitoring using the methodology applied by Biosis (2015[5]), completed as per the requirements of the VMP.

The results of this monitoring will inform Finance in prioritising management measures aimed at ensuring the long term preservation of significant ecological values.

1.2 Objectives of the Project

The primary objectives of the project are to:

- undertake the baseline and Year 2 monitoring of the Project Area
- collate the data, analyse it against the performance indicators and provide the data and analysis to Finance (not possible for Year 2 data, baseline data is presented for future monitoring purposes)
- review mitigation actions recommended by Biosis (2015), and apply where threats to Box Gum Woodland or NTG are identified.

---

[1] Umwelt (2016) Vegetation Management Plan: Block 48 Wallaroo Road. Draft Report prepared for Department of Finance, January 2016.

[2] KBR (2014) Block 48 Wallaroo Road, Vegetation Management Plan. Prepared for Department of Finance by Kellogg Brown and Root Pty Ltd, 5 March 2014.

[3] Sharp. S. and Gould, L. (2014) ACT Region Vegwatch Manual: Vegetation and habitat condition assessment and monitoring for community. Molonglo Catchment Group, 2014

[4] Rehwinkel, R (2007) A Method to Assess Grassy Ecosystem Sites: Using Floristic Information to Assess a Site's Quality. NSW Department of Environment and Climate Change, November 2007.

[5] Biosis (2015) Block 48, Hall ACT – Year 1 Vegetation Condition Monitoring Report. Prepared for the Commonwealth Department of Finance, Final V2, March 2015.

1.3 Acknowledgements

The monitoring report for Block 48 Wallaroo Road has relied on the following previous work:

- the Biosis (2015) vegetation monitoring report, of which much of the original text have been adopted (noting that the methodology has largely changed since this report based on the current project brief)
- the KBR (2014) VMP, which provides guidance on the initial methodology.

2.0 Methodology

As stipulated in the project brief, monitoring was undertaken using a quadrat-based method applied by KBR (2014) and Biosis (2015), as well as quadrat methods outlined by Sharp and Gould (2014). The monitoring was undertaken by two ecologists on 2 November 2015, covering:

- two 20 x 20 metre quadrats in NTG, with 50 metre step-point transects and 10 x 10 metre nested quadrats
- eight 20 x 20 metre Box Gum Woodland quadrats, with 50 metre step-point transects and with 10 x 10 metre nested quadrats.

Twenty by twenty metre quadrats were required to satisfy the methodology outlined in Sharp and Gould (2014) (baseline monitoring), with 10 x 10 metre quadrats nested within to satisfy the methodology outlined in KBR (2014) (Year 2 monitoring).

Note that one quadrat mapped by KBR (2014) as occurring in Box Gum Woodland was resolved by Umwelt (2016) to actually be occurring within NTG (Refer to **Section 4**).

The location of these quadrats is shown in **Figure 2.1.**

2.1 Year 2 Monitoring

2.1.1 Data Collected for Each Quadrat

Each 10 x 10 metre quadrat was marked out with survey flags using a hand-held GPS, nested within 20 x 20 metre quadrats used for baseline monitoring. For each quadrat, in addition to recording soil damage from stock and presence of threatened flora and fauna, the percentage cover for each the following variables was collected using the field sheets provided with the KBR (2014) VMP:

- all indigenous species
- all indigenous grass species
- key grass species (NTG Quadrat only) (*Themeda triandra*, *Poa labillardierei* var. *labillardierei*, *Rytidosperma* spp. and *Austrostipa* spp.)
- herbs and forbs
- sedges and rushes
- exotic species
- weeds of national significance (WoNS) and noxious weeds
- bare ground
- surface rock
- moss, lichens and soil crust
- organic litter
- canopy, immature canopy and recruiting canopy (Box Gum Woodland quadrats only).

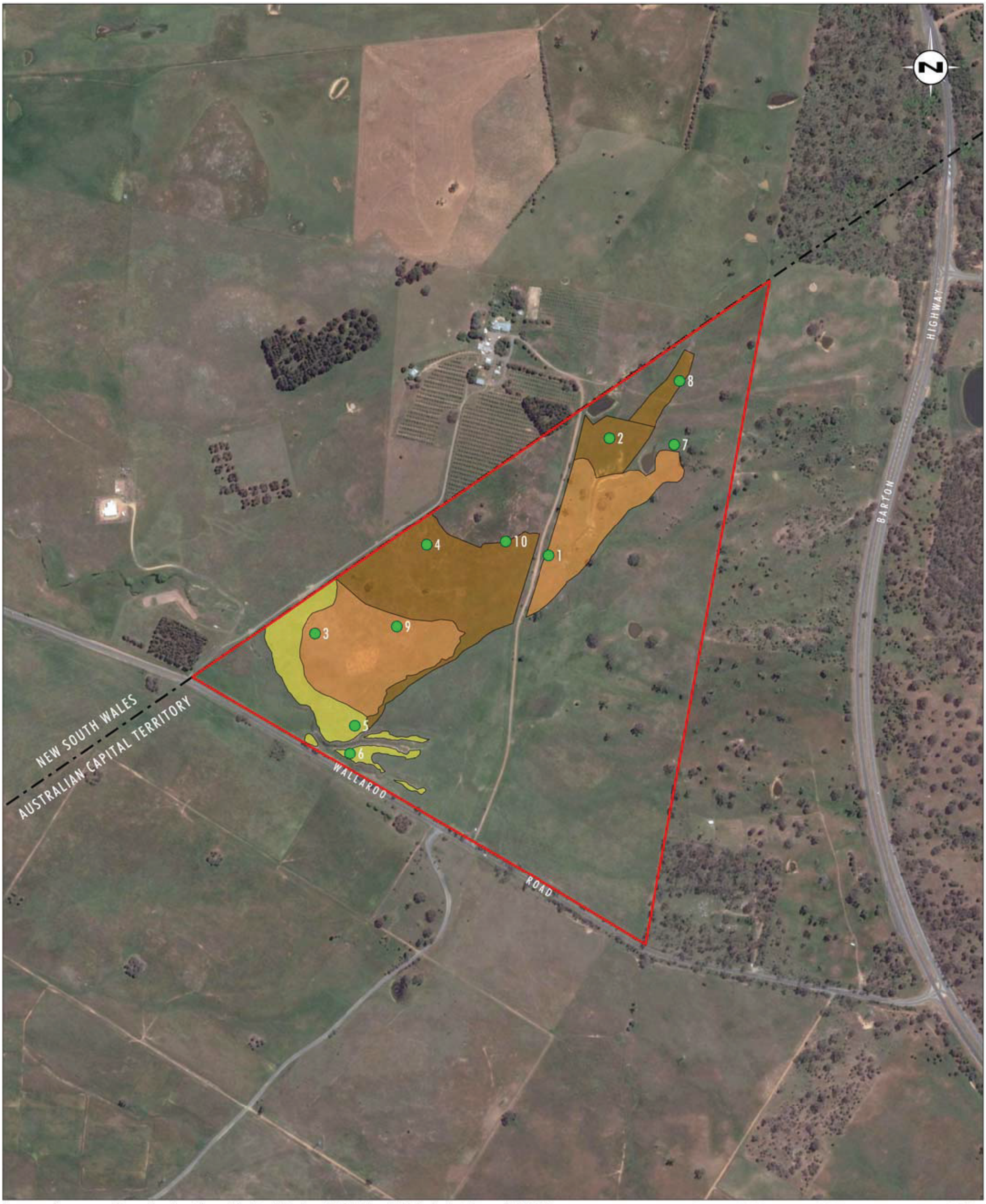

Image Source: Google Earth - DigitalGlobe (2015), CNES / Astrium (2015)

0 100 250 500m
1:10 000

Legend
- Project Area (Block 48)
- State Boundary
- Box Gum Grassy Woodland and Derived Grassland
- Box Gum Grassy Woodland and Derived Grassland HQ
- Natural Temperate Grassland
- Plot Location

FIGURE 2.1

Plot Locations and Vegetation

File Name (A4): R04/8018_011.dgn
20160115 14.55

All percentage cover metrics were estimated through visual subjective assessment. In addition to the above data, an inventory of the native species present was made for each quadrat. For the Box Gum Woodland quadrats, the number of native non-grass species and the number of 'important species' (from EPBC Act Policy Statement 3.5) was also noted. Dominant pasture weeds, significant weeds and impacts of pest animals were recorded where relevant to management actions.

With regards to the methods of recording cover, as per KBR's methodology, percentage cover of most features (indigenous species, exotic species, surface rock, moss, lichen and soil crust, litter, and bare ground) was recorded in a manner which allowed for overlap. Recording percentage cover in this manner often results in the total adding to considerably more than 100. Within the 'per cent cover of indigenous species' and the 'per cent cover of exotic species' categories, the constituent groups were required to equal the total for the category. Accordingly, this report determines whether Year 1 targets have been met.

2.1.2 Analysis

The quadrat results were compared to the Year 1 targets which are presented in the KBR (2014) VMP. These targets are shown in **Table 2.1** below. The results were also compared to the baseline monitoring data presented in the Vegetation Condition Assessment. The results are presented in **Section 3**.

Note that the KBR (2014) report has targets for Year 1, 3 and 5. As such, there are no Year 2 targets to compare with. Accordingly, this report determines whether Year 1 targets have been met.

A comment on targets

On Commonwealth land, the Australian Government is obliged to maintain MNES rather than seek an increase in value. Accordingly, targets should be set to ensure that that each MNES is *maintained* rather than *improved* with respect to extent and condition indicators. The only exceptions to this are:

- for the establishment of an advance offset site in accordance with the EPBC Act offset policy for which a known baseline of quality will be determined and targets for improvements in relevant MNES are established in order to demonstrate early delivery of environmental gain, or
- in the event of a site being used as an offset, in which case improvement criteria would be set out in an Offset Management Plan in accordance with targets for quality, distribution or population improvements established through an approval from the Minister for the Environment under the EPBC Act.

The VMP prepared by KBR (2014) described its objective as seeking to maintain MNES however also included targets for the enhancement of natural values (apart from the targets for controlling threatening processes such as weeds). As demonstrated by Biosis (2015) and subsequently Umwelt (2016), the monitoring methods and baseline described by KBR (2014) were inappropriate for ongoing comparison. Accordingly application of targets for improvement are meaningless in terms of Finance’s statutory obligations under the EPBC Act, the objectives for the VMP as stated and utility of the baseline data.

Notwithstanding the above, basic analysis has been undertaken and is presented in **Table 3.1**.

2.1.3 Additional Information

Prior to engagement and based on a recommendation from the Biosis (2015) report, Finance determined that methods developed by Sharp and Gould (2014) should be applied for future monitoring. Based on the experience of Biosis (2015) and Umwelt’s review, it was apparent that methods applied by KBR (2014) were not repeatable for the purpose of monitoring changes in condition. For instance, the percentage of vegetation cover variables was estimated in a subjective fashion, and there was no separation between annual and perennial exotic vegetation considered important for grassy ecosystem management. The methods outlined in **Section 2.2** are well-accepted and broadly applied in grassy ecosystem monitoring programs in the region, and as such are more appropriate to determine changes in condition over time with regards to EPBC Act listed matters.

2.2 Baseline Monitoring

Following two years of data collection using the methods outlined above (**Section 2.1**), a simpler and more repeatable technique commonly used in the Southern Tablelands was adopted, based on the recommendation of Biosis (2015) and Finance. Given the lack of relationship with the previous highly qualitative methods, assessment undertaken by Umwelt in spring 2015 should be considered as baseline.

Georeference information for each quadrat is shown in **Table 2.2**. Georeference information is in MGA55, with eastings and northings taken from the start of the transect. The quadrat/transect design is shown in **Figure 2.2**.

Table 2.1 Targets at Year 1, from KBR (2014) VMP

Management Unit	Variable	Target at Year 1[1]
high quality Box Gum Woodland quadrats	native grass cover	50%
	species richness*	10% increase
degraded Box Gum Woodland quadrats	native grass cover	50%
	species richness*	2% increase
NTG quadrat	native grass cover	60%
	extent**	no reduction in extent
all Box Gum Woodland quadrats	eucalypt cover (recruits, saplings, and mature trees)	1% total cover
	number of non-grass species	12
	length of logs	0.5 metres
all monitoring quadrats	herb, forb, rush, and sedge cover	10% cover
	bare ground	10% cover
	organic litter	5% cover
	total exotic species cover	<25% cover

[1] No year 2 targets available for comparison.
*Interpreted by Biosis (2015) and this project as 'native species richness'. The only measure of native species richness that KBR recorded was non-grass species (assumed to be native non-grass species).

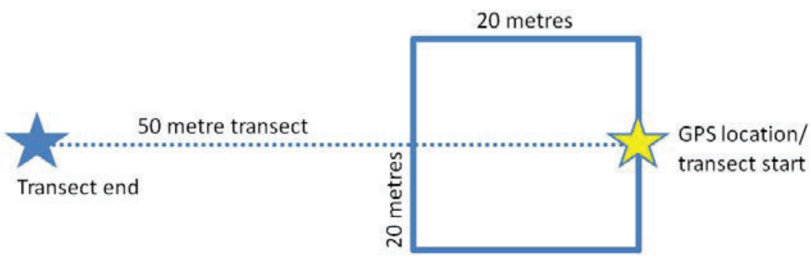

Figure 2.2

Quadrat and transect design

Table 2.2 Quadrat Locations and Transect Bearings

Quadrat	Easting	Northing	Transect Bearing
Q1	687024	6106563	09°
Q2	687137	6106782	215°
Q3	686588	6106418	195°
Q4	686796	6106583	157°
Q5	686662	6106246	265°
Q6	686653	6106194	67°
Q7	687258	6106770	195°
Q8	687268	6106889	10°
Q9	686740	6106431	95°
Q10	686943	6106589	51°

2.2.1 Data Collected for Each Quadrat/Transect

Table 2.3 Data Collected for Each Quadrat and Transect

Variable	Method
20 x 20 metre quadrat	
Native plant species richness	Native plant species refers to vascular species local to the area which, if planted, come from a local seed source. Systematically walk the plot counting the number of native plant species for all vascular plants (i.e. the species do not have to be identified).
Native midstorey cover	The mid-storey contains all vegetation between the overstorey stratum and 1m in height (typically tall shrubs, under-storey trees and tree regeneration) and includes all species native to the ACT (i.e. native species not local to the area can contribute to mid-storey structure). Foliage cover of the mid-storey is expressed as a % and can be measured using the following method: At 10 points along the 50m transect (i.e. every 5m) estimate per cent foliage cover in the mid-storey. Divide the total by the number of points (i.e. 10) measured along the transect (e.g. 50%, 0%, 0%, 40%, 0%, 45%, 50%, 55%, 0%, 0% = 240/10 =24% foliage cover).
At 10 points along 50 metre transects	
Native overstorey cover	Native over-storey is the tallest woody stratum present (including emergent trees) above 1m and includes all species native to the ACT (i.e. native species not local to the area can contribute to overstorey structure). In a woodland community the over-storey stratum is the tree layer, and in a shrubland community the over-storey stratum is the tallest shrub layer. Some vegetation types (e.g. grasslands) may not have an over-storey stratum. Over-storey cover is estimated as per cent foliage cover, which is equivalent to the amount of shadow that would be cast on the ground if there were a light source directly overhead and can be estimated using the following method: At 10 points along the 50 m transect (i.e. every 5 m) estimate per cent foliage cover directly overhead using the images provided on Page 4. Divide the total by the number of points (i.e. 10) measured along the transect (e.g. 50%, 0%, 0%, 40%, 0%, 45%, 50%, 55%, 0%, 0% = 240/10 =24% foliage cover).
At 50 points along 50 metre transects	
Native ground cover (grasses)	The ground stratum contains all native vegetation below 1m in height and includes all species native to the ACT (i.e. is not confined to species indigenous to the area). The ground stratum (grasses) refers to native grasses (i.e. plants belonging to the family Poaceae). The ground stratum (forbs) refers to native forbs. The ground stratum (sedges) refers to native sedges. The ground stratum (rushes) refers to native rushes.
Native ground cover (shrubs)	
Native ground cover (forbs)	
Native ground cover (sedges)	

Variable	Method
Native ground cover (rushes)	The ground stratum (ferns) refers to native ferns. Foliage cover of the ground stratum (grasses) is expressed as a % and can be measured using the following method: At 50 points along the 50m transect (i.e. every 1 m) record whether native grass intersects that point. Divide the total of 'hits' by the number of points measured along the transect (i.e. 50).
Native ground cover (ferns)	
Perennial Exotic plant cover	Perennial exotic plants are vascular perennial plants not native to Australia. Perennial exotic cover is measured as a % of total ground cover vegetation.
Annual Exotic plant cover	Perennial exotic plants are vascular perennial plants not native to Australia. Perennial exotic cover is measured as a % of total ground cover vegetation.
Additional Variables (not collected, may be relevant pending future restoration of Box Gum Woodland)	
Over-storey regeneration	*Collected across entire zone.* Regeneration is measured as the proportion of over-storey species present at the site that is regenerating (i.e. with dbh < 5cm). For example if there are three tree species present at the site but only one of these species is regenerating, then the value is 0.33. The maximum value for this measure is 1.
Total length of fallen logs	*Collected in 20 x 50 metre quadrat.* This is the total length of logs at least 10cm diameter and at least 0.5 metres long. The diameter is estimated with a measuring tape (or callipers if available) held horizontally immediately above the log and the length is estimated to the nearest metre by measuring with a tape, or pacing, along the part of the log that is at least 10cm diameter. If estimating length by pacing then the actual length of a sample of logs should be measured regularly with a tape so the assessor can calibrate their estimate derived from pacing. Only those parts of logs lying within the plot are measured.
Number of large trees	*Collected in 20 x 50 metre quadrat.* This is a count of the number of living and dead trees within a 50mx20m plot which have a circumference of 150cm, 1m above ground height.

2.2.2 Floristic Value Score

Full-floristic data was also entered into the Floristic Value Score spreadsheet (Rehwinkel, 2007) in order to determine its floristic quality. The method is based upon the 'significant species' concept, which provides increased value to sites containing a variety of rare or grazing sensitive species. This is preferable over simple indicators such as floristic richness (or species count), which can provide value to sites with a number of unpalatable species.

2.2.3 Target Setting

On Commonwealth land, the Australian Government is obliged to maintain MNES rather than seek an increase in value. Accordingly, the only target required is to ensure that each MNES is maintained with respect to extent and condition indicators (variables in **Table 2.3**).

Should the Project Area be managed as an Offset in the future, improvement criteria should be set out in an Offset Management Plan.

2.2.4 Analysis

As a baseline survey, no analysis has been undertake. However, in future years it is recommended to undertake simple regression analysis of:

- Floristic Value Score
- each of the variables outlined in **Table 2.2**.

3.0 Results

3.1 Year 2

A comparison of the performance of 10 x 10 metre quadrats in comparison to previous years and targets set out in the original VMP (KBR, 2014; **Table 2.1**) are presented in **Table 3.1**. All entries are percentages except for 'number of non-grass species', 'number of important species', and 'number of native species', which are species counts.

Trends across years are difficult to determine as any variables related to percentage cover are estimates only, and are likely to vary between observers (a phenomenon known as observer bias). As monitoring has been undertaken by three separate ecologists (or groups thereof), interpretation of these results needs to account for observer bias. For such a subjective method, this is also true across years, albeit to a lesser extent.

Notwithstanding this, each quadrat is currently considered to be meeting some targets set out in the original VMP (KBR, 2014). **Table 3.1** highlights targets that are currently being met in green, with targets currently not being met in red. Non-highlighted cells do not have targets, or are from previous years.

Perhaps the best result is in the notable increase in vegetation cover. Approximately three months prior to the 2015 survey, stock was removed from Block 48 to allow for recovery. For the most part, vegetation cover has increased and is currently at levels considered acceptable based on local observations (note there are no metrics for comparison). Importantly, vegetation cover within golden sun moth (*Synemon plana*; critically endangered under the EPBC Act) habitat is at an acceptable level, although an upper threshold of c. 80 per cent should be set as exceedingly high vegetation cover will reduce opportunities for breeding within intertussock spaces.

Numerous noxious weeds were observed, and the location of these have been marked and provided in the updated VMP (Umwelt, 2016). These include serrated tussock (*Nassella trichotoma*), St John's wort (*Hypericum perforatum*) and blackberry (*Rubus fruticosus* agg.). These should be controlled in line with the VMP to ensure they do not degrade higher conservation value landscapes.

Table 2.1 targets an increase in the extent of NTG. The extent of NTG within the Project Area has increased, but not as a result of management. A small area of approximately 0.5 hectares of NTG was identified by KBR (2014) along the southern boundary surrounding the drainage lines, with an additional area of 1.8 hectares identified by Umwelt (2015), bringing the total to 2.3 hectares. The additional area was identified in the south-east is immediately north of the creek near Wallaroo Road and extends to an area adjacent to the NSW boundary, scaling the slope of the west-facing hill to about the 600 metre contour, a common scenario on exposed west-facing hills (Armstrong et al, 2013[6]). Accordingly, the extent of Box Gum Woodland has decreased by 1.8 hectares however this should not be considered a function of management failure but a consequence of more appropriate interpretation of landform, floristics and condition in comparison to published and legal definitions of the community.

No threatened flora or fauna species were recorded opportunistically within the Project Area during the survey. A native and exotic species list is presented as **Appendix 1**.

[6] Armstrong RC, Turner K, McDougall KL, Rehwinkel R & Crooks J (2013) Plant Communities of the Upper Murrumbidgee Catchment in New South Wales and the Australian Capital Territory. *Cunninghamia* **13**:125-265. http://www.rbgsyd.nsw.gov.au/__data/assets/pdf_file/0019/128521/Cun131arm125.pdf.

Table 3.1 Block 48 Vegetation Quadrat Data, Baseline (KBR 2014), Year 1 (Biosis), and Year 2 (Umwelt)

Variable	Q 1 (Box Gum HQ)			Q 2 (Box Gum LQ)			Q 3 (NTG)			Q 4 (Box Gum LQ)			Q 5 (NTG)		
	B	Y 1	Y 2	B	Y 1	Y 2	B	Y 1	Y 2	B	Y 1	Y 2	B	Y 1	Y 2
total indigenous cover	65	50	**75**	50	40	**70**	80	80	**70**	55	30	**35**	75	80	**55**
indigenous grass cover	55	40	**65**	45	35	**75**	45	50	**60**	54	30	**30**	60	70	**35**
indigenous non-grass cover	10	15	**5**	5	5	**5**	35	30	**10**	1	0	**5**	15	10	**35**
sedge and rush cover	1	4	**x***	2	2	**x***	2	4	**x***	0.5	0	**x***	5	5	**x***
herb and forb cover	9	1	**5**	3	3	**5**	33	26	**10**	0.5	0	**5**	10	5	**20**
total exotic cover	25	65	**20**	35	80	**10**	2	18	**10**	35	75	**30**	20	25	**15**
WoNS cover	0	0	**<1**	0.5	1	**0**	0	0	**0**	0	0	**0**	0	0	**0**
noxious weed cover	1	0.5	**<5**	0.5	3	**0**	0	0	**0**	0	0.5	**0**	3	0.5	**0**
bare ground	25	15	**2**	15	5	**5**	25	25	**5**	15	20	**1**	5	1	**10**
rock cover	3	3	**3**	0	0	**0**	5	15	**5**	1	1	**1**	0.5	0.5	**5**
moss and lichen cover	3	3	**2**	0	0	**0**	7	18	**5**	1	1	**1**	0.5	1	**0.5**
organic litter	2	5	**3**	2	5	**5**	1	1	**5**	2	2	**1**	5	5	**15**
logs	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
characteristic grass cover	55	40	**65**	45	35	**75**	45	50	**60**	54	30	**30**	60	70	**35**
no. of native non-grass species	18	16	**18**	15	10	**14**	18	5	**16**	3	1	**6**	13	9	**10**
no. of important species	7	7	**6**	5	5	**5**	8	4	**7**	1	0	**2**	6	5	**5**
no. of native species	-	21	**26**	-	13	**18**	-	9	**21**	-	4	**12**	-	13	**14**
canopy cover	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
immature canopy cover	0	0	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
recruiting eucalypt cover	0.5	0.5	**1**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
total eucalypt cover	0.5	0.5	**2**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**

* Information not collected, not included on original proforma.

Table 3.1 (continued) Block 48 Vegetation Quadrat Data, Baseline (KBR 2014), Year 1 (Biosis), and Year 2 (Umwelt)

Variable	Q 6 (NTG)			Q 7 (Box Gum HQ)			Q 8 (Box Gum LQ)			Q 9 (Box Gum HQ)			Q 10 (Box Gum LQ)		
	B	Y 1	Y 2	B	Y 1	Y 2	B	Y 1	Y 2	B	Y 1	Y 2	B	Y 1	Y 2
total indigenous cover	80	80	**75**	65	40	**50**	60	45	**45**	70	65	**45**	45	15	**40**
indigenous grass cover	65	65	**65**	55	25	**50**	45	30	**44**	55	50	**40**	43	15	**40**
indigenous non-grass cover	10	15	**5**	10	15	**1**	15	15	**1**	15	15	**5**	1	0	**0.5**
sedge and rush cover	5	1	**x***	5	11	**x***	8	13	**x***	5	5	**x***	0.5	0	**x***
herb and forb cover	15	14	**10**	5	4	**1**	7	2	**1**	10	10	**5**	0.5	0	**0.5**
total exotic cover	10	15	**20**	35	70	**20**	40	50	**45**	15	30	**1**	45	85	**40**
WoNS cover	0	0	**0**	0	0	**0**	0	0	**0**	0.5	0.5	**0**	0	0	**0**
noxious weed cover	0.5	0	**0**	0	0	**0**	0.5	0.5	**0**	2	3	**0**	5	5	**0**
bare ground	15	2	**1**	3	2	**5**	10	25	**5**	20	25	**10**	15	5	**10**
rock cover	0	0	**0**	0	0	**0**	1	2	**0**	5	3	**1**	7	7	**1**
moss and lichen cover	0	0	**0**	0	0	**0**	1	2	**0**	10	12	**3**	5	5	**1**
organic litter	3	8	**1**	15	9	**5**	5	5	**5**	3	4	**10**	5	2	**10**
logs	0	0	**0**	0.5	0.5	**0**	0	0	**0**	0	0	**0**	0	0	**0**
characteristic grass cover	63	65	**65**	55	25	**50**	45	30	**44**	55	50	**40**	43	15	**40**
no. of native non-grass species	n/a	n/a	**13**	12	6	**17**	14	7	**12**	16	6	**12**	6	1	**5**
no. of important species	n/a	n/a	**5**	4	2	**3**	5	3	**2**	3	4	**5**	1	0	**1**
no. of native species	n/a	n/a	**20**	-	12	**21**	-	12	**16**	-	10	**17**	-	4	**9**
canopy cover	0	0	**0**	1	1	**0**	0	0	**0**	0	0	**0**	0	0	**0**
immature canopy cover	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**	0	0	**0**
recruiting eucalypt cover	0	0	**0**	0	0.5	**0**	0	0	**0**	0	0	**0**	0	0	**0**
total eucalypt cover	0	0	**0**	1	1.5	**2**	0	0	**0**	0	0	**0**	0	0	**0**

3.2 Baseline

No analysis was undertaken on the baseline data due to a lack of comparison datasets. **Table 3.2** provides a summary of the data collected, which may be used for trend analysis in future years.

Table 3.2 Benchmark Data

Variable	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Floristic Value Score	29	15	24	5	14	17	11	9	15	4
Native plant species richness	26	18	21	12	14	20	21	16	17	9
Native overstorey cover	0	0	0	0	0	0	0	0	0	0
Native midstorey cover	1	0	0	0	0	0	0	0	0	0
Native ground cover (grass)	64	48	58	30	48	74	50	54	50	50
Native ground cover (shrubs)	0	0	0	0	0	0	0	0	0	0
Native ground cover (forbs)	0	4	4	0	4	0	2	16	6	0
Native ground cover (sedges)	0	0	0	0	0	0	0	0	0	0
Native ground cover (rushes)	0	0	0	0	0	0	0	0	0	0
Native ground cover (ferns)	0	0	0	0	0	0	0	0	0	0
Perennial Exotic plant cover	10	24	8	30	4	4	24	10	10	2
Annual Exotic plant cover	12	16	24	30	28	20	14	16	28	32

4.0 Conclusion

As discussed in **Section 3.1**, determining trends in subjectively collected data is limited by observer bias and a lack of continuum three separate ecologists (or groups thereof) undertaking the assessment. As such, it is difficult to determine whether the site is changing in condition with any confidence. A combination of monitoring weeds as per the VMP (Umwelt, 2016) monitoring floristic values in 20 x 20 metre quadrats and 50 metre transects using more repeatable methods will increase confidence in observations. Adhering to the following recommendations will provide for a more robust monitoring program:

- Marking each 20 x 20 metre quadrat corner with permanent markers, as well as the start and end of each transect.
- Discontinuing original data collection methods as outlined in **Section 2.1**, and continuing with methods outlined in **Section 2.2**.
- Ensuring that conservation management actions outlined in the VMP (Umwelt, 2016) are undertaken.

5.0 References

Armstrong RC, Turner K, McDougall KL, Rehwinkel R & Crooks J (2013) Plant Communities of the Upper Murrumbidgee Catchment in New South Wales and the Australian Capital Territory. *Cunninghamia* **13**:125-265. http://www.rbgsyd.nsw.gov.au/__data/assets/ pdf_file/0019/128521/Cun131arm125.pdf.

Biosis (2015) Block 48, Hall ACT – Year 1 Vegetation Condition Monitoring Report. Prepared for the Commonwealth Department of Finance, Final V2, March 2015.

KBR (2014) Block 48 Wallaroo Road, Vegetation Management Plan. Prepared for Department of Finance by Kellogg Brown and Root Pty Ltd, 5 March 2014.

Rehwinkel, R (2007) A Method to Assess Grassy Ecosystem Sites: Using Floristic Information to Assess a Site's Quality. NSW Department of Environment and Climate Change, November 2007.

Sharp. S. and Gould, L. (2014) ACT Region Vegwatch Manual: Vegetation and Habitat Condition Assessment and Monitoring for Community. Molonglo Catchment Group, 2014

Umwelt (Australia) Pty Limited (2016) Vegetation Management Plan: Block 48 Wallaroo Road. Draft Report prepared for Department of Finance, January 2016.

APPENDIX 1

Flora Species List

Species	1	2	3	4	5	6	7	8	9	10
*Acaena ovina**	x		x			x		x	x	
*Acetosella vulgaris**	x	x					x			
Aira sp.*	x	x	x	x	x	x	x	x	x	x
Amphibromus sp.							x			
*Arctotheca calendula**				x						x
Asperula conferta						x				
Austrostipa bigeniculata						x		x	x	
Austrostipa scabra			x	x	x	x				
Austrostipa scabra subsp. *falcata*									x	x
Avena sp.*	x	x	x	x	x		x		x	x
Bothriochloa macra	x		x	x		x			x	x
*Briza maxima**	x					x	x			
*Briza minor**	x	x			x	x	x			
*Bromus diandrus**				x					x	
*Bromus hordeaceus**		x			x			x	x	x
*Bromus molliformis**	x		x	x		x	x			
Carex appressa		x					x	x		
Carex sp.						x				
*Carthamus lanatus**	x	x	x	x	x				x	x
*Centaurium erythraea**	x	x	x		x	x		x		
Chamaesyce drummondii					x			x		
Cheilanthes sieberi	x									
*Chondrilla juncea**		x	x	x	x				x	x
Chrysocephalum apiculatum		x	x		x	x			x	
*Cirsium vulgare**	x		x		x					
Convolvulus angustissimus			x							x
Conyza sp.*			x							

Species	1	2	3	4	5	6	7	8	9	10
Cotula australis		x								
Crassula sieberiana					x					x
Cynoglossum suaveolens				x						
*Cynosurus echinatus**	x									
*Cyperus eragrostis**								x		
Desmodium varians			x	x					x	x
Dichelachne sp.							x			
Drosera peltata							x			
Drosera sp.		x								
*Echium plantagineum**	x	x	x	x					x	x
Eleocharis acuta							x			
Anthosachne scabra	x			x		x	x			x
Enneapogon nigricans			x							
Enteropogon acicularis		x								
*Erodium botrys**									x	
*Erodium cicutarium**		x		x	x				x	x
Eryngium ovinum	x									
Eucalyptus blakelyi	x						x			
Eucalyptus bridgesiana							x			
Euchiton gymnocephalus	x	x							x	
Euchiton sphaericus	x		x					x		
*Festuca arundinacea**						x	x			
*Festuca pratensis**						x				
*Gamochaeta purpurea**		x				x	x	x		
Glycine tabacina					x					
Goodenia hederacea			x							
Goodenia pinnatifida						x				

Species	1	2	3	4	5	6	7	8	9	10
Haloragis heterophylla							x	x		
*Holcus lanatus**	x	x			x		x	x		
*Hordeum leporinum**										x
Hypericum gramineum	x									
*Hypericum perforatum**	x									
*Hypochaeris glabra**		x	x	x	x		x	x	x	x
*Hypochaeris radicata**	x	x	x	x	x	x	x	x	x	x
Isolepis hookeriana							x			
Juncus bufonius							x			
Juncus filicaulis	x	x				x	x	x		
Juncus sp.	x					x		x		
*Lactuca serriola**				x						
Leptorhynchos squamatus	x	x			x	x		x		
*Lolium perenne**				x				x	x	x
Lomandra bracteata						x		x		
Lomandra filiformis subsp. *coriacea*	x	x	x	x	x		x	x	x	x
Lomandra filiformis subsp. *filiformis*	x	x	x	x					x	
Lomandra multiflora subsp. *multiflora*			x		x				x	
Luzula sp.	x					x				
Lythrum hyssopifolia							x			
Microlaena stipoides	x			x		x	x	x		
*Onopordum acanthium**		x								x
Panicum effusum	x	x	x		x					
*Paspalum dilatatum**	x	x				x	x	x		x
Persicaria prostrata							x			
*Petrorhagia nanteuilii**	x	x	x	x	x		x		x	x
*Phalaris aquatica**	x	x		x		x	x	x		x

Species	1	2	3	4	5	6	7	8	9	10
Pimelea curviflora			x							
*Plantago lanceolata**	x	x	x			x	x	x	x	
Plantago varia	x									
*Poa bulbosa**				x						
Poa sieberiana	x				x	x				
Polygonum aviculare								x		
Prunus sp.*							x			
*Rosa rubiginosa**		x				x			x	
Rumex brownii	x	x		x	x	x	x	x		x
*Rumex crispus**								x		
Rytidosperma carphoides	x	x	x		x	x		x	x	x
Rytidosperma sp.	x	x	x	x						
*Salvia verbenaca**				x						
*Sanguisorba minor **								x		
Schoenus apogon		x				x	x			
*Sonchus asper**	x									
*Sonchus oleraceus**				x						
Themeda triandra	x	x	x	x	x	x	x	x	x	
*Tolpis barbata**			x						x	x
Tragopogon sp.*				x						
Tricoryne elatior	x	x	x				x		x	
*Trifolium arvense**		x	x	x	x	x		x	x	x
*Trifolium campestre**			x	x	x					
*Trifolium dubium**		x						x		
*Trifolium glomeratum **	x	x	x		x	x	x	x	x	x
*Trifolium repens**	x			x				x		
Trifolium sp.*									x	x

Species	1	2	3	4	5	6	7	8	9	10
*Trifolium subterraneum**					x					
Triptilodiscus pygmaeus	x	x	x		x		x		x	
*Verbascum thapsus**									x	
*Vulpia myuros**		x			x			x		x
Vulpia sp.*	x		x	x		x	x			
Wahlenbergia communis	x			x					x	
Wahlenbergia luteola									x	
Wahlenbergia multicaulis			x					x		
Wahlenbergia sp.						x				
Wurmbea dioica			x							

Newcastle	Perth	Canberra	Sydney	Brisbane
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APPENDIX 2

Referral Decision Notice and RAI

Australian Government

Department of the Environment and Energy

Notification of

REFERRAL DECISION AND DESIGNATED PROPONENT – controlled action
DECISION ON ASSESSMENT APPROACH – preliminary documentation

Divestment of Blocks 3 and 15, Section 22, Barton, Australian Capital Territory (EPBC 2017/8028)

This decision is made under section 75 and section 87 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

proposed action	To clear all vegetation from, and then sell, Blocks 3 and 15, Section 22, Barton, Australian Capital Territory [See EPBC Act Referral 2017/8028].

decision on proposed action	The proposed action is a controlled action. The project will require assessment and approval under the EPBC Act before it can proceed.
relevant controlling provisions	• listed threatened species and communities (section 18 and section 18A) • Commonwealth action (section 28)
designated proponent	Department of Finance ABN 61 970 632 495

assessment approach	The project will be assessed by preliminary documentation.

Decision-maker

name and position	Antonella Bates Acting Assistant Secretary Assessments (NSW, ACT) and Fuel Branch
signature	A. Ba
date of decision	11 October 2017

EPBC Ref: 2017/8028

Ms Elizabeth Hickey
Acting Assistant Secretary
Department of Finance
1 Canberra Avenue
FORREST ACT 2603

Dear Ms Hickey

Decision on referral
Divestment of Blocks 3 and 15, Section 22, Barton, Australian Capital Territory (EPBC 2017/8028)

Thank you for submitting a referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This is to advise you of my decision on the referral of the proposed action to clear all vegetation from, and then sell, Blocks 3 and 15, Section 22, Barton, Australian Capital Territory.

As a delegate of the Minister for the Environment and Energy, I have decided under section 75 of the EPBC Act that the proposed action is a controlled action and, as such, it requires assessment and a decision about whether approval for it should be given under the EPBC Act.

The information that I have considered indicates that the proposed action is likely to have a significant impact on the following matters protected by the EPBC Act:

- listed threatened species and communities (section 18 and section 18A)
- Commonwealth action (section 28)

Based on the information available in the referral, the proposed action is likely to have a significant impact on the following matters of national environmental significance, including but not limited to:

- The clearance of at least 0.32 ha of the critically endangered *Natural Temperate Grassland of the South Eastern Highlands* threatened ecological community.
- The clearance of 0.56 ha of habitat, which may be critical for the survival of the critically endangered Golden Sun Moth (*Synemon plana*) and likely indirect impacts on an additional 0.4 ha of Golden Sun Moth habitat within the Sydney Avenue road verges.
- Potential (yet undetermined) impacts on the vulnerable Striped Legless Lizard (*Delma impar*), through the clearing of 1.25 ha of potential habitat.
- Potential (yet undetermined) impacts on scientific heritage values associated with the clearance of Golden Sun Moth habitat at the site.

Please note that this decision only relates to the potential for significant impacts on matters protected by the Australian Government under Chapter 2 of the EPBC Act.

I have also decided that the project will need to be assessed by preliminary documentation.

A copy of the document recording these decisions is enclosed. I have also written to the ACT Environment, Planning and Sustainable Development directorate to advise them of these decisions.

Each assessment approach requires different levels of information and involves different steps. All levels of assessment include a public consultation phase *in which any third parties can comment on the proposed action*. Details on the assessment process for the project and the responsibilities of the proponent are set out in the enclosed fact sheet. Further information is available from the Department's website at: www.environment.gov.au/protection/environment-assessments. The assessment officer will contact you shortly to discuss the assessment process.

While I have determined that your project will be assessed by preliminary documentation, some further information will be required to be able to assess the relevant impacts of the action. You should expect to receive a letter from the Department within 10 business days of the payment of Stage 1 fees, outlining the information required.

Indigenous communities may also need to be consulted during the assessment process. For more information on how and when indigenous engagement should occur during environmental assessments, please refer to the indigenous engagement guidelines at: www.environment.gov.au/epbc/publications/engage-early.

Please note, under subsection 520(4A) of the EPBC Act and the *Environment Protection and Biodiversity Conservation Regulations 2000*, your assessment is subject to cost recovery. Please find attached a copy of the fee schedule for your proposal and an invoice for Stage 1. Fees will be payable prior to each stage of the assessment proceeding. Further details on cost recovery are available on the Department's website at: www.environment.gov.au/epbc/cost-recovery.

If you disagree with the fee schedule provided, you may apply under section 514Y of the EPBC Act for reconsideration of the method used to work out the fee. The application for reconsideration must be made within 30 business days of the date of this letter and can only be made once for a fee. Further details regarding the reconsideration process can be found on the Department's website at: www.environment.gov.au/epbc/cost-recovery.

Please also note that once a proposal to take an action has been referred under the EPBC Act, it is an offence under section 74AA to take the action while the decision making process is on-going (unless that action is specifically excluded from the referral or other exemptions apply). Persons convicted of an offence under this provision of the EPBC Act may be liable for a penalty of up to 500 penalty units. The EPBC Act is available online at: www.environment.gov.au/epbc/about/index.html.

If you have any questions about the referral process or this decision, please contact the assessment officer, Jamie Machin, by email to jamie.machin@environment.gov.au, or telephone (02) 6275 2303 and quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely

Antonella Bates
Acting Assistant Secretary
Assessments (NSW, ACT) and Fuel Branch

11 October 2017

Preliminary Documentation Requirements for:

Divestment of Blocks 3 and 15, Section 22, Barton, Australian Capital Territory (EPBC 2017/8028)

In order for the Commonwealth Department of the Environment and Energy (the Department) to adequately assess the nature, scale and severity of likely impacts of the proposed action on matters of national environmental significance (MNES) listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and determine the adequacy of avoidance, mitigation and compensatory measures, please provide the following:

General content, format and style

The preliminary documentation package (PD), should be provided as a consolidated package or single indexed document along with any appendices. Your original referral and any additional information supplied during the referral period should be included as an appendix (under s95A (3)(a) and (b) of the EPBC Act).

The information provided should be objective, clear, succinct, and where appropriate, supported by maps, plans, diagrams or other descriptive detail. All sources must be appropriately referenced using the Harvard standard. The reference list should include the address of any web pages used as data sources. The PD should also include a list of persons or agencies consulted and the names of, and work done by, the persons involved in preparing the documentation.

The documentation should be written to enable interested stakeholders and the Minister to understand the environmental consequences of the proposed development. The information presented should also allow any conclusions reached to be independently assessed. Detailed technical information, studies or investigations supporting the text of the main document should be included as appendices where feasible, or at least directly linked to avoid readers having to search for the documents. Any such documents that are not already available to the public should be made available at appropriate locations at least during the period for public display of the PD. If it is necessary to make use of material that is considered to be confidential in nature, the proponent should consult the Department on the preferred presentation of that material, before submitting the documents to the Department.

Any variables or assumptions made in the assessment should be clearly stated and discussed. The extent to which limitations, if any, of available information may influence the conclusions of the environmental assessment should be discussed.

The assessment should clearly address any standards or criteria published by the Department that are relevant to matters being assessed, and appropriate reference must be made to any relevant policy documents.

The PD should be produced on A4 size paper capable of being photocopied, with maps and diagrams on A4 or A3 size and in colour where possible. The proponent should consider the format and style of the document appropriate for publication on the internet. The capacity of the website to store data and display the material may have some bearing on how the document is constructed.

Further information required for assessment

1. Identification of matters of national environmental significance

Natural Temperate Grassland of the South Eastern Highlands

The referral states that targeted surveys of the proposed action conducted by the proponent in 2015 and 2016 to delineate the area of NTG at the site were conducted following survey guidelines in the NTG conservation advice. The referral states that approximately 0.32 ha of NTG was recorded in the proposed action area.

Information required in Preliminary documentation

- No additional information required.

Golden Sun Moth (Synemon plana)

The referral states that comprehensive field surveys for Golden Sun Moth (GSM) and GSM habitat in the proposed action area were conducted in 2007 (Rowell 2008). These surveys were consistent with survey guidelines for the GSM within the *Significant Impact Guidelines for the Critically Endangered Golden Sun Moth (Synemon plana)* (GSM significant impact guidelines). The 2007 survey estimated the extent of GSM habitat as 0.56 ha, comprising the full extent of NTG at the site (0.4 ha) and 0.16 ha of 'native pasture' adjacent to Sydney Avenue. The same survey also noted that an undefined area of 'the verges and median strips of the adjacent roads provide a degraded grassland buffer, which has the potential to become auxiliary habitat if rehabilitated'.

The referral (Section 3.1) assumes habitat for GSM to be equivalent with extent of NTG at the site (0.32 ha). The referral also states that a further 0.4 ha of GSM habitat is present within the Sydney Avenue road verges.

It is unclear whether surveys for GSM habitat have been conducted across the proposed action area (including both the area of NTG and the area of native pasture adjacent to Sydney Avenue referred to by Rowell (2008)) since the 2007 surveys.

Unless more recent surveys demonstrate otherwise, the Department considers that the total area of GSM habitat identified in the proposed action area during the 2007 survey (0.56 ha) should be considered to represent habitat for the species. Including the additional 0.4 ha of GSM habitat that the referral acknowledges is present within the Sydney Avenue road verges, the Department considers that the total area of GSM habitat impacted by the proposed action is 0.96 ha.

Information required in Preliminary documentation

- Please provide additional information / clarification on surveys carried out for GSM habitat in the proposed action area since 2007 to substantiate the statement in the referral that GSM habitat in the proposed action area is equivalent to the area of NTG (0.32 ha).

Striped legless lizard (Delma impar)

The referral states that the Striped Legless Lizard (SLL) historically occurred within the proposed action area but notes that 'given the intensity of the surrounding development and disturbance and lack of any records of the species presence, it is considered unlikely that they continue to occupy a small and isolated patch'. During the public comment period for the referral, the ACT Government notified the Department that this species was recorded at the site in 2016.

Information required in Preliminary documentation

- Please contact the ACT Government and / or other sources to ensure that you have provided the most current information on SLL at the site to verify its location, abundance and other supporting information (e.g survey methodology used and survey reports documenting the recording).
- Based on the above information make an assessment of whether the population of SLL at the site is likely to form an important population using criteria included in:
    - *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance, Department of the Environment, Water, Heritage and the Arts* (2013) (significant impact guidelines)
    - *Conservation Advice Delma impar, striped legless lizard, Threatened Species Scientific Committee* (2016) (striped legless lizard conservation advice)
    - *Environment Protected and Biodiversity Conservation Act 1999 referral guidelines for the vulnerable striped legless lizard, Delma impar* (2011) (striped legless lizard referral guidelines)

Environmental values of the proposed action area (specifically scientific heritage values)

An action by a Commonwealth agency requires consideration of the whole environment. Environment is defined in the EPBC Act as:

a) ecosystems and their constituent parts

b) natural and physical resources

c) qualities and characteristics of locations, places and areas

d) heritage values of places

e) the social, economic and cultural aspects of a, b, c and d.

Heritage values (of a place) are defined under section 528 of the EPBC Act as the place's natural and cultural environment having aesthetic, historic, scientific or social significance, for current and future generations of Australians'.

Scientific heritage values of the York Park site have been described by Hogg (2012), who notes that these values relate to the fact that the GSM population at the site has been monitored periodically since the 1990s and has been subject to detailed population estimates. It is the most intensively studied GSM site in the ACT out of approximately 60 sites and hence it is of significant scientific importance in the context of this species. Rowell (2008) notes that the York Park GSM population is of scientific value due to its research history, and may suffer adverse impacts from development of the adjacent part of Block 3. Clarke (1998) also considers that this site warranted special attention due to its 'high profile and considerable research focus in past years'.

The heritage impact study (HIS) submitted to the Department as part of the referral acknowledges these scientific heritage values and references a previous consultant report (Umwelt 2014) that states that York Park has been subject to a large number of ecological studies, particularly for the

GSM population, including long-term studies focusing on population dynamics and genetic studies for more than 20 years.

The Department considers that because apparently limited consultation with the scientific community has taken place during the preparation of the referral documentation, the scientific heritage values of the proposed action area may have been underestimated by the proponent. Values underestimated include the scientific heritage values associated with longitudinal survey data on basic biology, persistence on small sites, response to shading etc.

Information required in Preliminary documentation

- Please document consultations held with the scientific community to date relating to the site's scientific heritage values and / or carry out further consultation with the scientific community to quantify the specific scientific heritage values of the proposed action area.

2. Assessment of impacts

Natural Temperate Grassland of the South Eastern Highlands

The proposed action will clear at least 0.32 ha of NTG within the proposed action area – an impact that the referral acknowledges is likely to be a significant impact to the community. The referral notes that the area of grassland within the Sydney Avenue road verges does not meet the condition requirements specified in the NTG conservation advice.

Information required in Preliminary documentation

- No additional information required

Golden Sun Moth (Synemon plana)

Information required in Preliminary documentation

- Based on the additional information / clarification on the extent of GSM habitat in the proposed action area discuss impacts to the species associated with the proposed action.

Striped legless lizard (Delma impar)

Information required in Preliminary documentation

- Please assess the likelihood of significant impacts to the SLL population in the proposed action area using the criteria included in the striped legless lizard conservation advice, striped legless lizard referral guidelines and the significant impact guidelines (as they relate to a vulnerable species).

Environmental values of the proposed action area (specifically scientific heritage values)

Information required in Preliminary documentation

- Based on the additional information on the scientific heritage values of the site, please confirm the nature and extent of potential impacts on these values.

- Please assess the likelihood of significant impacts to scientific heritage values in the proposed action area using the criteria included in *Significant Impact Guidelines 1.2 – Actions on, or* *impacting upon, Commonwealth land, and actions by Commonwealth agencies, Department of the Sustainability, Environment, Water, Population and Communities (2013).*

3. Proposed avoidance, mitigation and management measures

<u>General</u>

The Department notes that the proposed action involves clearing of the site, meaning that avoidance and mitigation measures may not be relevant in this case.

Information required in Preliminary documentation

- To the extent relevant, specific and detailed descriptions of proposed avoidance and mitigation measures are required for the impacts identified **for each MNES**.
- Include, for each measure:

i. An assessment of the expected or predicted effectiveness of the measures in reducing impacts to the community and other MNES. Include supporting evidence and details of the expected on-ground benefits to be gained through each of these measures.

ii. Environmental objectives; performance criteria and measurability of outcomes; monitoring; corrective actions (including trigger points or thresholds for actions) and adaptive management; responsibility; and timeframes for proposed mitigation measures.

iii. Demonstrated willingness and capability of achieving outcomes. Clear commitments about how these measures will be reported and audited (by whom, to whom, how often).

iv. Predicted cost of mitigation and management measures and how they will be funded in perpetuity (and by whom).

v. Any statutory or policy basis for the mitigation measures.

vi. A risk analysis associated with achieving the outcomes and the level of control the proponent will have in achieving environmental objectives.

vii. The mechanisms (and the period of operation) for ensuring the actions and protections are maintained.

viii. Plans should refer to relevant conservation advices, recovery plans, threat abatement plans, and other guidance documents published by the Department. To assist you, the Department's Environmental Management Plan Guidelines 2014 are available at: www.environment.gov.au/epbc/publications/environmental-management-plan-guidelines.

<u>*Environmental values of the proposed action area (specifically scientific heritage values)*</u>

Information required in Preliminary documentation

- Based on the assessment of likelihood of significant impacts to scientific heritage values in the proposed action area, provide information on measures (following on from discussion with the scientific community) which can be adopted to mitigate these impacts.

4. Offsets

Offsets are required for any residual significant impacts to each MNES that remains after avoidance, mitigation and management measures have been applied. Offsets do not reduce the likely impacts of a proposed action. Instead, offsets compensate for any residual significant impact. Offsets should compensate for an impact for the full duration of the impact. It is important to note that it may not be possible or appropriate to offset some impacts due to their nature or magnitude.

The offset package can comprise a combination of direct offsets and other compensatory measures, so long as it meets the requirements of the EPBC Act Offset Policy. Offsets should align with conservation priorities for the impacted MNES and must directly contribute to an overall conservation outcome that improves or maintains their viability.

The PD should include details of any offset package proposed to be implemented, along with:

- A description of how the offset package meets the requirements of the *EPBC Act Environmental Offsets Policy* (October 2012) available at: www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy and accompanying Offsets Assessment Guide; or
- Details of how the offset meets an endorsed state offsets policy.

The PD must also include a statement on the cost effectiveness of the measures proposed and how these will be funded.

Specifically, the PD should demonstrate how the residual impacts to MNES will be offset in accordance with the direct (like for like) offsetting requirements, as required under the EPBC Act Offsets Policy and relevant Commonwealth guidelines. In relation to impacts on scientific heritage values, the PD should describe how proposed offsets address the specific environmental heritage values raised during consultation.

5. Economic and social matters

The PD must provide information on the relevant economic and social impacts of the proposed action (positive and negative). Consideration of economic and social matters should include:

- costs as well as benefits
- consideration of different scales where relevant
- specific dollar or other numeric values where relevant.

6. Environmental record of person(s) proposing to take the action

The information provided must include details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:

(a) the person proposing to take the action; and

(b) For an action for which a person has applied for a permit, the person making the application.

If the person proposing to take the action is a corporation, details of the corporation’s environmental policy and planning framework must also be included.

APPENDIX 3

NCP Amendment 88

National Capital Plan – Amendment 88 – Blocks 3 and 15 Section 22 Barton[1]

Australian Capital Territory (Planning and Land Management) Act 1988

I, DARREN CHESTER, Acting Minister for Local Government and Territories, approve this amendment of the National Capital Plan under section 19(1)(a) of the *Australian Capital Territory (Planning and Land Management) Act 1988.*

Dated 5 December 2017

DARREN CHESTER
Acting Minister for Local Government and Territories

---

1 Name of instrument

This instrument is the *National Capital Plan – Amendment 88 – Blocks 3 and 15 Section 22 Barton*.

2 Commencement

This instrument commences on the date of its registration.

3 Amendment of National Capital Plan

Schedule 1 amends the National Capital Plan.

Schedule 1 Amendment

(section 3)

[1] Section 4.4.5, Location Specific

Delete section titled ‘Land use for York Park area’ and replace with:

Development and redevelopment should accord with the detailed conditions of planning, design and development below.

Permitted land uses for the York Park area generally are:

- Diplomatic Mission (with the exception of Blocks 3 and 15 Section 22 Barton)
- National Capital Use
- Office (which may include Commonwealth offices and offices for national associations)
- Open Space.

Permitted ancillary uses are:

- Retail
- Personal Service Establishment
- Child Care Centre.

Additional permitted land uses for Blocks 3 and 15 Section 22 Barton are:

- Commercial Accommodation (not including a caravan park/camping ground)
- Residential
- Additional permitted ancillary land uses for Blocks 3 and 15 Section 22 Barton are:
    - Cafés
    - Restaurants.

Commercial parking structures in the York Park area are to be located where identified on the Indicative Development Plan at Figure 17. Retail and Personal Service Establishments are permitted at the ground level of parking structures as ancillary small scale facilities.

Retail and Personal Service Establishments should be provided at the ground floor level of Offices and structured Car Parks in the location identified for a ‘Retail Plaza’ on the Indicative Development Plans at Figure 17 and Figure 20.

Large spaces for recreation are to be provided at either end of Windsor Walk including a large space suitable for active recreation at the Canberra Avenue end of Windsor Walk as depicted in Figure 17.

[2] Figure 17: York Park Masterplan – Indicative development plan

Delete Figure 17 and replace with:

YORK PARK MASTERPLAN
Indicative Development Plan

NORTH

LEGEND
- EXISTING BUILDING
- FUTURE BUILDING
- TALL BUILDING ZONE (max 602m)
- ENTRY COURT
- RETAIL PLAZA

[3] Section 4.4.5, Other sites

Delete section titled ‘Block 3 Section 22 Barton’.

Note

1. All legislative instruments and compilations are registered on the Federal Register of Legislation kept under the *Legislation Act 2003*. See http://www.legislation.gov.au.

APPENDIX 4

2018 GSM Ecological and Impact Assessment Report

umwelt

Inspired people | Dedicated team
Quality outcomes

Australian Government
Department of Finance

GOLDEN SUN MOTH ECOLOGICAL SURVEYS

Blocks 3 and 15, Section 22, Barton ACT
Rural Block 48, Hall ACT
Lot 1, Wallaroo Road, NSW

FINAL

June 2018

Australian Government
Department of Finance

GOLDEN SUN MOTH ECOLOGICAL SURVEYS

Blocks 3 and 15, Section 22, Barton ACT
Rural Block 48, Hall ACT
Lot 1, Wallaroo Road, NSW

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
The Department of Finance

Project Director:	Naomi Buchhorn
Project Manager:	Amanda Mulherin
Report No.	8144/R01/Final
Date:	June 2018

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Document Status

Rev No.	Reviewer		Approved for Issue	
	Name	Date	Name	Date
Final	Naomi Buchhorn	07 June 2018	Naomi Buchhorn	07 June 2018

Executive Summary

The Commonwealth Department of Finance (Finance) is proposing to divest of Blocks 3 and 15, Section 22, Barton, Australian Capital Territory (ACT) 2600. Prior to sale, the land will be cleared resulting in a full impact to all environmental values currently present.

This action is currently subject to a referral submitted to the Commonwealth Department of the Environment and Energy (DoEE) under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act), referral reference EPBC 2017/8028.

Umwelt (Australia) Pty Ltd (Umwelt) has been engaged by Finance to undertake surveys of golden sun moth (*Synemon plana*) and an impact assessment for the proposed action, which will support the EPBC Referral as part of the Preliminary Documentation. This report supports the original impact assessment submitted with the Referral (Umwelt, 2017).

Known environmental values protected by the EPBC Act that are present within the Project Area include:

- Natural Temperate Grassland of the South Eastern Highlands (NTG), a critically endangered ecological community;
- golden sun moth (*Synemon plana*) (GSM), a critically endangered invertebrate species; and
- striped legless lizard (*Delma impar*) (SLL), a vulnerable reptile species.

Scope of Assessment

As part of the EPBC Referral process, DoEE has requested that Finance provide additional information on the surveys undertaken for GSM since 2007 to confirm the extent of GSM habitat that will be impacted by the proposed action.

This report provides the results of a desktop assessment and surveys targeting GSM which were undertaken in November and December 2017. Surveys were undertaken at the following locations:

- Barton study area: Blocks 3 and 15, Section 22, Barton, ACT; and the two (2) most south-eastern median strips of Sydney Avenue.
- Block 48 study area: Registered Rural Block 48, Hall, ACT.
- Lot 1 study area: Lot 1 in DP 1144979, Wallaroo Road, New South Wales.

Specifically, these surveys were undertaken in the following stages:

1. Desktop Review to identify the GSM surveys undertaken since 2007.
2. Targeted GSM surveys at the Project Area using transect counts of flying males methodology in accordance with GSM survey guidelines (DEWHA, 2009).
3. Surveys targeting female moths at Blocks 3 and 15, Section 22, Barton.

4. Habitat Assessment using a combination of 50 metre step-point transects and meandering survey methodology.

5. Assess the significance of the likely impacts of the proposed action with consideration of the following guidelines:

    a. EPBC Significant Impact Guidelines 1.1 (DSEWPaC, 2013); and

    b. GSM Significant Impact Guidelines (DEWHA, 2009).

Survey Results

GSM was confirmed to be present at all three study areas. The locations of GSM records at the Block 48 and Lot 1 study area were generally consistent with previous records. At the Barton study area, GSM were found to occupy a larger area than previously recorded within Block 3, and were confirmed to occur on Block 15 and within the Sydney Avenue median strips.

GSM habitat was identified based on consideration of the presence of feed species (ie. 'C3' grasses); previous GSM habitat mapping and/or flying records; and new GSM records. The following table summarises the extent of habitat

Habitat Quality	Barton Study Area (ha)	Block 48 Study Area (ha)	Lot 1 Study Area (ha)
Low	0.40	0	0
Moderate (Disturbed)	0.74	0	0
Moderate	0	0.6	0.64
High	0.32	5.72	0
Total	**1.46**	**6.2**	**0.64**

No female moths were identified during searches of the Barton study area.

Impact Assessment

The impact assessment completed for the original Referral (Umwelt, 2017) determined that impacts to 0.72 hectares of GSM habitat at the Barton study area would be significant, and therefore would require offsetting.

This survey determined that there is 1.46 hectares of GSM habitat present within the Barton study area; all of which would be impacted by the proposed action.

As this is a greater impact than originally included in the Referral, it is still regarded a significant impact. The Offset Strategy which will be prepared for the proposed action must compensate for the loss of 1.46 hectares of GSM habitat.

Table of Contents

Figures

Tables

1.0 Introduction

Umwelt Australia Pty Ltd (Umwelt) was commissioned by the Commonwealth Department of Finance (Finance) to undertake ecological surveys at properties with known ecological values. Previous ecological investigations of these properties have identified the following matters of national environmental significance (MNES), protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act):

- Natural Temperate Grassland of the South Eastern Highlands (NTG), a critically endangered ecological community;
- golden sun moth (*Synemon plana*) (GSM), a critically endangered invertebrate species; and
- striped legless lizard (*Delma impar*) (SLL), a vulnerable reptile species.

The results of these surveys will support a referral (EPBC 2017/8028) submitted by Finance seeking approval from the Commonwealth Department of the Environment and Energy (DoEE) for the proposed divestment of Block 3, Section 22, Barton, Australian Capital Territory (ACT).

1.1 Project Area

The Project Area consists of the following three (3) discrete study areas:

- 'Barton'(**Figure 1.1**): totalling 1.65 hectares, including the following areas:
  - Block 3, Section 22, Barton ACT 2600 (referred to as Block 3 herein), which is 1.15 hectares in size;
  - Block 15, Section 22, Barton ACT 2600 (referred to as Block 15 herein), 0.10 hectares; and
  - the two (2) most south-eastern median strips of Sydney Avenue, which are approximately 0.4 hectares in total.

  The Barton study area includes the York Park Conservation Area (0.51 hectares), which extends across the southern portion of Block 3 and Block 15.
- 'Block 48': Registered Rural Block 48, Wallaroo Road, Hall, ACT 2618 (**Figure 1.2**) (referred to as Block 48 herein). Block 48 is 57.95 hectares in size.
- 'Lot 1': Lot 1 in DP 1144979, Wallaroo Road, NSW 2618 (**Figure 1.2**) (referred to as Lot 1 herein). Lot 1 is approximately 108 hectares in size.

Barton is currently vacant land, located on the corner of Sydney Avenue and National Circuit within the highly developed suburb of Barton in Canberra, ACT. Surrounding land uses include accommodation (hotels), office space, residential (apartments), and major roads. Block 15 and the south-eastern portion of Block 3 are managed as an area called 'York Park Conservation Area', with the aim of maintaining the MNES values onsite. The York Park Conservation Area has been managed as a single vegetation unit, separately from the remainder of the Barton study area for some years.

The Sydney Avenue median strips have been included in the Barton study area as the referral process determined that it was likely that these areas support GSM and GSM habitat, and would be indirectly impacted by the proposed action (Umwelt, 2017).

Block 48 and Lot 1 are both Commonwealth land currently leased as rural holdings used primarily for cattle grazing. At the time of assessment, both sites had existing contractual clauses requiring the lessees to manage and maintain the existing MNES values present at both study areas. These properties have been included in surveys as potential offset sites for the Project.

1.2 Project Background

Finance proposes to divest Block 3 in a single, open market sale to a private purchaser for the purpose of development. The divestment may also include the adjacent Block 15, which is currently Territory land managed by the ACT Government. The proposal includes the clearing of both blocks prior to sale. Clearing will occur between exchange and completion of contracts for sale, prior to transfer.

Both Blocks 3 and 15 are 'designated land' under the *National Capital Plan 1990* (as amended), being land having 'special characteristics of the National Capital' (s. 1.2, *National Capital Plan 1990*). Block 3 is also National Land managed by Finance and therefore is not subject to Territory planning legislation.

Any development of Block 3 and 15 following divestment will be subject to the *National Capital Plan 1990* and approval from the National Capital Authority (NCA). In order to facilitate development of Block 3 and 15, the Proponent submitted a proposed amendment to the *National Capital Plan 1990*. This amendment, which allows for development of the land as a mixed use precinct, was supported by the Acting Minister for Local Government and Territories, the Hon. Darren Chester MP on 5 December 2017; and was gazetted on 8 February 2018. The intended development is still subject to approval of the referral (EPBC 2017/8028) by DoEE.

Umwelt, on behalf of Finance, prepared and submitted a referral (EPBC 2017/8028) for the proposed action to DoEE on 25 August 2017. The proposed action was determined to be a controlled action under the EPBC Act on 11 October 2017, due to the likelihood of significant impacts to threatened species and communities, and as a Commonwealth action. As such, it would be assessed on preliminary documentation.

Following the referral determination, Finance received advice from DoEE on the requirements for the preliminary documentation. This advice identified five key information areas that required clarification in order for a complete assessment to be made. These were:

- **GSM**: additional information on the surveys undertaken for GSM since 2007 to substantiate the statement in the referral that GSM habitat in the impact area is equivalent to the area of NTG (ie. 0.32 hectares).
- **SLL**: confirm that SLL has been recorded at the site, and if so, provide an assessment of the importance of the population in accordance with relevant Commonwealth guidelines.
- **Scientific Heritage**: document any consultations held with the scientific community to date relating to the site's scientific heritage values. If required, conduct further consultation so that the specific scientific heritage values can be quantified and assessed against the Significant Impact Guidelines 1.2 (DSEWPaC, 2013); and mitigated.
- **Offset Strategy**: provide information on the proposed offset strategy; including an assessment of the strategy against the EPBC Act Environmental Offsets Policy (DoE, 2012).
- **Economic and Social Matters**: provide information on the relevant economic and social impacts of the proposed action, including consideration of costs and benefits across multiple scales as appropriate.

This document has been prepared to address the request for information regarding GSM. All other matters raised by DoEE will be addressed separately. In addition to providing clarification on the quantum of impact to GSM, this document will also provide a conclusion regarding the likelihood of a significant impact to GSM, and may inform any offset strategy and associated calculations if required.

The referral determination confirmed the outcome of the impact assessment submitted with the referral (Umwelt, 2017) that the impact to GSM is significant and will require offsetting under the EPBC Offset Policy (DoE, 2012). DoEE, as part of its preliminary documentation requirements, sought further clarification on the full extent of GSM habitat present at the impact site, including the surrounding Sydney Avenue median strips (i.e. Barton study area).

Additional surveys were also performed at Block 48 and Lot 1, to reconfirm the extent of GSM habitat present in these areas. This allows survey results for all three study areas to be compared and assessed for offset purposes in the future.

Image Source: Environment and Planning Directorate, ACT Government (2016)

0 50 100 200m
1:5 000

Legend
Study Area
York Park

FIGURE 1.1

Barton Study Area Locality Plan

Image Source: Environment and Planning Directorate, ACT Government (2016) and Google Earth (2015)

Legend

Study Area

State/Territory Boundary

FIGURE 1.2

Lot 1 and Block 48 Study Areas Locality Plan

2.0 Method

2.1 Literature Review

A literature review was undertaken to determine the previous extent and quality of GSM habitat present in the Project Area. The results of the literature review allowed the GSM surveys and habitat assessments to be targeted to locations most likely to still provide habitat for GSM.

2.2 Golden Sun Moth Survey

GSM is an EPBC Act critically endangered species that is known to occur throughout the Project Area (see **Section 3.1**). It is a medium sized, day-flying moth that spends much of its lifecycle in the soil, feeding on the roots of 'C3' grasses (almost exclusively on wallaby grass (*Rytidosperma* spp.), spear grass (*Austrostipa* spp.), and Chilean needle grass (*Nassella neesiana*)) (DEWHA, 2009). GSM emerge in moth form, typically during mid-November to mid-December, with an individual living for up to four (4) days post emergence.

The start of the flying season for 2017 was identified in consultation with other ecologists and specialists working in the region. Surveys were not commenced until after the flying season had been confirmed across many similar sites nearby.

GSM surveys were undertaken in accordance with the Commonwealth survey guidelines for the species (DEWHA, 2009). These guidelines target times of highest male moth flying activity, so that the species is most easily detected. Surveys are required to be undertaken over a period of four (4) non-consecutive days during suitable climatic conditions.

The Commonwealth survey guidelines for GSM identify the following optimum survey conditions recommended for the species:

- a warm to hot day (above 20°C by 10.00);
- the warmest part the day (i.e. between 10.00 and 14.00);
- clear or mostly cloudless sky;
- still, or relatively still wind conditions during the survey period; and
- greater than two days since rain.

Transect surveys were undertaken at the Barton and Block 48 study areas on four (4) separate occasions during appropriate survey conditions. Two (2) separate transect surveys were undertaken during appropriate survey conditions at the Lot 1 study area.

Given the short window available for surveying, not all survey days met all recommended Commonwealth survey conditions (DEWHA, 2009). However, it is unlikely that survey conditions affected the identification of GSM within the Project Area, as explained further in with the results in **Section 3.2**.

Transects were located in areas with known GSM populations as identified in literature review and referral survey events were staggered to increase the likelihood of detection given the short adult life span of GSM (1-4 days). **Figures 2.1 to 2.3** show the location of transects; which were spaced to avoid double counting of flying males and did not fall within 10 metres of the external property boundary to avoid edge effects.

umwelt

Image Source: Environment and Planning Directorate, ACT Government (2016)
Data Source: Barton Habitat Umwelt (2016a)

0 25 50 100m
1:2 000

Legend

- Study Area
- York Park
- GSM Transects
- Known GSM Habitat Pre 2017 Surveys

FIGURE 2.1

GSM Survey Transects at Barton Study Area

File Name (A4): R01/8144_003.dgn
20180321 14.32

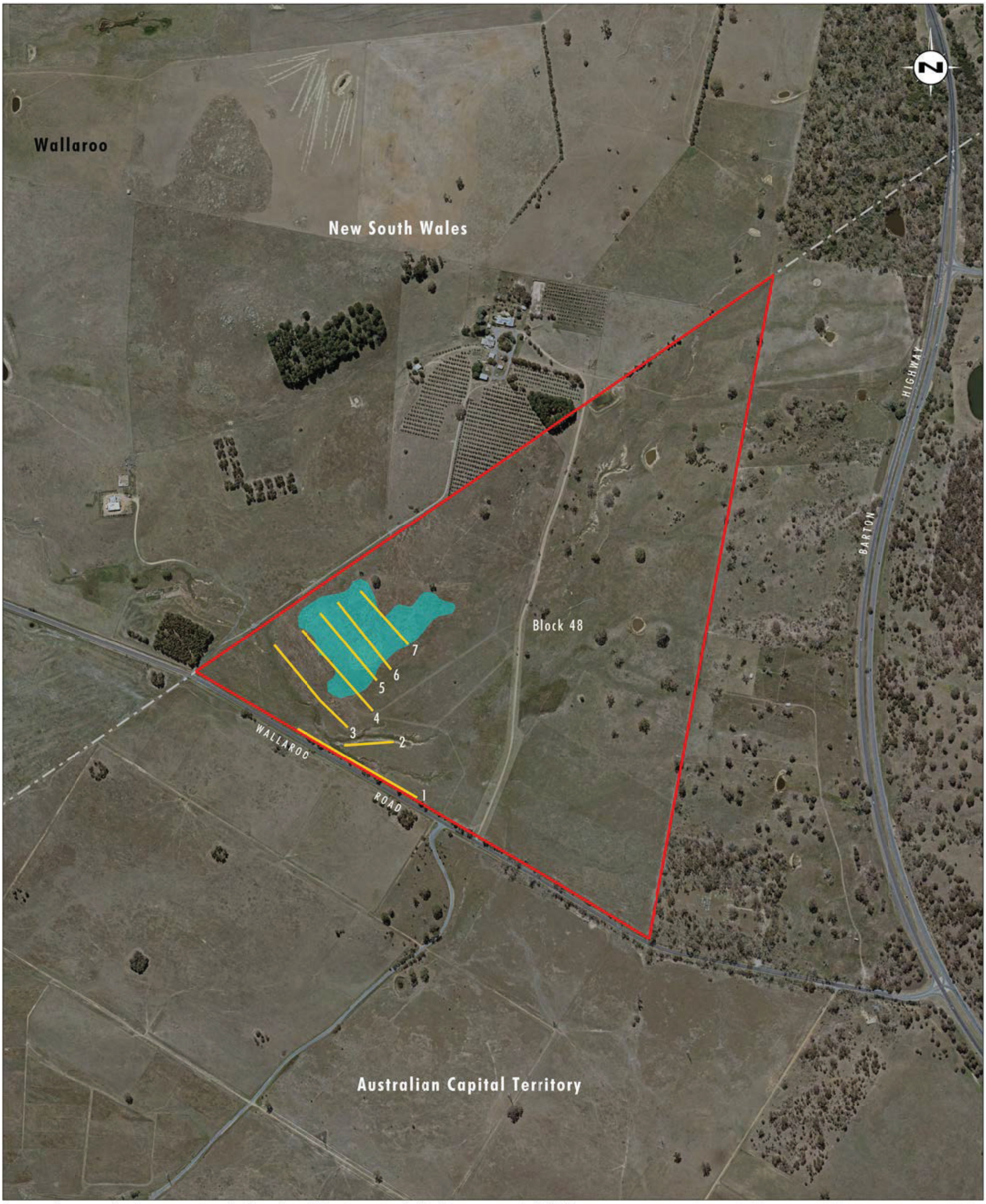

Image Source: Environment and Planning Directorate, ACT Government (2016)
Data Source: Block 48 Habitat Umwelt (2016b)

0 100 250 500m
1:10 000

Legend

- Study Area
- State/Territory Boundary
- GSM Transects
- Known GSM Habitat Pre 2017 Surveys

FIGURE 2.2

GSM Survey Transects at Block 48 Study Area

Image Source: Environment and Planning Directorate, ACT Government (2016)
Data Source: Lot 1 Habitct Umwelt (2016c and 2016f)

0 100 250 500m
1:10 000

Legend
- Study Area
- State/Territory Boundary
- GSM Transects
- Known GSM Habitat Pre 2017 Surveys

FIGURE 2.3

GSM Survey Transects at Lot 1 Study Area

2.3 Habitat Survey and Assessment

GSM habitat is primarily native temperate grasslands; however, GSM will also occur in grassy woodlands that contain feed species and exotic grasslands dominated by Chilean needle grass. For the purposes of this ecological assessment, GSM habitat was mapped according to dominant vegetation type and the presence of feed species (i.e. 'C3' grasses; namely wallaby grass, spear grass, and Chilean needle grass).
A combination of meandering surveys and step-point transects were used to determine the extent and quality of GSM habitat present across the Project Area.

The meandering survey consisted of walking the perimeter of each habitat type and recording the route taken in a GPS. Habitat type was determined by a visual assessment of each study area by a qualified ecologist. The results of the meandering survey were validated by step-point transects.

The step-point transect method assesses the relative abundance of plant species, and gives an indication of the dominant species, degree of weed invasion, and cover of bare ground (see Sharp *et al.* 2005). At every one (1) metre mark the observer notes any plant species, rock, bare ground, cryptogram, or litter that occurs at that point across all strata. Tussock size and the presence of thatch are also recorded as relevant. For plant species of note (e.g. GSM feed species or noxious weeds) these are specifically noted. All other plant species are noted to type (e.g. native forb). The location of step-point transects are shown in **Figures 2.4** to **2.6**.

In addition to validating broad habitat types defined by the meandering survey, the step-point transect results were used to quantify habitat quality. The following definitions (adapted from Rowell, 2013) were used to determine the habitat quality present within the Project Area:

- Low quality habitat:
  - exotic grasslands with a moderate amount of GSM feed species (including Chilean needle grass);
  - native grasslands dominated by kangaroo grass (*Themeda triandra*), with a moderate component of native GSM feed species on shallow, eroded soils; or
  - moderately dense mixed grassland, with a moderate component of GSM feed species.
- Moderate (Disturbed) quality habitat: exotic grassland dominated by Chilean needle grass.
- Moderate quality habitat: native grassland with low to moderate weed cover and a moderate cover of native GSM feed species.
- High quality habitat: dominated by native grasses, including a moderate component of wallaby grasses, moderate diversity of native forbs, and moderate bare ground (excluding rocky outcrops with shallow soil).

Sites dominated by Chilean needle grass have been shown to support high numbers of GSM, initially indicating high quality habitat for the species. However, due to the potential for fluctuations in biomass and the overall negative environmental impact of Chilean needle grass, such areas only constitute moderate quality habitat at best (Rowell, 2013).

umwelt

Image Source: Environment and Planning Directorate, ACT Government (2016)

0 25 50 100m
1:2 000

Legend
Study Area
York Park
GSM Habitat Transects

FIGURE 2.4

Barton Study Area GSM Habitat Transect Locations

File Name (A4): R01/8144_009.dgn
20180216 14.46

Image Source: Environment and Planning Directorate, ACT Government (2016)

0 100 250 500m
1:10 000

Legend

- Study Area
- State/Territory Boundary
- GSM Habitat Transects

FIGURE 2.5

Block 48 Study Area
GSM Habitat Transect Locations

Image Source: Environment and Planning Directorate, ACT Government (2016)

0 100 250 500m
1:10 000

Legend

- Study Area
- State/Territory Boundary
- GSM Habitat Transects

FIGURE 2.6

Lot 1 Study Area
GSM Habitat Transect Locations

3.0 Results

3.1 Literature Review

A large number of ecological surveys have been conducted across the Project Area. Many of these targeted GSM and NTG, and included ongoing monitoring, vegetation management plans, and population studies.

A GSM Maintenance Plan was prepared by Parsons Brinckerhoff (2008) to provide a framework for ongoing best-practice management of the ecological values associated with the use of Blocks 3 and 15 (then Blocks 3 and 7, Section 22). The Maintenance Plan (Parsons Brinckerhoff, 2008) noted that approximately 0.5 hectares of GSM habitat occurred within the York Park Conservation Area. This was based on ACT Government data from the late 1990s and 2005. The GSM Maintenance Plan also established ongoing monitoring methodology for GSM and NTG which formed the basis of many of the surveys described below.

Barton Study Area:

- AHE (2005) 'ACT Action Plan 28'. The York Park Conservation Area is specifically identified in the ACT native lowland grassland action plan as containing NTG and GSM habitat. It is not clear where this data comes from or its age.

- Rowell (2007) 'Survey and Impact Assessment at Golden Sun Moth *Synemon plana* site, Blocks 3 and 7, Section 22 Barton (York Park)'. This survey was completed to support an understanding of the environmental factors for Block 3 and included capture-mark-release techniques to estimate the population size.

- Richter *et al* (2009) 'Community Monitoring of Golden Sun Moths in the Australian Capital Territory Region, 2008-2009'. This project was a pilot GSM monitoring program that surveyed a number of sites across the ACT and the surrounding region, including the York Park Conservation Area and Sydney Avenue median strips. Surveys were undertaken by community members supervised and trained by ecologists.

- Rowell (2012) 'Five (5)-year Monitoring Event for Golden Sun Moth'. The GSM Maintenance Plan for the York Park Conservation Area included five (5)-yearly population monitoring that utilised a capture-mark-release method (Parsons Brinckerhoff, 2008). This report provides the results of the 2011 surveys.

- Umwelt (2014) 'Natural Temperate Grassland Maintenance Plan Block 3 Section 22 Barton ACT'. An update to the Parsons Brinkerhoff (2008) Maintenance Plan for York Park Conservation Area only. Provided management recommendations to maintain the NTG and associated GSM values at the site.

- Umwelt (2015) 'Natural Temperate Grassland Condition Assessment and Golden Sun Moth Monitoring Event'. Provides the results of the 2014 monitoring event as recommended by Umwelt (2014). The monitoring targets GSM and NTG within York Park Conservation Area (as amended following the approval of the proposed development of Little National Hotel on the adjacent block (EPBC Referral 2012/6606)).

- SMEC (2016) 'Golden Sun Moth Monitoring 2015 York Park' and SMEC (2017) 'Golden Sun Moth Monitoring 2016 York Park Conservation Area'. GSM monitoring report for York Park Conservation Area only, prepared as a condition of approval under EBPC Referral 2012/6606. Monitoring includes a count of flying moths, pupae case survey, vegetation survey, and soil temperature monitoring.

- Umwelt (2016a) 'Golden Sun Moth and Natural Temperate Grassland Vegetation Management Plan Block 3, Section 22, Barton ACT'. Provides the results of the 2015 monitoring event as recommended by Umwelt (2014). The monitoring targeted GSM and NTG within the York Park Conservation Area.

Block 48 and Lot 1 Study Areas:

- Robert Jessop (2014a) 'Block 48 Wallaroo Road Golden Sun Moth Survey 2013' and Robert Jessop (2014b) 'Lots 1 and 2 Wallaroo Road Golden Sun Moth Survey 2013'. GSM surveys used to inform the relevant Kellogg Brown & Root reports (2014a; 2014b). Results were provided in terms of GSM numbers observed rather than habitat area.

- Umwelt (2016b) 'Vegetation Management Plan Block 48 Wallaroo Road' and Umwelt (2016c) 'Vegetation Management Plan Lot 1 Wallaroo Road'. Both reports prepared and updated as part of Finance's due diligence as a Commonwealth Department that manages land with MNES values present. These reports updated Kellogg Brown & Root (2014a; 2014b) Vegetation Management Plan respectively. MNES identified at both blocks include GSM and NTG. Block 48 has white box – yellow box – Blakely's red gum grassy woodland and derived native grassland (an EPBC critically endangered ecological community) recorded. Lot 1 has the EPBC migratory species rainbow bee-eater (*Merops ornatus*) and the NSW listed White Box Yellow Box Blakely's Red Gum Woodland endangered ecological community.

- Vegetation monitoring has occurred on three occasions at both sites and were used to inform the relevant updates to the vegetation management plans (see below):

    - Kellogg Brown & Root (2013) 'Block 48 Vegetation Condition Assessment Report' and Kellogg Brown & Root (2014c) 'Lots 1 and 2 Wallaroo Road Vegetation Condition Assessment Report'.

    - Biosis (2015a) 'Block 48, Hall ACT – Year 1 Vegetation Condition Monitoring Report' and Biosis (2015b) 'Lots 1 & 2, Wallaroo Road – Year 1 Vegetation Condition Monitoring Report'. This provided baseline monitoring of vegetation at Block 48 and Lot 1 respectively.

    - Umwelt (2016d) 'Year 2/Baseline Vegetation Condition Monitoring Block 48 Wallaroo Road, Hall ACT' and Umwelt (2016e) 'Year 2/Baseline Vegetation Condition Monitoring Report Lot 1 Wallaroo Road, Hall NSW'. These reports provide the results of the Year 2 monitoring event for Block 48 and Lot 1 respectively and were used to inform the update to the relevant vegetation management plans (Umwelt 2016b; 2016c).

Past surveys demonstrate a decrease in availability of GSM habitat within York Park Conservation Area since 2013 (see **Table 3.1**). The primary reasons for this decrease in habitat are described as follows:

- EPBC approved impact, associated with EPBC Referral 2012/6606. This referral was for the construction of the Little National Hotel, which included a driveway off National Circuit. The driveway directly impacted upon approximately 0.21 hectares of NTG in the north of York Park Conservation Area.

- Weed incursion has also been recorded (Umwelt, 2014; 2015; 2016a), primarily through the southern portion of Block 3. This weed incursion has been exotic perennial grass species: cocksfoot (*Dactylis glomerata*), and phalaris (*Phalaris aquatica*). Due to small width of the weed incursion, male moths were observed flying over this area, however, neither of these species are C3 grasses, therefore do not form habitat for GSM (Umwelt, 2016a).

- Upgrades to the footpath adjacent to National Circuit disturbed the grassland of York Park Conservation Area. This area was re-planted with native kangaroo grass, which is not a GSM feed species, therefore these works also reduced the area of GSM habitat present within York Park Conservation Area (Umwelt, 2016a).

During the preparation of the referral in 2017, an Umwelt ecologist re-visited York Park Conservation Area, and confirmed the extent of GSM habitat was 0.32 hectares as previously reported (Referral 2017/8028). It was also noted at this time, that the ACT Government (2015) had mapped the two south-eastern median strips of Sydney Avenue as being GSM habitat. These areas had not been surveyed since 2006, when they were confirmed as habitat (Rowell, 2009).

The referral (2017/8028) assessed the impact to GSM based on the following habitat areas:

- 0.32 hectares within the York Park Conservation Area, consisting of high quality habitat within NTG; and

- 0.4 hectares across the entirety of both median strips, of unknown quality.

Table 3.1 GSM Habitat within Each Study Area Identified in Literature Review

Study Area	Prior to 2005^	2006	2008	2011	2013	2014	2015	2016
Barton - York Park Conservation Area	0.4ha (AHE, 2005)	0.56ha (Rowell, 2007)	0.56ha (Parsons Brinckerhoff, 2008)	0.56ha (Rowell, 2012)	0.56ha (Umwelt, 2014)	0.34ha (Umwelt, 2015)	0.32ha (Umwelt, 2016a)	0.32ha (Umwelt, 2017)
Barton - Remaining Area*	No data	Not considered to be GSM habitat (Rowell, 2007)	No data	No data	No data	No data	No data	No data
Barton - Median Strips	No data	Potential habitat if rehabilitated (Rowell, 2007)	GSM recorded (Richter *et al*, 2009)	No data	No data	No data	No data	0.4ha assumed habitat (Umwelt, 2017)
Block 48	No data	No data	No data	No data	7.08ha (Robert Jessop, 2014a)	Similar to 2013 extent mapped by Robert Jessop (2014a) (Rowell, 2015)	3.06ha (Umwelt, 2016b)	No data
Lot 1	No data	No data	No data	15.7ha (Parsons Brinckerhoff, 2010)	4.47ha (Robert Jessop, 2014b)	Similar to 2013 extent mapped by Robert Jessop (2014b) (Rowell, 2015)	0.65ha (Umwelt, 2016c)	No data

*Remaining Area = Block 3 that is not part of York Park Conservation Area.
^Note: actual date of survey data unknown.

3.2 Golden Sun Moth Survey Results

All surveys of the Project Area were undertaken between November and December 2017 at the locations shown in **Figures 2.1** to **2.3**. The specific days and times of the surveys are provided in the tables in the following sections.

Consultation with other ACT specialists (including ACT and NSW Government ecologists and consultants) was undertaken to ensure that the local GSM flying season had begun, prior to the surveys being undertaken. Preliminary advice from these discussions show an early November 2017 start to the flying season; with the end around 23 December 2017 at most sites. Low numbers of flying males were recorded into mid-January 2018, however these observations are considered to occur outside of the peak (i.e. optimal) survey time.

It is a limitation of these surveys that the exact EPBC survey conditions were not optimally met for each survey day. Conditions at the start of November and again in December were cooler than average, with most days not meeting the 20 degrees Celsius by 10am requirement. Notwithstanding the prevailing weather conditions, GSM were known to be flying at other sites in the Canberra area.

The flying season was also marked by regular showers, with significant rainfall during the first week of December (Weather Zone, 2018). On days when optimal conditions could not be met, days that were sunny with light winds were favoured over warmer temperatures and higher winds. It is not considered likely that the survey conditions affected the identification of GSM within the Barton or Block 48 study areas given they were recorded in areas where they were previously unidentified (see **Section 3.2.1**).

In late November 2017, Lot 1 was added to the Project Area. Accordingly it was not possible to complete the minimum survey effort (four times) before GSM stopped flying for the season. Information from previous years' was used to substantiate any conclusions regarding this study area.

3.2.1 Barton Study Area

The GSM survey results for the Barton study area, including the climatic conditions at the time of the survey, are provided in **Table 3.2**.

Of note, GSM were confirmed to be flying at both Sydney Avenue median strips and throughout the north-western portion of Block 3. The number of moths recorded in and their extent throughout these areas indicate that it is likely that the moths observed emerged from these areas, rather than flying over from the York Park Conservation Area.

The number of male GSM observed within the York Park Conservation Area was slightly higher than in previous years (Umwelt, 2016a), yet was generally consistent with expected results. Given the higher number of sightings within the York Park Conservation Area, this area still appears to support the core population for the Barton study area.

Temporal differentiation between the exotic dominated Block 3 (i.e. the portion outside of the York Park Conservation Area) and median strips was also observed, with moths seeming to emerge later in the season (see results from 13 December 2017) in these areas, when the numbers at the York Park Conservation Area were starting to decrease. In addition, moths recorded at York Park Conservation Area during this time were primarily flushed, whilst those in other areas were still free flying.

Table 3.2 GSM Survey Conditions and Results – Barton Study Area

Survey Date and Time	Weather Conditions	Sightings of Males		
		York Park	Medians	Block 3
21 November 2017 12.10-12.56	10.00 Temperature: 18.4˚C. Days since rain: 2. Temperature: 22.5˚C – 23.5˚C; partly cloudy (3/8); low wind (7-24km/hr) east to east-nor-east. Meet recommended criteria? No.	72	6	7
24 November 2017 10.04-10.13	10.00 Temperature: 21.1˚C. Days since rain: 5. Temperature: 21˚C; cloudy (5/8); low wind (6-11km/hr) north-easterly. Meet recommended criteria? Yes.	0	0	13
28 November 2017 13.07-14.01	10.00 Temperature: 19.6˚C. Days since rain: 0. Temperature: 24˚C – 26˚C; partly cloudy (1/8 to 4/8); low wind (5-20km/hr) southerly to easterly. Meet recommended criteria? No.	47	7	7
13 December 2017 10.58-11.30	10.00 Temperature: 21.8˚C. Days since rain: 4. Temperature: 27.4˚C – 28.4˚C; sunny (0/8); low wind but gusty towards the end (9-26km/hr), northerly to north-nor-westerly. Meet recommended criteria? Yes.	10	11	37
Total Sightings		**129**	**24**	**64**

The recommended survey conditions were met on two (2) of the four (4) survey efforts for the Barton study area (see **Table 3.2**). As the temperature was not above 20 degrees Celsius at 10.00 on 21 and 28 November 2017, these survey efforts did not meet the recommended survey conditions. However, as conditions during the actual survey periods were met and moths were recorded throughout the Barton study area, this discrepancy is not considered to impact the survey results on this day. Rain was also recorded within the Canberra region on 27 November 2017, meaning that the survey conducted on 28 November 2017 did not occur more than two (2) days after rainfall. Very little of this rainfall occurred at the Barton study area and the soil was dry during the surveys; the localised rainfall event is not considered to have affected the survey results on this day.

A search for females was also undertaken at the Barton study area on 28 November 2017, between 14.27 and 15.15. No females were recorded. Records of female moths are used to confirm the presence of GSM habitat (opposed to grassland which males happen to be flying over); however, given the number of male moths recorded during this survey, the lack of female records is not considered to preclude the Sydney Avenue median strips or areas of Block 3 outside of the York Park Conservation Area being identified as GSM habitat.

3.2.2 Block 48 Study Area

The GSM survey results for the Block 48 study area, including the climatic conditions at the time of the survey, are shown in **Table 3.3**.

GSM was not recorded in any new areas, with activity primarily occurring within the NTG and derived box gum woodland in the south-west. Low numbers of moths were recorded within the NTG patches along the drainage lines. These results are primarily consistent with previous survey results (Umwelt, 2016b).

Table 3.3 GSM Survey Conditions and Results – Block 48 Study Area

Survey Date and Time	Weather Conditions	Sightings of Males
22 November 2017 11.23-11.55	10.00 Temperature: 17.1˚C. Days since rain: 3. Temperature: 21˚C-22˚C; partial cloud (1/8); light wind (7-17km/hr) northerly. Meet recommended criteria? No.	126
23 November 2017 13.17-14.09	10.00 Temperature: 21.1˚C. Days since rain: 4. Temperature: 25.5˚C; light cloud (1/8); moderate wind (20-26km/hr) north-westerly. Meet recommended criteria? No.	37
29 November 2017 13.35-13.59	10.00 Temperature: 21.8˚C. Days since rain: 1. Temperature: 27˚C; partly cloudy (2/8); light wind (8-15km/hr) east-sou-easterly. Meet recommended criteria? No.	8
13 December 2017 12.12-13.11	10.00 Temperature: 21.8 ˚C. Days since rain: 4. Temperature: 29.7˚C – 30.4˚C; sunny (0/8); moderate to high wind (24-39km/hr), north-westerly. Meet recommended criteria? No.	20
Total Sightings		**191**

Given its ridgetop location, Block 48 typically experiences greater wind speeds than surrounding areas, yet GSM have been known to fly during these conditions at this site. While wind speeds on 23 November 2017 and 13 December 2017 exceeded the recommended 'calm' conditions for survey; they are not considered abnormal for the study area. To compensate for any impacts the wind speed may have had on detection, transects were walked at a slower pace. It is therefore considered that the survey conditions were appropriate for GSM survey on these dates.

As the temperature was not above 20 degrees Celsius at 10:00 on 22 November 2017, this survey effort did not meet the recommended survey conditions. However, as conditions during the actual survey periods were met and the highest number of moths was recorded, it would appear that this discrepancy has not impacted the survey results on this day. Rain was also recorded within the Canberra region on 27 November 2017, meaning that the survey conducted on 29 November 2017 did not occur more than two days after rainfall. Very little of this rainfall occurred at the Block 48 study area and the soil was dry once surveys were undertaken; this discrepancy is considered not to have affected the survey results on this day.

3.2.3 Lot 1 Study Area

Lot 1 was added as a study area later in the Project, based on the preliminary results from the Barton study area. As such, Lot 1 was only surveyed on two (2) occasions, rather than the preferred four (4) efforts. This is a limitation of this survey, as such, should be considered in conjunction with recent survey results from previous years. The GSM survey results for the Lot 1 study area, including the climatic conditions at the time of the survey, are shown in **Table 3.4**.

Table 3.4 GSM Survey Conditions and Results – Lot 1 Study Area

Survey Date and Time	Weather Conditions	Sightings of Males
22 November 2017 13.02-13.04	10.00 Temperature: 17.1˚C. Days since rain: 3. Temperature: 23.5˚C; light cloud (1/8); light wind (11-24km/hr) northerly. Meet recommended criteria? No.	7
14 December 2017 10.10-13.25	10.00 Temperature: 27.4˚C. Days since rain: 5. Temperature: 26.7˚C – 30.7˚C; clearing cloud (6/8 – 1/8); moderate to high wind (22-39km/hr) north-westerly. Meet recommended criteria? No.	0
	Total Sighting	**7**

As the temperature was not above 20 degrees Celsius at 10:00 on 22 November 2017, this survey effort did not meet the recommended survey conditions. However, as conditions during the actual survey periods were met and the highest number of moths was recorded, this discrepancy is not considered to impact the survey results on this day. Similar to the Block 48 study area, the Lot 1 study area experiences higher wind speeds than the urban Barton study area. As GSM is known to persist and be recorded at Lot 1 in these conditions, the wind speeds recorded on 14 December 2017 were considered appropriate for GSM survey on this date.

GSM was confirmed at within one (1) discrete patch of NTG in the Lot 1 study area. No other moths were observed during this survey.

The number of flying male moths recorded within this patch of habitat is consistent with results from Jessop (2014b). Previous records for Lot 1 have indicated that there are a number of other small, discrete patches of GSM habitat present throughout the site (Robert Jessop, 2014b n=6; Umwelt, 2016c n=1).

3.3 Habitat Survey and Assessment Results

3.3.1 Barton Study Area

Two (2) step-point transects were surveyed within the Barton study are; one (1) in the NTG and the other in the exotic grassland at the back of Block 3 (**Figure 2.4**). The results of the transect surveys are summarised in **Table 3.5**.

The NTG has greater structural diversity, demonstrated by the fair distribution of both small and large tussocks, and cover types. The NTG also has a high percentage (18.45%) of GSM feed species present, of which 16.07% was native spear grasses. Though not captured in the step-point transect wallaby grasses were also noted within the NTG. Bare ground was relatively low (1.19%), however thatch cover was quite high. It is not clear what effect this may have on GSM, especially whether females will utilise thatch for displaying purposes.

Conversely, the exotic grassland structure is dominated by large tussocks interspersed by bare ground. The amount of bare ground is not uniform across the back of Block 3; areas with a large amount of bare ground seem to have been affected by previous erosion and/or scarring from earth works. Other areas showed limited bare ground, dominated by large tussocks. Chilean needle grass cover was much higher in this area (5.37%), and was supplemented by the presence of some native GSM feed species, including wallaby grass (0.67%).

Table 3.5 Step-point Transect Results – Barton Study Area

Vegetation Type	NTG	Exotic Grassland
Large Tussock	2.98%	7.38%
Small Tussock	4.76%	3.36%
Thatch	14.29%	8.05%
Litter	0.60%	-
Bare Ground	1.19%	13.42%
Lichen/Moss	8.33%	0.67%
Exotic Annual Grass	19.65%	11.41%
Native Forb/Sedge/Rush	5.96%	4.03%
Exotic Forb/Other	7.74%	16.77%
Exotic Perennial Grass	4.17%	26.17%
Native Perennial Grass	30.35%	8.72%
Native GSM Feed Species	16.07%	2.68%
Exotic GSM Feed Species	2.38%	5.37%

No formal habitat transects were undertaken within the median strips. Observations from Umwelt ecologists during flora and GSM surveys noted the following:

- Dominated by exotic species, including Chilean needle-grass and a high number of exotic forb species (e.g. *Hirschfeldia incana* (hoary mustard), *Hypochaeris radicata* (cat's ear), and *Plantago* spp. (plantains)).
- Native species that were present were predominantly spear grass and wallaby grass.
- Moderate cover of bare ground.
- High disturbance – both median strips are accessed daily by pedestrians, and informal paths have been created though the western median strip. Both median strips appear to be mowed regularly.
- The planted trees along the perimeter of the median strips are unlikely to shade out GSM at present. As they get larger, they are likely to have a greater impact over time.

3.3.2 Block 48

Seven (7) step-point transects were surveyed at Block 48. The results of the transect surveys are summarised in **Table 3.6**.

Transect C was located in the primary patch of known GSM habitat at Block 48. This habitat chiefly contains small grass tussocks, interspersed with bare ground; with large tussocks, rock, lichen, and thatch having a moderate presence. There is a high percentage (21.37%) of GSM feed species, of which, 16.24% is wallaby grass.

Transect E was located partially within an area of potential GSM habitat, with all GSM feed species being identified at the western end of the transect. This transect generally showed a higher incidence of exotic annual weeds (38.92%), less structural diversity, and no native non-grass species.

GSM feed species were also recorded at Transects A and B in low numbers. As the cover of GSM feed species is less than 1% within Transect A it is not considered to constitute habitat for the species. It is unknown whether the 6.21% cover of GSM feed species at Transect B is sufficient to support the species.

No GSM feed species were recorded at transects D, F, and G.

Table 3.6 Step-point Transect Results – Block 48 Study Area

Vegetation Type	Transect A	Transect B	Transect C	Transect D	Transect E	Transect F	Transect G
Large Tussock	4.44%	5.59%	5.13%	4.44%	7.03%	4.79%	3.80%
Small Tussock	7.78%	4.97%	12.82%	6.67%	5.41%	11.38%	4.43%
Thatch	11.11%	10.56%	4.27%	12.22%	10.81%	8.98%	21.52%
Litter	-	-	1.71%	-	-	-	-
Bare Ground	3.33%	1.24%	8.55%	4.44%	3.24%	4.19%	1.27%
Rock	0.56%	3.11%	7.69%	-	-	-	-
Lichen/Moss	1.11%	8.07%	6.84%	-	0.54%	-	-
Exotic Annual Grass	36.67%	36.03%	8.55%	36.11%	38.92%	22.16%	10.13%
Native Forb/Sedge/Rush	1.11%	-	3.42%	-	-	1.20%	1.27%
Exotic Forb/Other	5.00%	11.8%	5.98%	9.45%	7.56%	11.38%	17.09%
Exotic Perennial Grass	13.89%	0.62%	-	6.11%	0.56%	10.78%	36.07%
Native Perennial Grass	15.01%	18%	35.05%	20.56%	25.94%	25.15%	4.43%
Native GSM Feed Species	0.56%	6.21%	21.37%	-	3.24%	-	-
Exotic GSM Feed Species	-	-	-	-	-	-	-