2021 MALLEEFOWL MONITORING

Covalent Lithium

ecoscape

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ACKNOWLEDGEMENTS

Ecoscape would like to acknowledge the assistance and support we received from the Covalent staff on-site who made us welcome and provided logistical support where needed. We look forward to returning for the next years monitoring.

SUMMARY

Ecoscape was engaged by Covalent Lithium in early 2021 to provide the following services for the project:

- undertake National Malleefowl Recovery Team (NMRT) Malleefowl mound monitoring for the 2021-22 monitoring period
- collate images of fauna species and activity from Malleefowl mounds.

The results of the Malleefowl mound monitoring and review of the recorded images of Malleefowl at mounds provides ongoing data that can be used for temporal comparisons of Malleefowl activity for the Covalent Earl Grey Lithium Project site.

Selected LiDAR data points were ground truthed to determine the mound status. Fifteen new Malleefowl mounds were identified from LiDAR results and added to the list of known Malleefowl mounds.

The 2021-22 monitoring recorded information on mounds classified as ANNUAL only, as this was the first year which excluded the 5 YR mounds, which will be monitored again in 2025. The 2021-22 monitoring period recorded one active mound within the development envelope (DE) and three active mounds outside the DE. There are 15 mounds that recorded Malleefowl activity during the 2021-22 monitoring period in comparison to 14 mounds with recorded Malleefowl activity in 2020-21.

An activity analysis indicates that there is potentially four distinct breeding pairs within the monitoring area. One breeding pair within the DE and another three close by (< than 900 m from the DE boundary). Activity patterns are compared over the years that indicate an ongoing increase in activity during 2021-22 from previous monitoring.

Trail cameras deployed at mounds identified seven different Malleefowl mounds that were visited by Feral Cats. This included both active and inactive Malleefowl mounds. European Red Fox was recorded at two mounds identified as being inactive, this is the first record of Fox since monitoring commenced in 2019.

To provide Malleefowl population health and abundance data the following aspects are recommended to be monitored annually:

- trail camera monitoring during the egg incubation season (September to January) of all Malleefowl mounds that have been identified as annual, within and adjacent to the development envelope
- maintain database of Malleefowl and other fauna species sightings within a fauna register and report annually on number and location of active mounds
- collate image data and report on status of all monitored mounds
- collate and report on records of sightings of feral predators captured on cameras at the monitored mounds
- complete ground truthing of LiDAR data within the development envelope opportunistically.

1 INTRODUCTION

Covalent Lithium is developing the Earl Grey Lithium Project (EGLP) located at Mt Holland which will include the construction and operation of a fully integrated mine, concentrator, and refinery in Western Australia. The project is centred on the Earl Grey hard-rock lithium deposit 105 km south of Southern Cross in Western Australia and approximately 500 km east of Perth. It is owned by a 50-50 joint venture (JV) between subsidiaries of Wesfarmers Pty Ltd (WES:ASX) and Sociedad Química y Minera de Chile S.A. (SQM: NYSE). Covalent is the manager for the JV and is responsible for the development and operation of the project.

The survey area includes the habitats of two conservation significant fauna species, the Malleefowl (*Leipoa ocellata*) and the Chuditch (*Dasyurus geoffroii*). Both species are listed as vulnerable (VU) under both the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the Western Australian *Biodiversity Conservation Act 2016* and are considered as Matters of National Environmental Significance (MNES).

Monitoring of Malleefowl mounds was undertaken during the mound building and egg laying summer season in 2021-22. Mounds identified as Annual monitoring were revisited and remeasured. Trail cameras were deployed on mounds to capture activity of Malleefowl and other fauna species including feral predators.

1.1 PROJECT SCOPE

Ecoscape was engaged to provide the following:

- monitoring of known Malleefowl mounds
- ground truthing of LiDAR results for potential Malleefowl mounds.

The requirements of the field survey were as follows:

- be conducted in accordance with current statutory and technical requirements and guidance
- be conducted by personnel complying with regulatory expectations, in relation to years of experience, to ground truth the desktop findings through a comprehensive and targeted survey
- identify, map and measure Malleefowl mounds to NMRT standards
- install and deploy trail cameras on mounds considered for annual and five year monitoring.

1.2 SURVEY AREA

1.2.1 REGIONAL LOCATION

The survey area is in the Shire of Yilgarn in the Goldfields region of Western Australia, about 100km south of Southern Cross. The development envelope (DE) is within the Great Western Woodlands (GWW) and is approximately 1,984 ha in extent (**Map 1**). The GWW is a 16 million hectare area extending from the wheatbelt to the edge of the deserts and is the largest intact area of Mediterranean Woodland on earth (DEC 2010). The GWW includes open eucalypt woodlands (63%), Mallee eucalypt woodlands, shrublands and grasslands (Fox et al. 2016). Less common habitats in the GWW include granite outcrops, banded ironstone formations, salt lakes and freshwater wetlands (Fox et al. 2016).

The DE is in the Southern Cross Subregion of the Coolgardie Bioregion of the Interim Biogeographic Regionalism for Australia (IBRA) classification system (Government & Energy 2017). The dominant land-uses in this bioregion are Crown Reserves and Unallocated Crown Land (66.7%), grazing on native pastures (17%), conservation (11.5%) and dryland agriculture (2.3%) (Cowan, Graham & McKenzie 2001). The greenstone hills, alluvial valleys and broad plains of calcareous earths support diverse eucalypt woodlands. The uplands support Mallee woodlands and scrub-heaths on sandplains, gravelly sandplains and lateritic breakaways, chains of salt lakes with dwarf shrublands of samphire occur in the valleys (Cowan, Graham & McKenzie 2001).

1.3 STATUTORY AND TECHNICAL FRAMEWORK

This environmental assessment was conducted in accordance with Commonwealth and State legislation and guidelines:

- Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)
- Western Australian Environmental Protection Act 1986 (EP Act)
- Western Australian Biodiversity Conservation Act 2016 (BC Act)
- Department of Environment Water Heritage and the Arts *Matters of National Environmental Significance. Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999* (DEWHA 2009).

In addition, the Minister for the Environment has published lists of fauna species in need of special protection because they are considered rare, likely to become extinct, or are presumed extinct. The current listings were published in the Government Gazette on 11 September 2018 (Government of Western Australia 2018) and was taken into account.

As well as those listed above, the assessment complied with EPA requirements for environmental survey and reporting in Western Australia, as outlined in:

- EPA Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment (2020).

1.3.1 COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

At a Commonwealth level, threatened taxa (flora and fauna) are protected under the EPBC Act, which lists species that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependant, Extinct, or Extinct in the Wild.

1.3.2 WESTERN AUSTRALIAN ENVIRONMENTAL PROTECTION ACT 1986

The Western Australian EP Act was created to provide for an Environmental Protection Authority (EPA) that has the responsibility for:

- prevention, control and abatement of pollution and environmental harm
- conservation, preservation, protection, enhancement, and management of the environment
- matters incidental to or connected with the above.

The EPA is responsible for providing the guidance and policy under which environmental assessments are conducted. It conducts environmental impact assessments (based on the information included in environmental assessments and provided by the proponent), initiates measures to protect the environment and provides advice to the Minister responsible for environmental matters.

1.3.3 WESTERN AUSTRALIAN BIODIVERSITY CONSERVATION ACT 2016

The Western Australian BC Act provides for the conservation, protection and ecologically sustainable use of biodiversity and biodiversity components in Western Australia. It commenced on 1 January 2019.

Threatened species (both flora and fauna) and ecological communities that meet the categories listed within the BC Act are highly protected and require authorisation by the Minister to take or disturb. These are known as Threatened Flora, Threatened Fauna and Threatened Ecological Communities. The conservation categories of Critically Endangered, Endangered and Vulnerable have been aligned with those detailed in the EPBC Act.

Flora and fauna species may be listed as being of special conservation interest if they have a naturally low population, restricted natural range, are subject to or recovering from a significant population decline or reduction of range or are of special interest, and the Minister considers that taking may result in depletion of the species. Migratory species and those subject to international agreements are also listed under the Act. These are known as specially protected species in the BC Act.

The most recent flora and fauna listings were published in the Government Gazette on 11 September 2018 (Government of Western Australia 2018).

1.3.4 WESTERN AUSTRALIAN PRIORITY FAUNA

Conservation significant fauna species are listed by the DBCA as Priority Fauna where populations are geographically restricted or threatened by local processes, or where there is insufficient information to formally assign them to threatened fauna categories. Whilst Priority Fauna are not specifically listed in the BC Act, these have a greater level of significance than other native species.

1.3.5 DBCA WILDLIFE LICENCES

The field survey for the 2020 Malleefowl monitoring program was undertaken by Ecoscape Principal Zoologist Bruce Turner and Zoologist Louisa Carlsson under DBCA Wildlife Licensing Fauna License No. BA27000085-3 and Threatened Fauna Authority TFA 2020-0070.

2 METHOD

The purpose of the 2021-22 Malleefowl monitoring was to collect monitoring data on all Malleefowl mounds within and outside the DE, classified as ANNUAL, as on-going monitoring of Malleefowl presence and, to deploy trail cameras on selected mounds. This is the third season of monitoring which commenced in the mound building season of 2019-20.

The 2021-22 Malleefowl monitoring was undertaken by Ecoscape zoologists Bruce Turner and Louisa Carlsson under DBCA Wildlife License No. BA27000085-3 between 4-10 October 2021.

2.1.1 MALLEEFOWL MONITORING

Malleefowl mounds previously identified as ANNUAL (Ecoscape (Australia) Pty Ltd 2019) were revisited, remeasured and assessed to determine current activity status. LiDAR results were also ground truthed for accuracy and new mounds were added to the mound database and measured to NMRT standards.

At each Malleefowl mound measured a series of criteria was addressed as stated in section three of the NMRT Monitoring Manual. Each mound was recorded as either active or inactive and given a mound profile. A series of measurements and observations were recorded. Mounds were marked with a numbered star picket, photographed and cross sticks were left in place over the mound for future monitoring events. A 20 m radius was searched around active mounds only for any signs of predation.

There were four mounds that had been excluded to the birds in preparation for removal, these mounds were not monitored. These mounds are located within the DE clearing approval area and were excluded to prevent Malleefowl from nesting on them which may have led to a potentially fatal impact. The list of excluded mounds is shown in **Table 1**.

Table 1: Malleefowl mounds excluded in 2021-22 monitoring period

Mound No.	Easting	Northing	Status
3	759133.710	6446066.500	ANNUAL
5	759571.050	6446334.560	ANNUAL
23	760393.670	6447381.410	ANNUAL
62	762197.180	6443821.820	ANNUAL

2.1.2 TRAIL CAMERA MONITORING

Trail cameras were mounted at mounds which were assessed as ANNUAL within and adjacent to the DE. Cameras were mounted on brackets attached to star pickets installed close to the mound and high enough off the ground to view the interior of the mound.

Image 1: Monitored mound showing location of post and camera

The cameras were deployed from late October 2021 to March 2022. Images from the trail cameras were downloaded for review and collation of species recorded.

Recorded images of Malleefowl were reviewed to determine areas of Malleefowl activity. This was achieved by logging the number of activity events recorded at each mound. An activity event is defined as an image, or group of images, separated by at least two hours between images. The results were then analysed using a GIS heat map based on the number of events recorded for each mound.

2.1.3 LIDAR DATA

Ground truthing of LiDAR results was undertaken to the north of the Covalent Development Envelope during a fauna survey (Ecoscape (Australia) Pty Ltd 2021) and one mound was confirmed during the monitoring event. LiDAR points determined to be Malleefowl mounds, either recent or historical, were added to the mound database and measured to NMRT standards.

As outlined within Anditi (2021, **Appendix Three**) Aerial LiDAR data covering the DE and surrounds was captured by McMullen Nolan Group Pty Ltd (MNG Survey) in July/August 2019. The LiDAR data consisted of aerial LiDAR at a nominally 120 m aircraft flight line spacing to record a minimum of 5 detection points per square meter.

Spatial analytics company Anditi Pty Ltd then analysed the MNG Survey data to identify potential Malleefowl nest mounds through automation via the 'Anditi Engine'; being the proprietary software developed by Anditi data scientists for smart point cloud and image processing. In this process, the ground is defined through classification algorithms and then Malleefowl mound detection algorithms are applied to the ground surface to detect ground features in the point cloud that best approximate a typical Malleefowl nest mound shape. Based on the algorithm match to shape, and manual checks of aerial imagery, a mound is classed from Class 1 to Class 4, being:

Class 1 - Very closely matches a typical Malleefowl nest mound shape and is highly likely to be a Malleefowl nest mound

Class 2 - Is similar to a Malleefowl nest mound shape and could be a Malleefowl nest mound

Class 3 - Is a nest mound shape that is approximately within the parameters of size for a Malleefowl nest mound but isn't very similar to a typical Malleefowl nest mound. This could be an old Malleefowl nest mound, a mound of earth around living or dead tree/vegetation, or natural hummocks around waterways

Class 4 - Is a nest mound shape that is approximately within the parameters of size for a Malleefowl nest mound but isn't very similar to a typical Malleefowl mound. This could be a broken Malleefowl nest mound, a mound of earth around living or dead tree/vegetation, natural hummocks around waterways, or tussock vegetation, with manual aerial imagery checking.

A digital elevation model (DEM) is created and contoured to highlight ground features. This is overlaid with the 3D LIDAR point cloud in the Anditi Editor so that manual editors can review the data from all angles. In some cases, the point cloud is coloured from the RGB colour orthophoto. All these options enhance the quality of the resulting rated mounds, removing vegetation and other false positives. All Class 1 and Class 2, and some Class 3 mounds, were checked manually by Anditi using all available methods (e.g., aerial imagery) and where false positives were detected, these were moved to Class 4.

All potential Malleefowl nest mounds identified by LiDAR as Class 1, Class 2 and Class 3 within the Indicative Site Layout (disturbance footprint) for proposed mining operations were ground-truthed by Ecoscape to determine if the locations contained a Malleefowl nest mound (or not). Points identified as Class 4 were not ground-truthed as these locations were considered unlikely to contain a Malleefowl nest mound.

Further detail on the LiDAR data collection and processing is contained within Anditi (2021) provided at **Appendix Three**.

3 RESULTS

3.1 MALLEEFOWL MOUND MONITORING

The 2021-22 monitoring focussed on ANNUAL mounds only. A total of 26 Malleefowl mounds classified as annual mounds were measured to NMRT standards and monitored by trail camera (**Table 5 Appendix Two**). One new mound identified from LiDAR data was ground truthed and measured to NMRT standards during the 2021-22 monitoring event. Eleven of these are within the DE and 15 are outside the DE (**Map 1**). Four mounds were recorded as ACTIVE (mound building and egg laying recorded), mound MM53 inside the DE, and mounds MM64, MM24 and, MM70 outside the DE (**Map 2**). Of the 26 measured mounds, 23 were monitored by trail camera (**Map 3**,**Table 2**).

Table 2: Malleefowl mounds trail camera monitored 2021-22

Monitoring Frequency	Mound Location	
	Inside DE	Outside DE
ANNUAL	11	12

Table 3 lists the results for the previous year's monitoring of 2020-21. The number of mounds between years differ in that 5YR mounds were not revisited in 2021-22 and four annual mounds within the DE have been excluded from monitoring (**Table 1**). The new mound identified from LiDAR data was not monitored by a trail camera and does not appear in the table summary.

Table 3: Malleefowl mounds trail camera monitored 2020-21

Monitoring Frequency	Mound Location	
	Inside DE	Outside DE
ANNUAL	15	12
5 YR	11	3
Total	**26**	**15**

Of the 23 trail camera monitored mounds one mound (MM53) was recorded as active (i.e., recorded mound building and egg laying activity) within the DE and three mounds (MM24, MM64 and MM70) were recorded as active outside the DE. The remaining 19 mounds, within and outside the DE, were inactive (i.e., no recorded mound building or egg laying activity) (**Table 5** in **Appendix Two**).

Eleven mounds, six inside the DE and five outside the DE, recorded Malleefowl visiting the mounds with no mound building or egg laying activity being recorded (**Table 4**). In comparison to the 2020-21 monitoring event there has been a two-fold increase in active mounds recorded and a slight increase in Malleefowl mounds which recorded general activity (not necessarily mound building and/or egg lying activity).

3.2 TRAIL CAMERA IMAGE REVIEW

A total of 23 trail cameras were placed at active mounds and mounds which had been active approximately within the past five years, 11 of these are located within the DE and 12 are located outside the DE (**Map 3**). **Table 5** in **Appendix Two** lists the locations for all Malleefowl mounds monitored during the survey and the mounds at which trail cameras were placed (**Map 3**).

All the cameras were revisited in November 2021 to have batteries replaced and image data downloaded and were then subsequently collected in March 2022. Cameras mounted at active mounds were serviced by Covalent staff every couple of weeks to replace batteries and download image data. The downloaded data was collated into folders for each monitored mound and then reviewed. The review process involved removing images with no fauna present (e.g., wind moving shrubs) and then sorting images with fauna present into species subfolders. Malleefowl visit events were collated and tabulated for GIS analysis.

Table 6 (**Appendix Two**) lists all species recorded by the trail cameras at the monitored mounds. Varanid species, Feral Cat and Fox were recorded on mounds indicating predators of Malleefowl eggs were active at the time of survey.

3.2.1 MALLEEFOWL

Images of Malleefowl were reviewed for behaviour, e.g., scratching or egg laying, with the number of activity events tabulated. Results are discussed with respect to possible abundance based on timing of image capture.

Fifteen (seven inside DE; eight outside DE) camera monitored Malleefowl mounds recorded Malleefowl and were mapped to indicate their spatial relationship to each other. One active mound (MM53) was inside the DE, and three active mounds (MM24, MM64 and MM70) were recorded outside the DE (**Map 2**).

Table 4: Malleefowl mounds that recorded activity

Mound ID	Number of recorded activity events	Monitoring Frequency	Inside DE (yes/no)	Feral Predators
MM02	1	ANNUAL	Yes	
MM17	2	ANNUAL	No	Yes
MM24 ACTIVE	Constant (>100)	ANNUAL	No	Yes
MM38	2	ANNUAL	Yes	
MM42	4	ANNUAL	Yes	
MM43	3	ANNUAL	Yes	Yes
MM53 ACTIVE	Constant (>100)	ANNUAL	Yes	Yes
MM56	5	ANNUAL	Yes	
MM60	1	ANNUAL	Yes	
MM63	9	ANNUAL	No	Yes
MM64 ACTIVE	Constant (>100)	ANNUAL	No	
MM65	3	ANNUAL	No	
MM66	21	ANNUAL	No	Yes
MM68	1	ANNUAL	No	
MM70 ACTIVE	Constant (>100)	ANNUAL	No	

The four mounds identified as active **Table 4** recorded constant images of pairs of Malleefowl scratching and laying (

Image 2 and **Image 3**). Mound 53 and Mound 64 are identified as being active for the second consecutive year.

Image 2: Mound MM70 recorded as Active

Image 3: Malleefowl at mound MM53

The review of trail camera footage identified that at least six chicks have hatched from MM 53 (**Image 4**). One deceased chick was identified at MM 24 (**Image 5**), on review of all imagery it appears likely that the chick has died within the mound and has not been predated upon.

Image 4: Malleefowl chick at mound MM53

Image 5: dead Malleefowl Chick at mound MM24

3.2.2 OTHER SPECIES

Western Brush Wallaby (**Image 6**), Sand Goanna, other small reptiles and a suite of small woodland bird species were recorded visiting active and inactive Malleefowl mounds. **Table 6** (**Appendix Two**) lists all species recorded visiting the trail camera monitored mounds during the 2021-2022 monitoring event.

Image 6: Western Brush Wallaby at mound MM43

3.2.3 INTRODUCED PREDATORS

Feral Cats were recorded by trail cameras (**Image 7**) at seven Malleefowl mounds (MM17, MM24, MM34, MM43, MM 53, MM63, and MM66). Five of these mounds (MM17, MM24, MM34, MM63, and M66) are outside the DE and, excluding MM66 to the northwest of the Earl Grey and Jasmine Pits, are within 1500 m of each other and did record feral cat activity during the previous monitoring event in 2020 (**Map 1**). Feral cats were recorded at active and inactive Malleefowl Mounds (**Table 4** and **Map 2**). Feral cats were also recorded within the Covalent DE at MM43 and MM53, which are in close proximity to one another south of the Covalent Airstrip. The 2021-2022 monitoring results identified feral cat activity at seven mounds indicating a slight reduction in feral cat activity compared to the previous monitoring event.

European Red Fox (**Image 8**) was recorded at MM4 (inside DE) and MM63 (outside DE), which are approximately 1900 m of each other. Both mounds were recorded to be inactive during this monitoring event, but the trail camera at MM63 recorded individual and isolated visits of Malleefowl.

Image 7: Feral Cat recorded at mound MM63

Image 8: European Red Fox at mound MM4

3.3 ACITIVTY ANALYSIS

An analysis was performed using the recorded events of activity at each mound to determine areas of Malleefowl activity. Tabulated event numbers for each mound that recorded activity by Malleefowl was analysed in GIS to produce a heat map of activity based on the number of events recorded for each mound by trail camera images.

Data for the three monitoring events (**Figure 1**, **Figure 2** and **Figure 3**) was subjected to the same GIS analysis to provide comparison between years.

3.3.1 2019-20 ANALYSIS

Malleefowl mound MM17 was the only mound active for the length of the 2019-20 monitoring period (**Figure 1**). Mound MM23 was recorded as active and then subsequently abandoned approximately halfway through the monitoring period, most likely due to a feral cat visit (Ecoscape (Australia) Pty Ltd 2019).

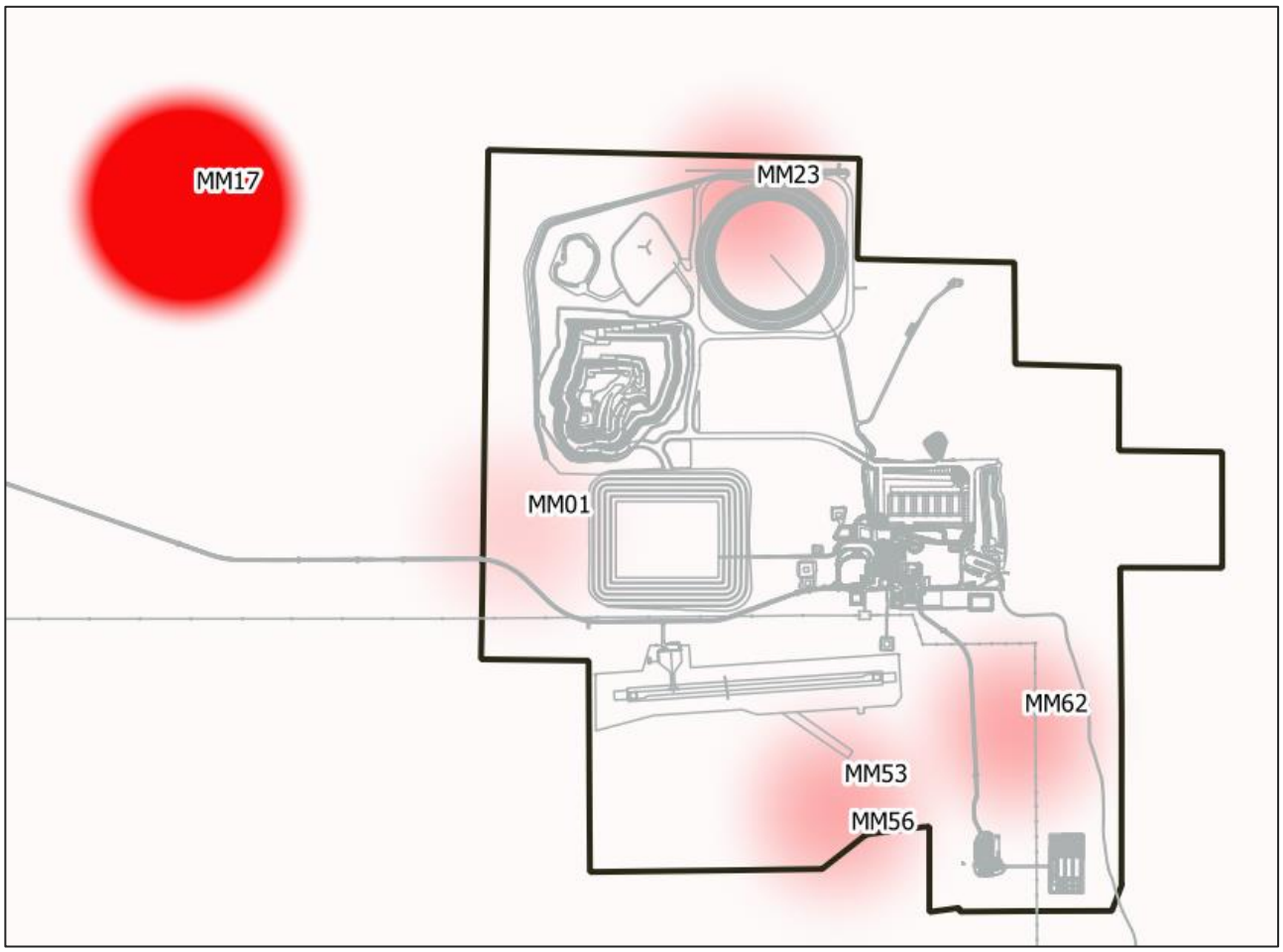

Figure 1: Malleefowl activity heat map based on number of events recorded 2019-20 at camera monitored mounds

3.3.2 2020-21 ANALYSIS

The activity pattern for 2020-21 is similar to 2019-20 in that Malleefowl activity was recorded around mounds located in the same areas with the exception of MM28 and MM64 (**Figure 2**). The obvious difference is the increase in activity during 2020-21 and this was supported by the increase in the number of sightings of Malleefowl being recorded on site since February 2021.

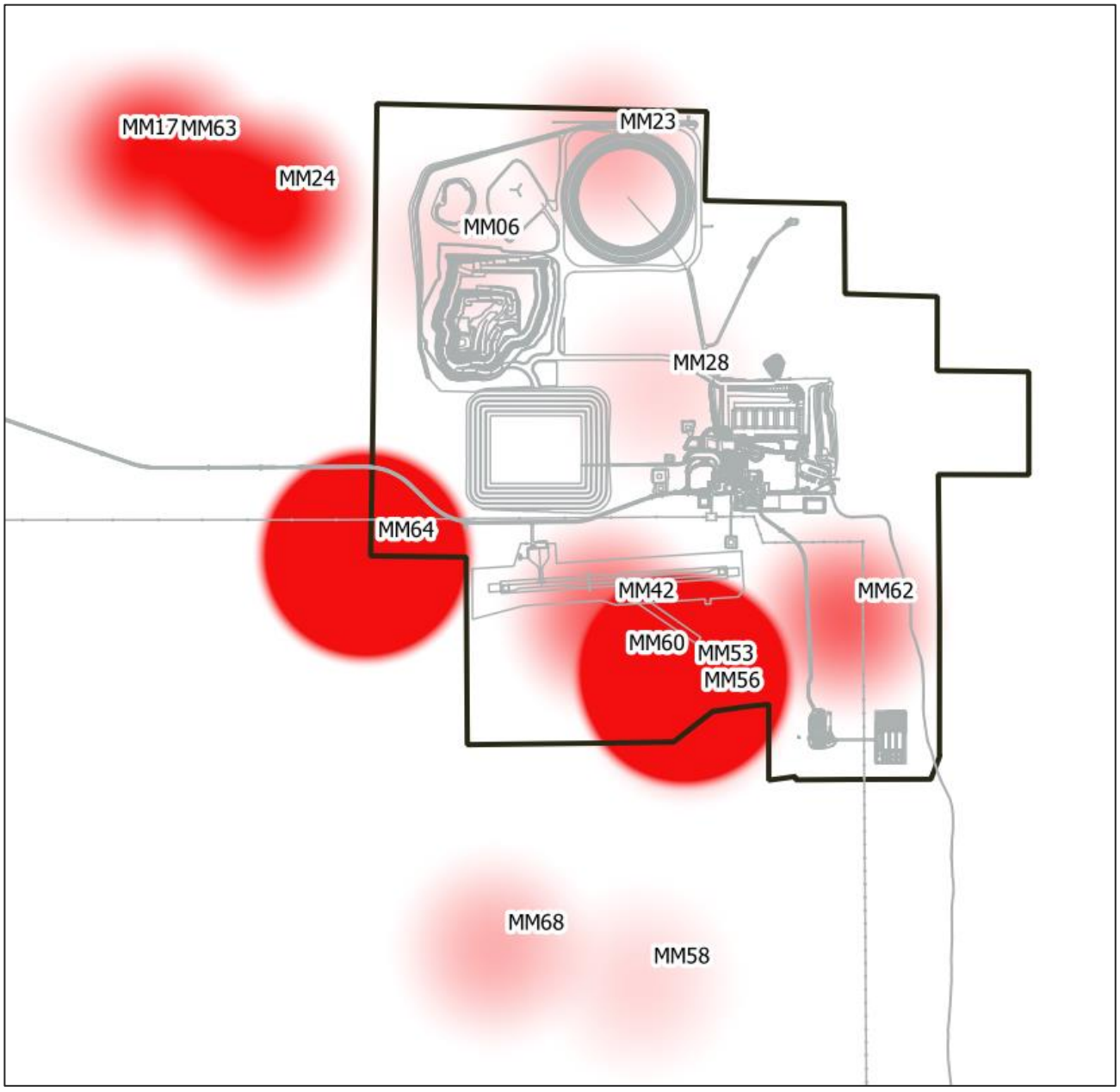

Figure 2: Malleefowl activity heat map based on number of events recorded in 2020-21 at camera monitored mounds

3.3.3 2021-22 ANALYSIS

The analysis determined that there are potentially four breeding pairs of Malleefowl within the area of the monitored mounds. **Figure 3** shows that Malleefowl activity is highest around the four active mounds MM53, MM24, MM70, and MM64. The activity around mounds MM63, MM66, MM65, MM42 and MM68 is not attributed to mound building or egg laying however these mounds were visited many times and most likely by the same birds that are nesting at the active mounds. Malleefowl activity was similar in the location of active mounds with the 2020-21 monitoring with the addition of one new active mound at MM66.

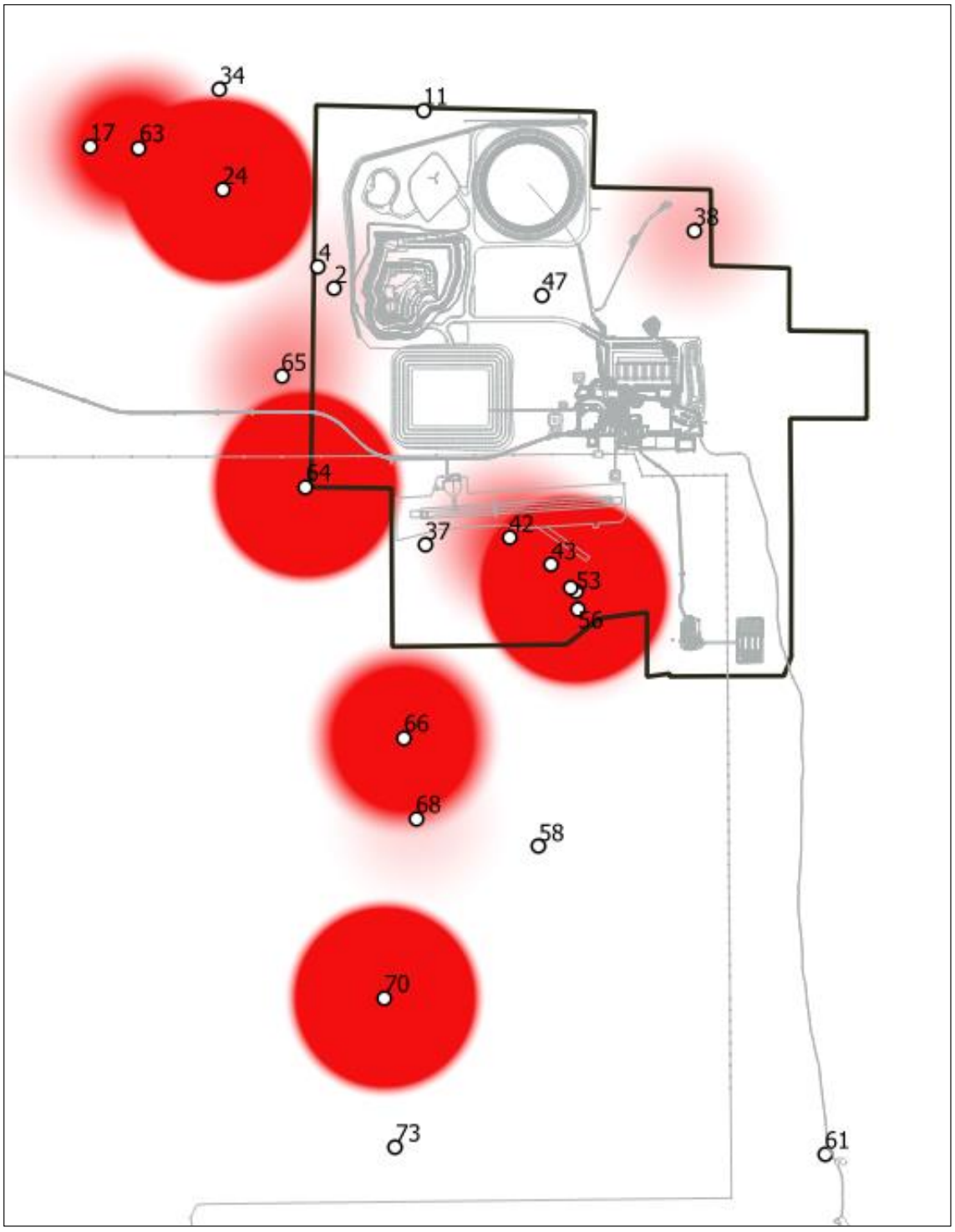

Figure 3: Malleefowl activity heat map based on number of events recorded in 2021-22 at camera monitored mounds.

3.4 LIDAR GROUND TRUTHING

Ground truthing of LiDAR results was undertaken during a fauna survey earlier in the year (Ecoscape 2021) and the actual monitoring event.

Fifteen new Malleefowl mounds were identified from LiDAR results and added to the list of known Malleefowl mounds (**Map 4**). None of the identified mounds were recorded as LiDAR Class 1. Eight were classified as LiDAR class 2, three as class 3 and four as class 4 (**Map 4**), which indicates that ground truthing is necessary to determine actual Malleefowl mound presence. LiDAR class definitions are summarised as:

Class 1 –highly likely to be a Malleefowl nest mound.
Class 2 –could be a Malleefowl nest mound.
Class 3 –isn't very similar to a typical Malleefowl mound.
Class 4 –isn't very similar to a typical Malleefowl mound and less so than Class 3.

4 DISCUSSION AND RECOMMENDATIONS

4.1 MALLEEFOWL MONITORING

4.1.1 MALLEEFOWL MOUND MONITORING

Four active mounds were recorded during the 2021-2022 monitoring period. Mounds MM 64 (outside DE) and MM 53 (inside DE) were also recorded as active during the 2020-21 monitoring event. Another two mounds (MM 24 and MM 70) located outside the DE were recorded as active. A total of 15 mounds recorded Malleefowl activity in 2021-22 compared to 14 mounds in 2020-21 indicating a slight increase in recorded Malleefowl activity.

Figure 2 and **Figure** 3 show the slight increase and shift between mounds of general Malleefowl activity in 2021-22 compared to the previous monitoring event. The four active mounds (MM 24, MM 53, MM 64, and MM 70) recording mound building and egg laying behaviour constantly through the monitoring period.

The results indicate that there were potentially four discrete breeding pairs of Malleefowl maintaining mounds during the 2021-22 monitoring period. It is likely there are two additional breeding pairs of Malleefowl around MM 63 and MM 66.

The 2022-2023 monitoring event will compromise all mounds listed as annual **Table 7** (**Appendix Two**). All mounds classified as 5 year will again be monitored in 2025.

4.1.2 ACTIVITY ANALYSIS

The analysis of images to produce activity patterns at the monitored mounds and the resulting heat maps indicate four areas of high activity for 2021-22 (**Figure 3**), with MM66 having potential to become an active mound in future breeding seasons and adding a fifth area of high activity. The activity patterns are similar to those observed during the previous 2020-2021 (**Figure 2**) and 2019-2020 (**Figure 1**) monitoring event. With activity intensifying in the north-west corner outside the DE and with new activity arising south of the DE.

The results indicate that potentially at least four Malleefowl pairs are known to be active within the monitoring area.

4.1.3 INTRODUCED PREDATORS

Over the 2021-22 period of trail camera monitoring seven different mounds recorded visits by Feral Cats. Four of these mounds (MM17, MM24, MM34, MM63) are all outside the DE to the northwest of the Earl Grey and Jasmine Pits and are within 1500 m of each other. The images recorded show distinguishing stripe patterns suitable to confirm that the animal seen on trail camera images in this area are likely to be the same individual, this is consistent with the results from the 2020-2021 monitoring event. Feral cats were also recorded at mounds MM43, MM53, and MM66 which are within 2000 m of one another surrounding the southern border of the DE. Image review suggests that this is likely to be the same individual.

During the 2021-2022 monitoring event a European Red Fox was recorded visiting mounds MM4 and MM63, both identified as being inactive. This is the first time that a European Red Fox has been recorded during the Malleefowl monitoring. Mounds MM4 and MM63 are within 1900 m of each other so it is likely that the Fox recorded is the same individual.

4.2 RECOMMENDATIONS

These recommendations are made without knowledge of the possible conditions of approval and pertain to monitoring of the likely Malleefowl population within the overall project area and are aligned with the guidelines of the NMRT Monitoring Manual.

Monitoring of mounds both within and outside of the DE may provide insight on the number of birds breeding and foraging that may be impacted by potential clearing activity.

To provide Malleefowl population health and abundance data the following aspects are recommended to be monitored annually:

- Trail camera monitoring during the egg incubation season for 2022-23 (September to January) of all Malleefowl mounds that have been identified as ANNUAL, within and adjacent to the DE.
- Maintain database of Malleefowl sightings within a fauna register and report annually on number and location of active mounds.
- Collate image data and report on status of all monitored mounds.
- Collate and report on records of sightings of feral predators and images captured on cameras at the monitored mounds.
- Complete ground truthing of LiDAR data within the DE.

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APPENDIX ONE MAPS

Map 1: Malleefowl mounds monitored

Map 2: Active mounds and mounds that recorded Malleefowl

Map 3: Malleefowl mounds monitored by camera

Map 4: Malleefowl mounds ground truthed from LiDAR data

APPENDIX TWO MONITORING RESULTS

Table 5: Malleefowl mounds visited and monitored during the 2021/2022 survey (nc denotes no camera; highlight indicates ACTIVE mound)

Mound No.	Date on	Camera No.	Easting	Northing	Action
2	06/10/2021	94	758814.450	6446062.100	ANNUAL
4	06/10/2021	86	758671.410	6446261.450	ANNUAL
11	05/10/2021	29	759608.780	6447663.710	ANNUAL
17	05/10/2021	7	756616.660	6447339.360	ANNUAL
24	05/10/2021	68	757807.780	6446949.680	ANNUAL
34	05/10/2021	24	757784.400	6447850.350	ANNUAL
37	06/10/2021	81A	759627.840	6443759.560	ANNUAL
38	06/10/2021	80	762041.070	6446580.550	ANNUAL
42	06/10/2021	47	760380.820	6443823.550	ANNUAL
43	06/10/2021	10	760762.250	6443581.310	ANNUAL
47	06/10/2021	87	760678.550	6446002.240	ANNUAL
53	06/10/2021	79	760983.090	6443348.360	ANNUAL
56	06/10/2021	17	761001.850	6443190.010	ANNUAL
58	05/10/2021	6	760649.570	6441052.370	ANNUAL
60	06/10/2021	65	760934.210	6443386.150	ANNUAL
61	05/10/2021	19	763216.780	6438292.680	ANNUAL
63	05/10/2021	11	757062.490	6447330.290	ANNUAL
64	06/10/2021	58	758558.640	6444285.370	ANNUAL
65	06/10/2021	84	758336.650	6445274.990	ANNUAL
66	06/10/2021	64	759437.293	6442033.674	ANNUAL
68	05/10/2021	81	759545.240	6441306.261	ANNUAL
70	05/10/2021	82	759262.392	6439696.610	ANNUAL
73	05/10/2021	99	759363.117	6438355.697	ANNUAL
75 new	09/10/2021	nc	758733.83	6442566.13	ANNUAL

Table 6: Species recorded by trail camera (* denotes introduced species)

Species	Common Name
Acanthiza chrysorrhoa	Yellow-rumped Thornbill
Calamanthus cautus	Shy Heathwren
Cinclosoma clarum	Western Chestnut Quail-thrush
Coturnix ypsilophora	Brown Quail
Cracticus torquatus	Grey Butcherbird
Ctenophorus caudicinctus	Ringtail Dragon
Ctenophorus cristatus	Bicycle Dragon
Ctenophorus isolepis	Central Military Dragon
Drymodes brunneopygia	Southern Scrub Robin
**Felis catus*	Cat
Gavicalis virescens	Singing Honeyeater
Gliciphila melanops	Tawny-crowned Honeyeater
Leipoa ocellata	Malleefowl
Lichenostomus cratitius	Purple-gaped Honeyeater
Lichenostomus leucotis novaenorciae	White-eared Honeyeater
Macropus fuliginosus melanops	Western Grey Kangaroo
Malurus pulcherrimus	Blue-breasted Fairy-wren
Notamacropus irma	Western Brush Wallaby
Notomys mitchellii	Mitchell's Hopping Mouse
Oreoica gutturalis	Crested Bellbird
Phaps chalcoptera	Common Bronzewing
Phaps elegans	Brush Bronzewing
Pogona minor minor	Western Bearded Dragon
Pomatostomus superciliosus	White-browed Babbler
Pseudechis australis	King Brown Snake
Tiliqua occipitalis	Western Bluetongue
Tiliqua rugosa rugosa	Bobtail
Varanus gouldii	Sand Goanna
**Vulpes vulpes*	European Red Fox

Table 7: Malleefowl mounds for 2022-23 monitoring program / recommendations

Mound No.	Easting	Northing	Action
2	758814.450	6446062.100	5-year
4	758671.410	6446261.450	5-year
11	759608.780	6447663.710	5-year
17	756616.660	6447339.360	ANNUAL
24	757807.780	6446949.680	ANNUAL
34	757784.400	6447850.350	ANNUAL
37	759627.840	6443759.560	5-year
38	762041.070	6446580.550	5-year
42	760380.820	6443823.550	5-year
43	760762.250	6443581.310	5-year
47	760678.550	6446002.240	5-year
53	760983.090	6443348.360	ANNUAL
56	761001.850	6443190.010	ANNUAL
58	760649.570	6441052.370	5-year
60	760934.210	6443386.150	5-year
61	763216.780	6438292.680	5-year
63	757062.490	6447330.290	5-year
64	758558.640	6444285.370	ANNUAL
65	758336.650	6445274.990	5-year
66	759437.293	6442033.674	5-year
68	759545.240	6441306.261	5-year
70	759262.392	6439696.610	ANNUAL
73	759363.117	6438355.697	ANNUAL
75	758733.83	6442566.13	5-year

APPENDIX THREE LIDAR METHOD