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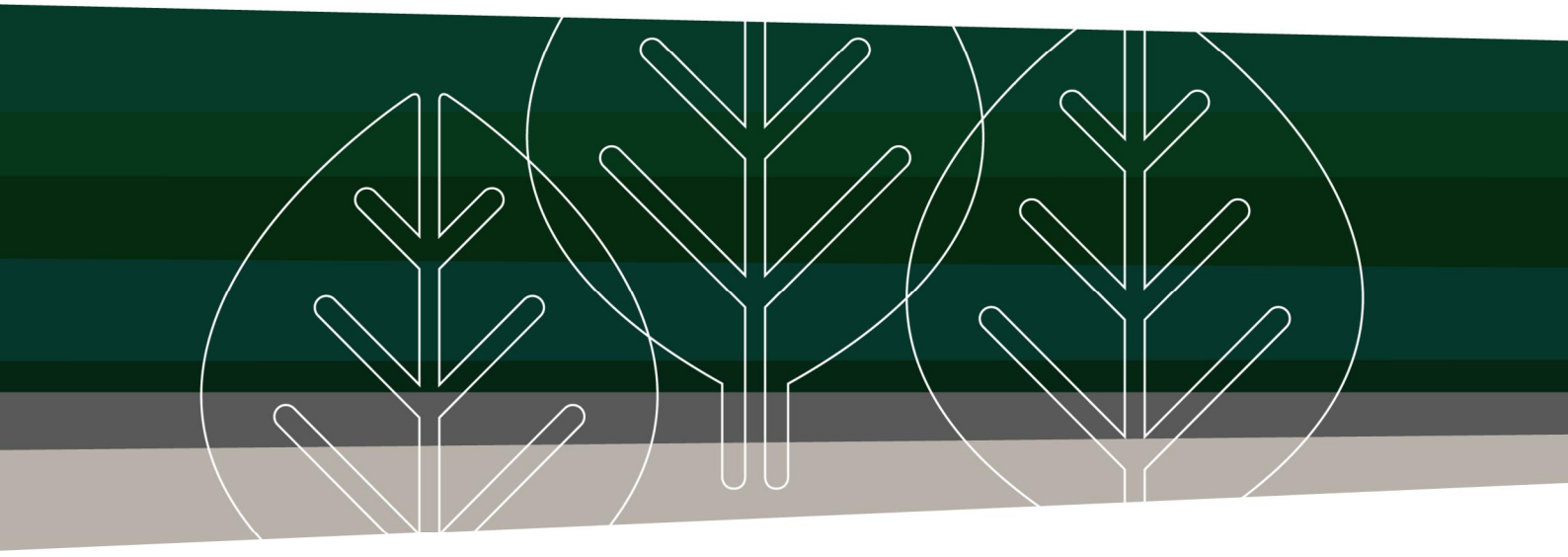

Contract: 2013/03726

Busselton Health Campus Conservation and Tuart Offset Works

BHC Tuart Offset Spring 2014 Monitoring Report

Department of Finance (Building Management and Works)

P597B-01-Rev0

January 2015

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1 EXECUTIVE SUMMARY

The Department of Finance (Building Management and Works) has constructed the new Busselton Health Campus to meet the demands of the growing population in the South West. As the construction of the new health campus involved the clearing of remnant bushland, and offset package was developed to mitigate the impacts. The offset package includes two areas:

1) Enhancement of surrounding remnant vegetation (Conservation Area) through infill planting;
2) Revegetation of 4 ha of the Ludlow Tuart Forest.

This monitoring report assesses progress for the second area of the offset package: the Ludlow Tuart Forest offset rehabilitation works.

Completion criteria were developed by the environmental consultants to measure the success of the revegetation activities undertaken. The criteria included measures of plant survival, plant density, weed cover and native foliage cover. A baseline survey was also undertaken by the consultants prior to the works commencing.

Initial works started in July 2013, with site preparation activities. Revegetation was staged over two years with larger trees planted in September 2013, and tubestock planted in July 2014 Following completion of the installation program, a three year monitoring and maintenance program commenced.

This is the first monitoring assessment of six to determine whether the Tuart Forest Offset revegetation works are progressing towards meeting the completion criteria, and to establish whether remedial action is required or not. A monitoring assessment is to occur every spring and autumn for three years.

The following observations were made during this assessment:

- *Agonis flexuosa* (Peppermint) seedling survival is 85% which is greater than the target of 75%;
- *Eucalyptus gomphocephala* (Tuart) seedling survival is 100%, which exceeds the target of 75%;
- Other native species are averaging a survival rate of 90%, which is above the completion criterion of 75%;
- The average weed cover is 1% across the site, with *Zantedeschia aethiopica* (Arum Lily), and *Trachyandra divaricata* (Dune Onion Weed) reduced by more than 80% across the site. Therefore the weed completion criteria are currently being achieved; and
- Natural recruitment has been observed across the site increasing plant density, native cover and species diversity.

Based on the observations, the Tuart Forest revegetation program is currently on track to meet the completion criteria. No remedial works are currently required, apart from the ongoing site visits, weed control and pest management works currently being undertaken.

2 INTRODUCTION

The Ludlow Tuart Forest is located approximately 190 km south of Perth in Busselton (See Appendix 1). As part of the State and Federal offset requirements, the Department of Health was required to implement a revegetation program for the 4 ha site to enable to construction of the new health campus. The revegetation program consists of:

- Remove, stockpile and burn the pine tree stumps onsite;
- Install a rabbit and kangaroo fence around the site;
- Mature Peppermint tree installation;
- Deep ripping and spreading of the ash beds around the site;
- Seedling propagation and installation; and
- Removal of particular weed species through a weed control program.

The Department of Finance (Building Management and Works) engaged Tranen to undertake the initial revegetation works and follow-up monitoring over a 3 year period, with assessments to be undertaken at the following times:

- Spring 2014 (current assessment);
- Autumn 2015;
- Spring 2015;
- Autumn 2016;
- Spring 2016; and
- Autumn 2017.

This, the first of the six scheduled monitoring assessments, was undertaken on the 4th November 2014 by Matt Blunt and Kris Olson of Tranen Revegetation Southwest.

2.1 Aim

The aim of this report is to provide an assessment of the current status of the various aspects of the revegetation program, and to compare this information to the completion criteria.

2.2 Completion Criteria

Below are the completion criteria for the BHC Tuart Forest Offset works. These targets are to be achieved by the end of the third year, but will also be applied during each of the monitoring events.

Table 1 Completion Criteria

Criterion		Basis	By Year 3
1	Tuart survival rate (%)	Quadrat	75
2	Peppermint survival rate (%)	Quadrat	75
3	Other native species survival rate (%)	Quadrat	75
4	Reduction in Arum Lily population (%)	PMP*	>80
5	Reduction in Dune Onion Weed Population (%)	PMP	>80

**Photo Monitoring Point (PMP)*

3 PROJECT BACKGROUND

3.1 Site Preparation

Pine stumps were removed in July 2013 using an excavator, and stockpiled throughout the site. During the removal, aboriginal monitors were onsite to identify any artefacts that may be uncovered during the works.

The stockpiles were then burnt in April 2014 by the Department of Parks and Wildlife to create ash beds. In May the site was then deep ripped to a depth of approximately 400mm, this incorporated the ash beds into the soil and broke up any surface compaction to allow greater root penetration for the seedlings.

3.2 Rabbit and Kangaroo Fence Installation

A rabbit and kangaroo fence was installed in November 2013 around the entire perimeter of the 4ha offset area. The kangaroo fence was a 10-line ring lock fence at a height of 1.8 metres, and the rabbit netting was attached 300mm high up the fence, and buried to a depth of 300mm.

Two gates were installed at the eastern and western ends of the fence to allow ease of access.

3.3 Mature Peppermint Installation

A total of 500 15L *Agonis flexuosa* trees were installed within the Tuart Offset Area in September 2013. For each tree, a hole was excavated, 2 fertiliser tablets installed, and then the tree installed. Two jarrah stakes were then installed and the tree tied to stabilise the tree during significant weather events, and to promote stem strength.

Watering of the trees over the summer period was not feasible due to access issues onsite.

3.4 Weed Control

Regular pre and post installation weed control (spring, autumn and winter) has been ongoing to minimise competition with native plants for resources, and to remove dominant weed species from the area. Currently the majority of the dominating weed species have been removed from site, with just the occasional specimen germinating.

3.5 Pest Control

Rabbit and fox bating commenced in December 2013, with the application of 1080 baits around the offset area. Another application of 1080 was undertaken in May and November 2014 within the fenced revegetation area, and the immediate surrounds.

Ongoing pest control for the next 2 years is scheduled to maximise the chances of seedling establishment and to promote natural recruitment within the area.

3.6 Baseline Data Survey

In May 2014, the environmental consultants installed the monitoring quadrats and photo monitoring point onsite. Once their locations were determined, data including native cover, weed cover and weed and native species present, was then collected. This data was then used to create the baseline for which future monitoring events were to be assessed against.

3.7 Seedling Propagation and Installation

Seed sourced from the local area was used to propagate 17,100 seedlings for planting at the Tuart Offset Site. Where seed was unavailable for some species, seedlings were sourced from local nurseries. Planting occurred when sufficient rainfall was recorded onsite to settle the rip lines and provide enough moisture for plant establishment.

The seedlings were installed in July 2014, and species were planted in landscape positions where they would naturally occur to maximise their likelihood of survival and best represent the surrounding vegetation structures. A native fertiliser tablet was also installed with each seedling to provide additional nutrients during its establishment phase.

4 MONITORING METHODOLOGY

A combination of quadrats and permanent photographic points have been established across the site for data collection for performance monitoring.

4.1 Quadrats

Five separate 5 m x 5 m quadrats were installed across the site, with the placement determined via a process of stratified random sampling. Two of the quadrats were located in the dryland area of the site, while the remaining three were installed in the wet area. The location of each quadrat is shown in Appendix 2.

Each quadrat was marked with galvanised steel droppers in each corner. The north-western corner dropper was then marked with an identification tag and flagging tape to create a photographic reference point, so over time the quadrat could be compared to provide a visual assessment of the revegetation progress. The photo was taken 3 m back from the north western corner. The co-ordinates for each quadrat were marked with a GPS at the centre point of the quadrats. The coordinates are shown below in Table 1.

Table 2 GPS Coordinates for Quadrats

Quadrat GPS Coordinates (GDA 94, MGA Zone 50)		
Quadrat	**Easting**	**Northing**
Q1	357421	6277641
Q2	356507	6277850
Q3	356572	6277745
Q4	356559	6277665
Q5	356508	6277649

4.2 Photo Monitoring Points

Four separate photo monitoring points (PMP) were set up to identify progress over time. Photos were taken facing the south east. Table 3 below lists the co-ordinates for the locations of the photos provided.

Table 3 GPS Coordinates for PMP's

PMP GPS Coordinates (GDA 94, MGA Zone 50)		
PMP	**Easting**	**Northing**
PMP1	356472	6277642
PMP2	356432	6277702
PMP3	356538	6277771
PMP4	356373	6277661

4.3 Monitoring Methodology

The following quantitative and qualitative data were recorded within each quadrat during the assessment:

Quantitative data:

- Seedlings alive;
- Seedlings dead;
- Native species recorded;
- Weed species recorded;
- Abundance of native vegetation (% cover);
- Density (stems/m^2) native vegetation; and
- Soil (% cover).

Qualitative data:

- The health of native vegetation;
- The health of weeds.

The entire site was also visually inspected by walkthrough, with observations also made of:

- Soil movement;
- Disturbances and predation;
- Comparison of quadrats to remainder of site; and
- Potential influences on and future indicators of success or failure.

Photographs were taken at each of the quadrats and PMP's, as well as of additional noteworthy subjects throughout the site.

5 RESULTS

A summary of the qualitative data recorded for each quadrat can be found in Appendix 3. The detailed raw data for the assessment of each quadrat can be found in Appendix 4. Photos of each quadrat can be found in Appendix 5. The following section details these results further.

5.1 Seedling Survival

5.1.1 Peppermints

Table 4 details the survival rate for the planted Peppermint seedlings.

Table 4 Peppermint Seedling Survival

Quadrat	Month	Vegetation Zone	Peppermints Counted	Peppermints Alive	Peppermints Dead	Peppermint Survival (%)
Q1	Nov-14	Dryland	1	1	0	100
Q2	Nov-14	Wetland	4	3	1	75
Q3	Nov-14	Dryland	2	2	0	100
Q4	Nov-14	Wetland	N/A	N/A	N/A	N/A
Q5	Nov-14	Wetland	N/A	N/A	N/A	N/A
Total	**Nov-14**		**7**	**6**	**0**	**85**

Peppermints were observed in quadrats Q1, Q2, and Q3, and not in Q4 and Q5 as they were not planted in the wetter areas. The overall survival rate for the three quadrats was 85% with 6 of the 7 plants assessed still alive.

5.1.2 Tuart

Table 5 summarises the Tuart seedling survival rates in each of the quadrats.

Table 5 Tuart Seedling Survival

Quadrat	Month	Vegetation Zone	Tuarts Counted	Tuarts Alive	Tuarts Dead	Tuart Survival (%)
Q1	Nov-14	Dryland	0	0	0	N/A
Q2	Nov-14	Wetland	0	0	0	N/A
Q3	Nov-14	Dryland	3	3	0	100
Q4	Nov-14	Wetland	N/A	N/A	N/A	N/A
Q5	Nov-14	Wetland	N/A	N/A	N/A	N/A
Total	**Nov-14**		**3**	**3**	**0**	**100**

Tuart seedlings were only observed in one of the five quadrats, this being Q3. In quadrats Q4 and Q5, Tuarts were not planted due to the area being too wet. The quadrats Q1 and Q2 were not located next to ash beds and so no Tuarts were observed in either of these.

The average Tuart seedling survival recorded was 100% with 3 out of 3 seedlings observed alive.

5.1.3 Other Native Species

Table 6 provides a summary of the planted seedling survival rates of all species except for the Peppermints and Tuarts, which were assessed separately.

Table 6 Other Native Species Seedling Survival

Quadrat	Month	Vegetation Zone	Seedlings Counted	Seedlings Alive	Seedlings Dead	Seedling Survival (%)
Q1	Nov-14	Dryland	23	23	0	100
Q2	Nov-14	Wetland	38	37	1	97
Q3	Nov-14	Dryland	25	22	3	88
Q4	Nov-14	Wetland	38	32	6	84
Q5	Nov-14	Wetland	11	9	2	82
Total	**Nov-14**		**27**	**25**	**2**	**90**

The dryland zone recorded an average seedling survival rate of 94%, with the highest survival rate recorded in quadrat Q1 with 100%.

The wetland zone recorded an average seedling survival rate of 87% across the three quadrats. The highest survival rate was recorded in Q2 with 97%, while the lowest was 82% and that was recorded in Q5.

Overall the average survival rate recorded across the five quadrats was 91%.

5.2 Native Density

Table 7 details the combined plant density, which includes the Peppermints, Tuarts, and other native species, in each of the monitoring quadrats.

Table 7 Native Density

Transect	Month	Vegetation Zone	Peppermints	Tuarts	Others	Total Plants	Total Plant Density (stems / m^2)
Q1	Nov-14	Dryland	1	0	23	24	1.0
Q2	Nov-14	Wetland	3	0	37	40	1.6
Q3	Nov-14	Dryland	2	3	22	27	1.1
Q4	Nov-14	Wetland	0	0	32	32	1.3
Q5	Nov-14	Wetland	0	0	9	9	0.4
Overall	**Nov-14**		**6**	**3**	**123**	**132**	**1.1**

The dryland zone recorded an average density of 1.1 plants / m^2, with quadrat Q3 recording the highest density with 1.1 plants / m^2.

The wetland zone recorded an average plant density of 1.1 plants / m^2. The highest density was recorded in quadrat Q2 with 1.6 plants / m^2. The lowest was recorded in Q5 with 0.4 plants/ m^2.

The average native density for all five quadrats was 1.1 plants / m^2, with all the quadrats except for Q5 recording 1 plant / m^2 or more.

5.3 Weed Cover

Table 8 summarises the weed cover recorded in each of the quadrats.

Table 8 Weed Cover

Transect	Month	Vegetation Zone	Baseline	Arum Lily Cover (%)	Dune Onion Weed Cover (%)	Other Cover (%)	Total Weed Cover (%)
Q1	Nov-14	Dryland	17	0	0	2	2
Q2	Nov-14	Wetland	16	0	0	1	1
Q3	Nov-14	Dryland	54	0	0	<1	<1
Q4	Nov-14	Wetland	46	0	0	1	1
Q5	Nov-14	Wetland	60	0	0	0	0
Avg	**Nov-14**		**39**	**0**	**0**	**1**	**1**

The dryland zone's average weed cover was 1%, with the highest of 2% being recorded in Q1. The lowest weed cover was recorded in Q3 with <1% recorded.

The wetland zone had an average weed cover of 1%. The highest cover of 1% was recorded in two of the quadrats, Q2 and Q4, while Q5 recorded the lowest cover with 0%.

The average weed cover across all of the five quadrats was 1%. Quadrats Q3 and Q5 recorded the largest decrease in weed cover when comparing the results against

the baseline data collected in May 2014. The dominant weed species observed were *Solanum nigrum* (Nightshade) and there was no record of *Zantedeschia aethiopica* (Arum Lily) and *Trachyandra divaricata* (Dune Onion Weed) being observed in any of the quadrats.

5.4 Species Richness

Table 9 details the species richness recorded in each of the five quadrats.

Table 9 Native Species Richness

Transect	Month	Vegetation Zone	Species Planted	Species Recorded	Overall Richness (%)
Q1	Nov-14	Dryland	23	12	52
Q2	Nov-14	Wetland	14	4	29
Q3	Nov-14	Dryland	23	10	43
Q4	Nov-14	Wetland	14	8	57
Q5	Nov-14	Wetland	14	5	36
TOTAL	**Nov-14**		**31**	**23**	**74**

The dryland zone recorded a species richness within the quadrats of 57% with 13 out of the 23 species planted recorded. The highest number of species recorded was in quadrat Q1 with 12. The lowest number of species recorded was in Q3 with 10. A number of other species were observed outside of the quadrats that were not recorded in any of the five quadrats.

The wetland zone recorded a species richness in the quadrats of 64%, with 9 out of the 14 species planted represented. The highest number of species recorded was in quadrat Q4 with 8 species represented. The quadrat with the lowest species was Q2 with 4 species present.

The species richness across all five of the quadrats was 23 species, or 74% of the total planted.

5.6 Native Cover

Table 10 summarises the native cover in each of the quadrats.

Table 10 Native Cover

Transect	Month	Vegetation Zone	Baseline (%)	Cover (%)
Q1	Nov-14	Dryland	0	3
Q2	Nov-14	Wetland	0.5	1
Q3	Nov-14	Dryland	0	2
Q4	Nov-14	Wetland	<1	4
Q5	Nov-14	Wetland	<1	<1
Avg	**Nov-14**		**0**	**3**

The dryland zone recorded an average native cover of 3%. The highest cover was recorded in Q1 with 3%, while the lowest was in Q3 recording 2%.

The wetland area had an average native cover of 2%, with the highest cover recorded in Q4 with 4% recorded. The lowest cover was recorded in Q5 with less than <1%.

The average native plant cover across all of the five quadrats was 3%.

5.7 Bare Soil Cover

Table 11 details the bare soil cover in each of the five quadrats. Bare soil cover is the percentage of soil cover within each quadrat was considered to determine the amount of space unoccupied by planting, weeds, or accumulated vegetative litter

Table 11 Bare Soil Cover

Transect	Month	Vegetation Zone	Baseline (%)	Cover (%)
Q1	Nov-14	Dryland	75	75
Q2	Nov-14	Wetland	90	90
Q3	Nov-14	Dryland	70	50
Q4	Nov-14	Wetland	60	85
Q5	Nov-14	Wetland	49	80
Avg	**Nov-14**		**69**	**76**

The dryland zone recorded and average bare soil cover of 63%. The highest soil cover was recorded in Q1 with 75% cover, while the lowest was recorded in Q3 with 50%.

In the wetland zone the average bare soil cover over the three quadrats was 85%. The quadrat that recorded the highest soil cover was Q2 with 90%, while the lowest was recorded in Q5 with 80%.

The average bare soil cover across all five of the quadrats was 76%, which is an increase of 7% when compared against the baseline data. Two out of the five quadrats recorded no change in bare soil cover when compared to the baseline data, while the two of the others, Q4 and Q5, recorded an increase. Q3 was the only quadrat to have a decrease in bare soil cover. The quadrat that recorded the greatest increase was Q5 with an increase of 31%.

6 DISCUSSION

6.1 Planted Seedling Survival

At present all of the seedlings survival criteria are exceeding the required targets. At present there is no need for remedial action with regards to seedlings survival. Some attrition is likely to occur over summer, and the autumn 2015 monitoring assessment will ascertain if further action may be required in winter 2015.

Peppermint tree survival is meeting the completion criteria of 75% survival, with an average of 85% being recorded across all of the quadrats. Two of the quadrats, Q4 and Q5 did not record any Peppermint seedlings as the quadrats are located in the wetter part of the site, and the Peppermint seedlings were placed in the drier areas.

The Tuart seedlings were only installed in the dryland areas of the site, and only where ash beds were present. This is the reason why only one of the quadrats (Q3) recorded Tuarts seedlings. The survival rate in this quadrat was 100% and is therefore meeting the survival rate completion criteria of 75%.

All other species recorded an average survival rate of 91%, which is higher than the required completion criteria of 75%.

6.2 Native Density

At present the Offset Area is recording an overall native density of 1.1 plants / m^2. There was only one quadrat that recorded less than 1 plant / m^2 and that was Q5, which recorded 0.4 plants / m^2.

Natural recruitment from the topsoil was observed sporadically over the site, with *Jacksonia furcellata* and *Gompholobium sp.* the dominant species. By continuing the weed and pest control program for the site, additional recruitment may occur, which will result in an increase the native density.

Native density was not part of the completion criertia for the offset site. It was measured to provide further clarity on how the works are progressing, as well as to help determine if remedial works are necessary.

6.3 Weeds

The average weed cover over the Offset Area is 1%, with the most prevalent species being Solanum nigrum (Nightshade). The weed cover has dropped significantly when compared to baseline data, indicating the weed control program has been successful to date.

The weed cover completion criteria of a reduction of 80% for both *Zantedeschia aethiopica* (Arum Lily) and *Trachyandra divaricata* (Dune Onion Weed) is currently being met, as neither of the two species were observed in any of the quadrats during the assessment.

6.4 Species Richness

The total number of species recorded was 23 out of 34 species planted, or 74%. This represents a well-mixed planting distribution, given that such a small sample set of the overall area is contained within the quadrats.

Quadrat Q4 recorded the highest species diversity with 57% of the species planted observed. The lowest was recorded in quadrat Q2 with 29% of species planted represented. However, the plant density in that quadrat was also significantly lower than other quadrats, so the species representation was also expected to be low.

6.5 Native Cover

The average native cover across all five of the quadrats is 3%, with the highest cover being recorded in quadrat Q4. The lowest cover was recorded in Q5 with <1%.

All of the quadrats except for Q5 recorded an increase in native cover when compared against the baseline data. The greatest increase was in Q4, with 4% more cover than the baseline. It is expected that the native cover will continue to increase as the seedlings establish themselves and begin to gain height and width.

Native cover is not one of the completion criteria being assessed. It was included in the assessment as it provides an indication on how the works are progressing and maturing on the ground.

6.6 Bare Soil Cover

The percentage of soil cover within each quadrat was considered to determine the amount of space unoccupied by planting, weeds, or accumulated vegetative litter. The average bare soil cover for the site was 76%. Two of the quadrats recorded the same bare soil cover as the baseline, while others recorded either an increase or decrease.

Quadrats Q4 and Q5 recorded an increase, as the weed cover of these areas were quite high when the baseline data was recorded. Regular weed control has reduced the weed cover, which has resulted in the bare soil cover increasing. As the weeds have been reduced, it will promote the growth of native seedlings, and encourage natural recruitment in the future.

Quadrat Q3 was the only quadrat to have a decline in the bare soil cover. This is due the existing Peppermints dropping leaves within the quadrat.

7 CONCLUSION

Overall the Offset Area is currently exceeding all of the established completion criteria. Therefore there are no remedial works necessary at this time, other than ongoing monitoring, and weed control to ensure weed levels remain low.

Progress currently exceeds all three completion criteria with regards to plant survival, and no further work is required at this time. However, some plant losses are expected over summer, and survival should be closely monitored in autumn 2015 to determine whether those losses are sufficient to warrant remedial planting in winter 2015.

The average weed cover was well below target at 1%, with no evidence across the site of the species of particular concern: *Zantedeschia aethiopica* (Arum Lily) and *Trachyandra divaricata* (Dune Onion Weed). The most prevalent weed species was *Solanum nigrum* (Nightshade).

Species richness was recorded, even though there is no formal completion criteria, as it can provide quidance for any remedial planting program. The species richness within the quadrats is 74% of the species planted, and all of the planted species not recorded within the quadrats were observed in other parts of the site. This indicates that all species planted are suited to the site conditions and may be appropriate for use in future infill planting.

The native cover has increased significantly from an average of <1% to 3% since the baseline data was collected in May 2013. Although not a completion criterion, native cover was included as future assessments will provide a measure of plant development rates, and this information may be useful for planning future activities.

8 RECOMMENDATIONS

The monitoring data gathered from the site has concluded that the planting is currently on track to achieve the long term project goals. Weeds, off-road activity and predation are the likely factors to affect the progress of the revegetation in these areas. All of these factors should be regularly monitored to ensure maximum survival and growth rates and the keep maintenance to a minimum.

As the Offset Area is currently meeting the completion criteria with respect to seedling survival and weed cover, there are no recommendations or remedial actions required at this stage, other than to continue with the formal and informal monitoring program, and reassess progress after the next assessment.

9 REFERENCES

Natural Area, 2013-1. Department of Health and Department of Finance (Building Management and Works), Tuart Forest Revegetation Management Plan, June 2013 – 39 pages.

Natural Area, 2013-2. Baseline Monitoring Data Busselton Hospital and Tuart Offset Site, May 2014 – 11 pages.

Natural Area, 2013-3. TF Monitoring Point Map, May 2014 – 1 page.

Appendix 1 Site Location

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Project: Busselton Health Campus Tuart Forest Offset
Project Number: P597B
Client: Department of Finance Building Management and Works

Drawing: Tuart Forest Offset Location
Drawing Number: P597B-02
Revision: 0

Date: 06/03/15
Drawn By: MSB

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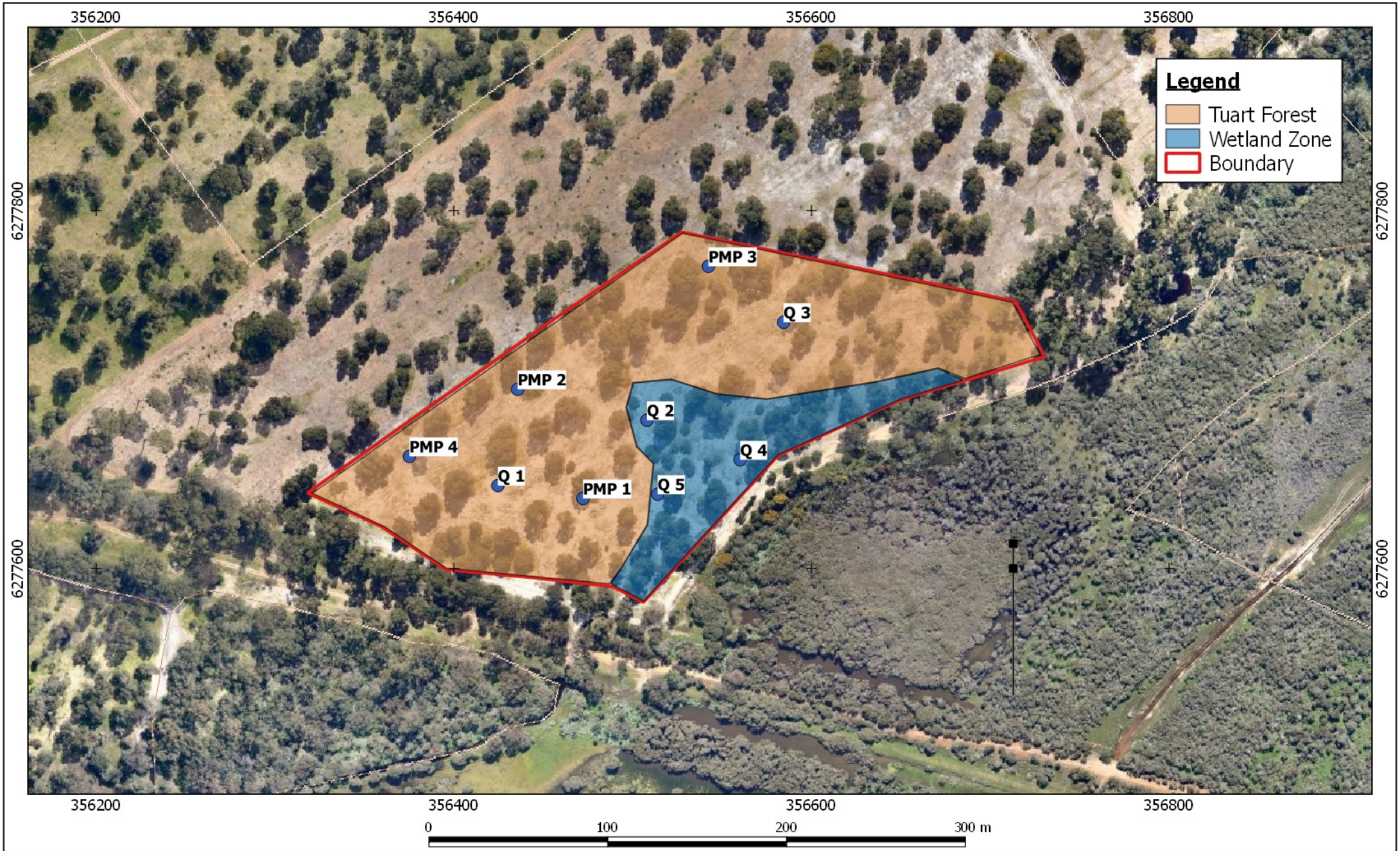
Appendix 2 Monitoring Locations



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Project: BHC Tuart Forest Offset
Project Number: P597B
Client: Department of Finance Building Management and Works

Drawing: Monitoring Locations
Drawing Number: P597B-01
Revision: 0

Date: 27/01/15
Drawn By: MSB

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Appendix 3 Overall Summary of Quantitative Data

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BHC Tuart Forest Offset

Quantitative Data Summary - Spring 2014

Quadrat	Assessed Completion Criteria				Other Data - Seedling Planting				
	Peppermint Seedling Survival (%)	Tuart Seedling Survival (%)	Other Seedling Survival (%)	Elimination of Target Weeds (Y/N)	Total Native Density (plants / $m^{2)}$	Species Richness (%)	Weed Cover (%)	Native Cover (%)	Bare Soil Cover (%)
Completion Criteria	75	75	75	Y	N/A	N/A	N/A	N/A	N/A
Q1	100	N/A	100	Y	1.0	52	2	3	75
Q2	75	N/A	97	Y	1.6	29	1	1	90
Q3	100	100	88	Y	1.1	43	<1	2	50
Q4	N/A	N/A	84	Y	1.3	57	1	4	85
Q5	N/A	N/A	82	Y	0.4	36	0	<1	80
Avg / Total	**85**	**100**	**90**	**Y**	**1.1**	**74**	**1**	**3**	**76**

Appendix 4 Quadrat Raw Data

tranen revegetation southwest

BHC Tuart Offset - Spring 2014
Q1 Dryland

GPS Location	Photo Location
E 357421.23	
N 6277641.56	

Species Planted	Baseline Cover %	% Cover	Seedlings Alive	Seedlings Dead
Acacia pulchella				
Acacia saligna				
Agonis flexuosa			1	
Banksia grandis			3	
Conostylis aculeata			2	
Corymbia calophylla			1	
Dianella revoluta				
Dichopogon capillipes				
Eucalyptus gomphocephala				
Grevillea vestita				
Hakea prostrata				
Hardenbergia comptoniana				
Hibbertia cuneiformis				
Hibbertia racemosa				
Jacksonia furcellata				
Kennedia prostrata				
Lepidosperma gladiatum			7	
Macrozamia reidlei			2	
Phyllanthus calycinus			1	
Rhagodia baccata			2	
Solanum symonii			2	
Sowerbea laxiflora				
Spyridium globulosum				
Other Species Recorded			1	
Kennedia coccinea			1	
Gompholobium ?sp				
Total Species Recorded			23	
			Spring 2014	
Weed Species Recorded				
Solanum nigrum	5%		1	
Arctotheca calendula	10%			
Ehrharta longiflora	1%			
Avena barbata	1%			

NATIVE VEGETATION:		Spring 2014		
HEALTH (RATE 1-5; 1=POOR):	2	3		
ABUNDANCE (% COVER)	0	3		
DENSITY (stems/m^2):	0	1-1.5		
% COVER SOIL	75%	75%		
DIVERSITY (%)	N/A			
WEEDS:				
HEALTH (RATE 1-5; 1=POOR):	4	1		
ABUNDANCE (% COVER) - WOODY	0	0		
ABUNDANCE (% COVER) - NON WOODY	11%	2%		
PRESENCE OF FAUNA	Y	Y		

Comments:

tranen
revegetation southwest

BHC Tuart Offset - Spring 2014
Q2 Wetland

GPS Location	Photo Location
E 356507.8	
N 627785.35	

Species	Baseline Cover %	Cover %	Seedlings Alive	Seedlings Dead
Acacia pulchella				
Acacia saligna				
Agonis flexuosa	0.25		4	1
Banksia grandis				
Billardiera fusiformis				
Corymbia calophylla				
Eucalyptus rudis				
Gahnia trifida				
Hibbertia racemosa				
Juncus pallidus				
Kunzea glabrescens				
Melaleuca incana				
Melaleuca rhaphiophylla				
Viminarea juncea				
Other Species Recorded				
Jacksonia furcellata	0.1		1	
Conostylus acculeata			2	
Trachymene ?sp			30	
Total Species Represented			37	
Weed Species Recorded				
Hypochaeris glabra	10%			
Ehrharta longiflora	6%			

NATIVE VEGETATION:		Spring 2014		
HEALTH (RATE 1-5; 1=POOR):	4	1		
ABUNDANCE (% COVER)	0.5	1		
DENSITY (stems/m^2):	0.25	0.25		
% COVER SOIL	90%	90%		
DIVERSITY (%)	N/A			
WEEDS:				
HEALTH (RATE 1-5; 1=POOR):	5	1		
ABUNDANCE (% COVER) - WOODY	0	1		
ABUNDANCE (% COVER) - NON WOODY	16%	0		
PRESCENCE OF FAUNA	Y	Y		

Comments:

tranen revegetation southwest

BHC Tuart Offset - Spring 2014
Q3 Dryland

GPS Location	Photo Location
E 356572.8	
N 6277745.84	

Species	Baseline Cover %	Cover %	Seedlings Alive	Seedlings Dead
Acacia pulchella				
Acacia saligna				
Agonis flexuosa			2	
Banksia grandis			1	
Conostylis aculeata			3	2
Corymbia calophylla				
Dianella revoluta			1	
Dichopogon capillipes				
Eucalyptus gomphocephala			3	
Grevillea vestita				
Hakea prostrata				
Hardenbergia comptoniana				
Hibbertia cuneiformis				
Hibbertia racemosa			1	
Jacksonia furcellata				
Kennedia prostrata			4	1
Lepidosperma gladiatum			4	
Macrozamia reidlei			1	
Phyllanthus calycinus			1	
Rhagodia baccata				
Solanum symonii				
Sowerbea laxiflora				
Spyridium globulosum				
Other Species Recorded				
Kennedia coccinea			1	
Total Species Represented			22	3
Weed Species Recorded (% Cover)				
Conyza sumatrensis	10%			
Solanum nigrum	10%			
Hypochaeris glabra	25%			
Ehrharta longiflora	4%			
Corrigiola litoralis	5%			

NATIVE VEGETATION:		Spring 2014		
HEALTH (RATE 1-5; 1=POOR):		2		
ABUNDANCE (% COVER)	0	2		
DENSITY (stems/m^2):	0	1		
% COVER SOIL	70%	50%		
DIVERSITY (%)	N/A			
WEEDS:				
HEALTH (RATE 1-5; 1=POOR):	5	1		
ABUNDANCE (% COVER) - WOODY	0	0		
ABUNDANCE (% COVER) - NON WOODY	30%	<1		
PRESENCE OF FAUNA	Y	Y		

Comments:

tranen
revegetation southwest

BHC Tuart Offset - Spring 2014
Q4 Wetland

GPS Location	Photo Location
E 356508.5	
N 6277649.0	

Species	Baseline Cover %	Cover %	Seedlings Alive	Seedlings Dead
Acacia pulchella				
Acacia saligna				
Agonis flexuosa				
Banksia grandis				
Billardiera fusiformis			2	
Corymbia calophylla				
Eucalyptus rudis			4	
Gahnia trifida			13	6
Hibbertia racemosa				
Juncus pallidus			7	
Kunzea glabrescens			1	
Melaleuca incana			3	
Melaleuca rhaphiophylla			1	
Viminarea juncea			1	
Other Species Recorded				
Lyginia barbata	0.1			
Total Species Recorded			32	6
Weed Species Recorded				
Arctotheca calendula	40%			
Solanum nigrum	5%		1	
Ehrharta longiflora	1%			

NATIVE VEGETATION:		Spring 2014		
HEALTH (RATE 1-5; 1=POOR):	4	3		
ABUNDANCE (% COVER)	0.1	4		
DENSITY (stems/m^2):	0	1		
% COVER SOIL	60%	85%		
DIVERSITY (%)	N/A			
WEEDS:				
HEALTH (RATE 1-5; 1=POOR):	5	1		
ABUNDANCE (% COVER) - WOODY	0	0		
ABUNDANCE (% COVER) - NON WOODY	39%	1%		
PRESENCE OF FAUNA	Y	Y		

Comments:

tranen revegetation southwest

BHC Tuart Offset - Spring 2014
Q5 Wetland

GPS Location	Photo Location
E 356559.0	
N 6277665.45	

Species	Baseline Cover %	Cover %	Seedlings Alive	Seedlings Dead
Acacia pulchella				
Acacia saligna				
Agonis flexuosa				
Banksia grandis				
Billardiera fusiformis				
Corymbia calophylla				
Eucalyptus rudis			3	
Gahnia trifida				
Hibbertia racemosa				
Juncus pallidus				
Kunzea glabrescens			2	
Melaleuca incana			1	
Melaleuca rhaphiophylla			1	1
Viminarea juncea			2	1
Other Species Recorded				
Jacksonia furcellata	0.1			
Total Species Represented			9	2
Weed Species Recorded (% Cover)				
Arctotheca calendula	50%			
Ehrharta longiflora	10%			

NATIVE VEGETATION:		Spring 2014		
HEALTH (RATE 1-5; 1=POOR):	5	1		
ABUNDANCE (% COVER)	0.1	<1		
DENSITY (stems/m^2):	0.1			
% COVER SOIL	49%	80%		
DIVERSITY (%)	N/A			
WEEDS:				
HEALTH (RATE 1-5; 1=POOR):	5	0		
ABUNDANCE (% COVER) - WOODY	0	0		
ABUNDANCE (% COVER) - NON WOODY	50%	0%		
PRESENCE OF FAUNA	Y	Y		

Comments: 5 Dead Natives

Appendix 5 Quadrat Photo Records

Quadrat 1

Quadrat 2

Quadrat 3

Quadrat 4

Quadrat 5

Appendix 6 Permanent Monitoring Point Photographs

PMP 1

PMP2

PMP3

PMP4