GHD

Water Corporation - Greenbushes to Kirup Link

Phytophthora Dieback occurrence assessment – Version 0.4

GLEVAN CONSULTING

Disclaimer

This report has been prepared in accordance with the scope of work agreed between the Client and Glevan Consulting and contains results and recommendations specific to the agreement. Results and recommendations in this report should not be referenced for other projects without the written consent of Glevan Consulting.

Procedures and guidelines stipulated in various Department of Environment and Conservation and Dieback Working Group manuals are applied as the base methodology used by Glevan Consulting in the delivery of the services and products required by this scope of work. These guidelines, along with overarching peer review and quality standards ensure that all results are presented to the highest standard.

Glevan Consulting has assessed areas based on existing evidence presented at the time of assessment. The Phytophthora pathogen may exist in the soil as incipient disease. Methods have been devised and utilised that compensate for this phenomenon; however, very new centres of infestation, that do not present any visible evidence, may remain undetected during the assessment.

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1 Summary

The Water Corporation's Warren–Blackwood Regional Water Supply Scheme is undergoing significant upgrades to meet the long-term supply needs of Boyup Brook, Hester, Greenbushes, Balingup, Mullalyup, Kirup, Bridgetown, Nannup and Manjimup.

The Warren–Blackwood area is dominated by surface water sources, with limited groundwater available. Nine local surface water sources contribute to the scheme, as well as one groundwater bore, which is licenced to take up to 1.09 billion litres per year, from the Yarragadee Aquifier (Water Corporation, n.d.).

One project as part of this program, is the Greenbushes to Kirup Link, a twenty-three kilometre link between Greenbushes and Kirup (Figure 1). Glevan Consulting assessed the vegetation within and adjacent to this corridor (the Project Area) for the presence of the disease caused by Phytophthora Dieback. The Project Area has six components, being:

Kirup Dam Bypass	Line Road, Kirup
Mullalyup Tank Site	3km west of Mullalyup
Balingup Tank Site	1.5km south of Balingup
Northern Alignment	Mullalyup to Balingup
Southern Alignment Part A	Old Padbury Road, Balingup
Southern Alignment Part B	Hay Road, Balingup to southern terminus.

The Project Area covered 16.49 hectares, of which 5.14 hectares was assessable.

The assessment was conducted by Evan Brown of Glevan Consulting in August 2017.

The Project Area generally receives greater than 1000mm of annual rainfall and contains nine vegetation structures (Table 3). All assessable vegetation was restricted to the Kirup, Dwellingup and Catterick vegetation structures which include (cumulatively) Phytophthora Dieback indicating species within the *Xylomelum, Banksia, Persoonia, Leucopogon, Macrozamia, Adenanthos* and *Xanthorrhoea* families.

The Kirup Dam Bypass and Mullalyup Tank site are both classified as Infested. One section of the Northern Alignment is Uninterpretable. The Southern Alignment Part B has two Infested

sections, two sections being Temporarily Uninterpretable (recently burnt), and one section of Uninfested and Uninterpretable.

The remaining areas are Excluded from the assessment (Table 2).

2 Introduction

2.1 Background

The Water Corporation's Warren–Blackwood Regional Water Supply Scheme is undergoing significant upgrades to meet the long-term supply needs of Boyup Brook, Hester, Greenbushes, Balingup, Mullalyup, Kirup, Bridgetown, Nannup and Manjimup.

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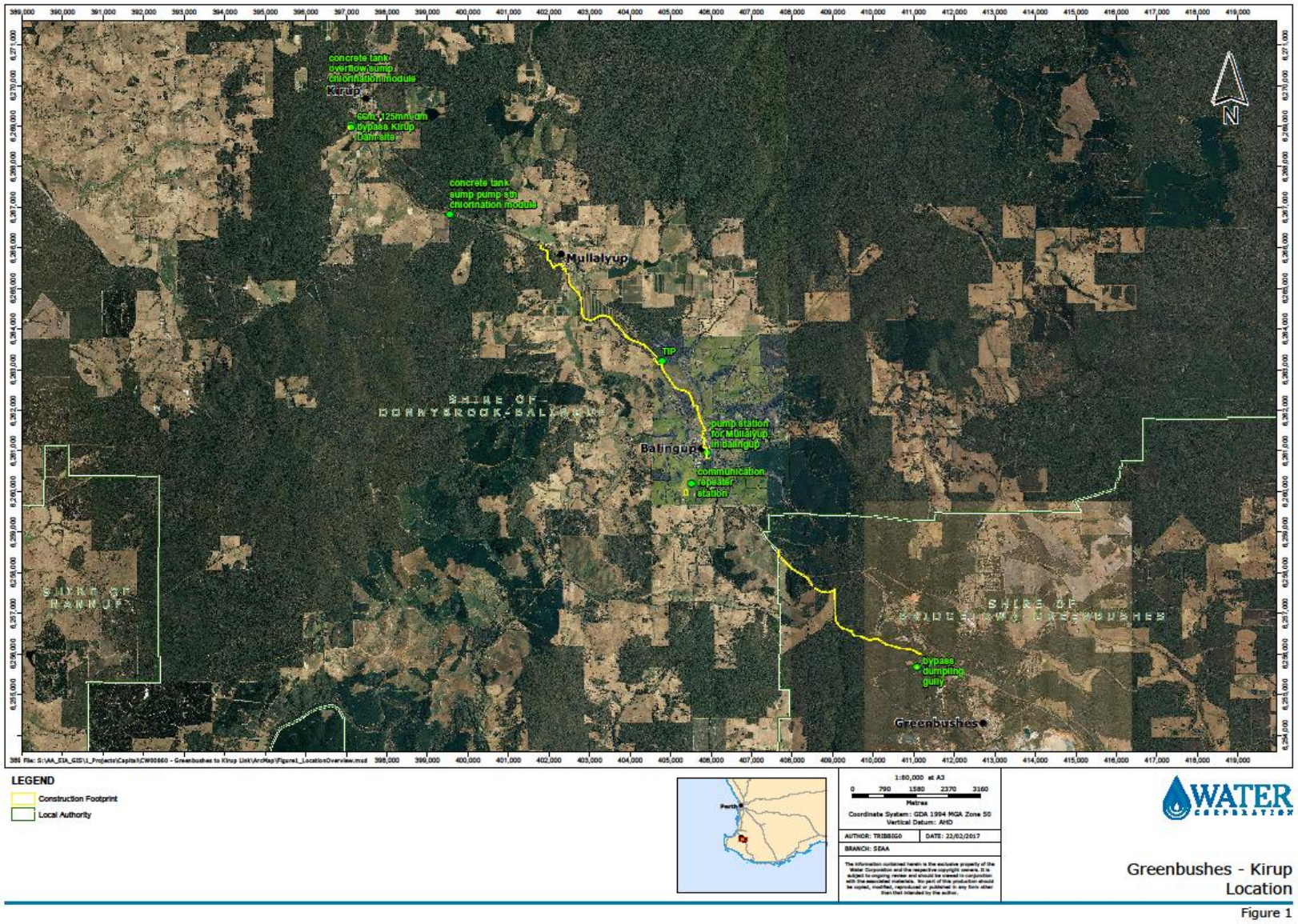

Figure 1 - Project overview (supplied by GHD)

2.2 Location of Project Area.

The Project Area has six components, being:

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Northern Alignment	Mullalyup to Balingup
Southern Alignment Part A	Old Padbury Road, Balingup
Southern Alignment Part B	Hay Road, Balingup to southern terminus.

2.3 Study team

The assessment was conducted by Evan Brown of Glevan Consulting in August 2017. Mr Brown is registered with the Department of Biodiversity, Conservation and Attractions (DBCA) in the detection, diagnosis and mapping of Phytophthora Dieback. This registration recognises the skills and experience of Mr Brown.

3 Phytophthora Dieback

The pathogen *Phytophthora cinnamomi* is an agent of environmental disease found in vulnerable areas of Western Australia.

Phytophthora Dieback is the common name for the observable disease result of interaction between the pathogen (*P. cinnamomi*) and the vegetation hosts (susceptible plant species within vulnerable areas). The environment conditions of the site significantly affect the pathogens ability to survive or flourish and spread over time.

All land with an annual average rainfall of more than 400 millimetres and suitable soil composition is considered vulnerable to Phytophthora Dieback. This large area stretches approximately from Perth, Bunbury and Augusta in the west to Narrogin, Ravensthorpe and Esperance in the east, and as far north as Kalbarri.

This vulnerable area has many different bioregions, having specific characteristics of each having been formed by climate and geology. These two factors are highly significant in determining the pathogen's effectiveness and resulting disease impact levels.

3.1 The Pathogen

Phytophthora cinnamomi is a microscopic water mould. It belongs to the class Oomycetes and belongs in the Kingdom Stramenopila. It is more closely related to brown algae than to true fungi.

Oomycetes organisms occupy both saprophytic and pathogenic lifestyles however *P. cinnamomi* is considered parasitic. It behaves largely as a necrotrophic pathogen causing damage to the host plant's root tissues because of infection and invasion.

The life cycle of *Phytophthora cinnamomi* is a continuous circle of infection, sporulation and further infection and is readily vectored by animals and human activity allowing for rapid invasion into new areas.

3.2 Host

A population of hosts is made up of susceptible, infected and immune or resistant individuals. The infection of host plants is an unseen activity happening constantly beneath the soil at an infested site.

The environmental conditions favouring or disfavouring the pathogen may change at a critical point during disease development, temporarily changing the rates of infection and invasion. This can be observed symptomatically after soil temperature change through winter months.

The plant host is a highly variable component of the disease development. Sites may range from having no susceptible host. Within vulnerable areas, three main family groups are regarded as highly susceptible to Phytophthora Dieback disease, being:

- Proteaceae
- Ericaceae
- Xanthorrhoeaceae.

3.3 Environment

Two fundamental environmental characteristics influencing Phytophthora Dieback disease are rainfall and soil.

Areas vulnerable to Phytophthora Dieback are defined as native vegetation which occur west of the 400-millimetre rainfall isohyet. The correlation of increased Phytophthora Dieback impact with increased annual rainfall is generally applicable.

Certain soil properties influence Phytophthora Dieback disease development within the vulnerable areas:

1. Moisture is critical for *Phytophthora cinnamomi* to survive in the soil and for sporangia production.
2. Soil pH affects the growth and reproduction of the pathogen. The calcareous sands closest to the coast are alkaline and hostile to *Phytophthora cinnamomi,* but are favourable to *P. multivora.*
3. Fertile soils are less favourable to Phytophthora Dieback because the richness of nutrients aids strong host resistance, good soil structure allows water movement and drainage, and high organic matter provides antagonistic microflora.
4. Coarse-textured soils have larger pore spaces which favour dispersal of spores.
5. The optimum temperature for *Phytophthora cinnamomi* sporulation is 21 to 30°C, peaking at 25°C., but some sporangia can still be produced at temperatures as low as 12°C. The optimum growth range is 15 to 30°C and temperatures lower than 5°C or greater than 35°C are unfavourable for the persistence of survival of spores and the vegetative mycelia of *P. cinnamomi.* (Department of Parks and Wildlife, 2015)

4 Methods

4.1 Pre survey desktop study

Known databases of *Phytophthora* locations retained by Glevan Consulting and Vegetation Health Services (DBCA) were searched to determine previous recoveries of *Phytophthora* within the project area.

Previous Phytophthora Dieback Occurrence reports and maps pertaining to the study area were also studied prior to undertaking the field work.

4.2 Interpretation

Based on the considerations of Section 3 'Phytophthora Dieback', the personnel involved in the field work determined the presence of Phytophthora Dieback based on symptoms and disease signatures displayed in susceptible vegetation. These symptoms are supported through the strategic sampling and subsequent recovery of Phytophthora from soil and tissue samples taken during the assessment.

The detection of the plant pathogen Phytophthora Dieback involves the observation and interpretation of plant deaths (or reduction of biomass or perceived temporal change in vegetation structure) using a logical assessment of factors that imply pathogen presence above other possible causes of plant deaths or vegetation change. A combination of the following factors may indicate the presence of disease caused by *Phytophthora* Dieback or other *Phytophthora* species.

<u>Deaths of disease indicating species:</u>

An indicator species is a plant species, which is reliably susceptible to Phytophthora Dieback (i.e. will die). Common indicators include several species of *Banksia, Patersonia*, *Persoonia*, and *Xanthorrhoea*. The distribution and composition of indicator species will vary from place to place according to vegetation types.

Chronology of deaths:

As the pathogen spreads through an area, some or all susceptible plants become infected and die. Consequently, there will be an age range from more recent deaths with yellowing or brown leaves through to older leafless stags to remnant stumps in the ground.

Pattern of deaths:

The topography, soil type, vegetation type and drainage characteristics of an area together with the influence of climatic patterns and disturbances will influence the shape or pattern of an infested area over time. A typical recent infestation may show a small cluster of dead indicator species which, in time, will spread to become a small circular shape 'the ulcer effect' and then begin lengthening towards natural drainage channels. A fringe of recent deaths is often seen around the edge of the infested area. Patterns may be further highlighted by a paucity of ground cover within the infested area.

Other causes of indicator species death:

Phytophthora cinnamomi is not the only agent to cause death of native vegetation. Other agents include, but are not limited to:

- other *Phytophthora* spp, *Armillaria luteobubalina*, various cankers, insects;
- drought, wind scorch, frost, salinity, water logging, fire and lightning;
- senescence, competition, physical damage;
- herbicides, chemical spills (for example fuel).

Based on the field assessment, the Project Area can be distributed to the following occurrence categories (Department of Parks and Wildlife, 2015).

Table 1 - Phytophthora Dieback occurrence categories

Vegetated area	Infested	Areas that have plant disease symptoms consistent with the presence of Phytophthora Dieback
	Uninfested	Areas free of plant disease symptoms that indicate the presence of Phytophthora Dieback.
	Uninterpretable	Areas where indicator plants are absent or too few to determine the presence or absence of Phytophthora Dieback.

	Temporarily Uninterpretable	Areas that are sufficiently disturbed so that Phytophthora Dieback occurrence mapping is not possible at the time of inspection.
	Not yet resolved	Areas where the interpretation process has not confidently determined the status of the vegetation.
Non-vegetated area	Excluded	Areas devoid of vegetation are excluded from the assessment area.

4.3 Demarcation of hygiene boundaries

Phytophthora Dieback infestations were demarcated with day-glow orange flagging tape. A single band of tape was tied to a suitable tree with the knot facing towards the infestation. The Uninterpretable boundaries were denoted with black and pink tiger tape. The taped boundaries were positioned approximately 15m outside the infested or uninterpretable areas, to provide the required buffer zone, and placed approximately 10 -15m apart.

4.4 Mapping

Subsequent to hygiene boundary demarcation, the boundaries were again walked and recorded utilising a handheld GPS. The recorded data was then transferred to a desktop computer and used to produce the relevant maps.

4.5 Limitations of disease mapping

The assessment for the disease caused by Phytophthora Dieback is based on interpreting the vegetation for symptoms which can be ascribed to the disease presence. These observable factors must be present during the assessment period. Management recommendations may be included if it is considered that the disease may be cryptic, or the project area displays evidence of activities that are considered a high risk of introducing the disease.

The validity of the hygiene boundaries mapped for this project is twelve months from the completion of this project. All boundaries should be reassessed by August 2018 if activities are still occurring beyond this time.

5 Project area environmental data

5.1 Rainfall

The Project Area generally receives greater than 1000mm of annual rainfall.

5.2 Vegetation structure

The Project Area contains nine vegetation structures (Table 3), as mapped for the Regional Forest Agreement (Mattiske & Havel, 1998). These are:

- Balingup
- Bridgetown
- Kirup
- Mumballup
- Queenwood
- Dwellingup, and
- Catterick.

All assessable vegetation was restricted to the Kirup, Dwellingup and Catterick vegetation structures. Phytophthora Dieback indicating species within this vegetation include:

- *Xylomelum occidentale,*
- *Banksia grandis*
- *Persoonia longifolia*
- *Leucopogon propinquus,*
- *Leucopogon verticillatus,*
- *Macrozamia riedlei,*
- *Banksia littoralis,*
- *Adenanthos obovatus, and*
- *Leucopogon australis subsp. acutifolius.*

6 Results

The Kirup Dam Bypass and Mullalyup Tank site are both classified as Infested. One section of the Northern Alignment is Uninterpretable. The Southern Alignment Part B has two Infested sections, two sections being Temporarily Uninterpretable (recently burnt), and one section of Uninfested and Uninterpretable.

The remaining areas are Excluded from the assessment (Table 2).

Table 2 - Area Summary

Category	Area (ha)	% of total area
Infested (with *P. cinnamomi*)	2.32 ha	14.05 %
Uninfested	0.70 ha	4.23 %
Temporarily Uninterpretable	1.08 ha	6.57 %
Uninterpretable	1.04 ha	6.32 %
Excluded	11.35 ha	68.83 %
TOTAL AREA	16.49 ha	

7 Discussion

Balingup Tank Site

The Balingup Tank Site (Map 1) contains no assessable vegetation and has been classified as Excluded.

Mullalyup Tank Site

The Mullalyup Tank Site (Map 2) contains vegetation that is displaying the symptoms of Phytophthora Dieback and is classified as Infested.

Kirup Dam Bypass

The Kirup Dam Bypass (Map 3) contains vegetation that is displaying the symptoms of Phytophthora Dieback and is classified as Infested.

Northern Alignment

The Northern Alignment (Map 4) extends from just north of Mullalyup to the southern end of the Balingup townsite.

One section of the route is vegetated however this vegetation did not contain a sufficient density of species to allow the confident assessment for the presence of Phytophthora Dieback and has been classified as Uninterpretable. The remainder of this section is Excluded.

Southern Alignment Part A

The Southern Alignment Part A (Map 5) extends south from the Padbury Reservoir and follows Padbury Road to the rail reserve, just west of Hay Road.

The entire section is Excluded as there is no assessable vegetation along the route. The majority of the route has been given to plantations and cleared road reserve.

Southern Alignment Part B

The Southern Alignment Part B (Map 6) extends from just west of Hay Road, through Greenbushes forest block and terminates at Reserve R6890.

The section from the rail reserve to Hay Road has recently been burnt and has been classified as Temporarily Uninterpretable.

From Hay Road and south along the western edge of the Greenbushes forest block are numerous deaths of Phytophthora Dieback indicating species, particularly within the *Banksia* and *Xanthorrhoea* families. This section has been classified as Infested.

A section from just west of the Bibbulmun Track to the creek just west of Greenbushes Loop has been classified as Temporarily Uninterpretable as it had been recently burnt.

A small section of infested vegetation has been demarcated adjacent to the creek that flows in from the east, on the northern side of Greenbushes Loop.

The southern end has been classified as Uninterpretable. Although pockets of vegetation exist with Phytophthora Dieback indicating species present, their location is sporadic and discontinuous.

8 Recommendations

- Soil and plant material of infested or unknown dieback status should not be introduced to uninfested or unmappable sections of the study area.

- Soil and plant material should not be transported from the infested or unmappable sections of the study area for use at any other protectable area site.

- Soil movement within each category is permissible, but should not occur across category boundaries, except where the source is uninfested.

- Vehicles and machinery should be clean upon entry into any of the site categories (except infested), and when moving across category boundaries. Moving from uninfested areas into other categories does not require clean down measures.

- Restrict access, where possible, to dry soil conditions only. Where vehicles or machinery are required to access the area during, or shortly after rainfall, they must carry clean down equipment, and remove any soil or plant material at designated hygiene points.

9 Bibliography

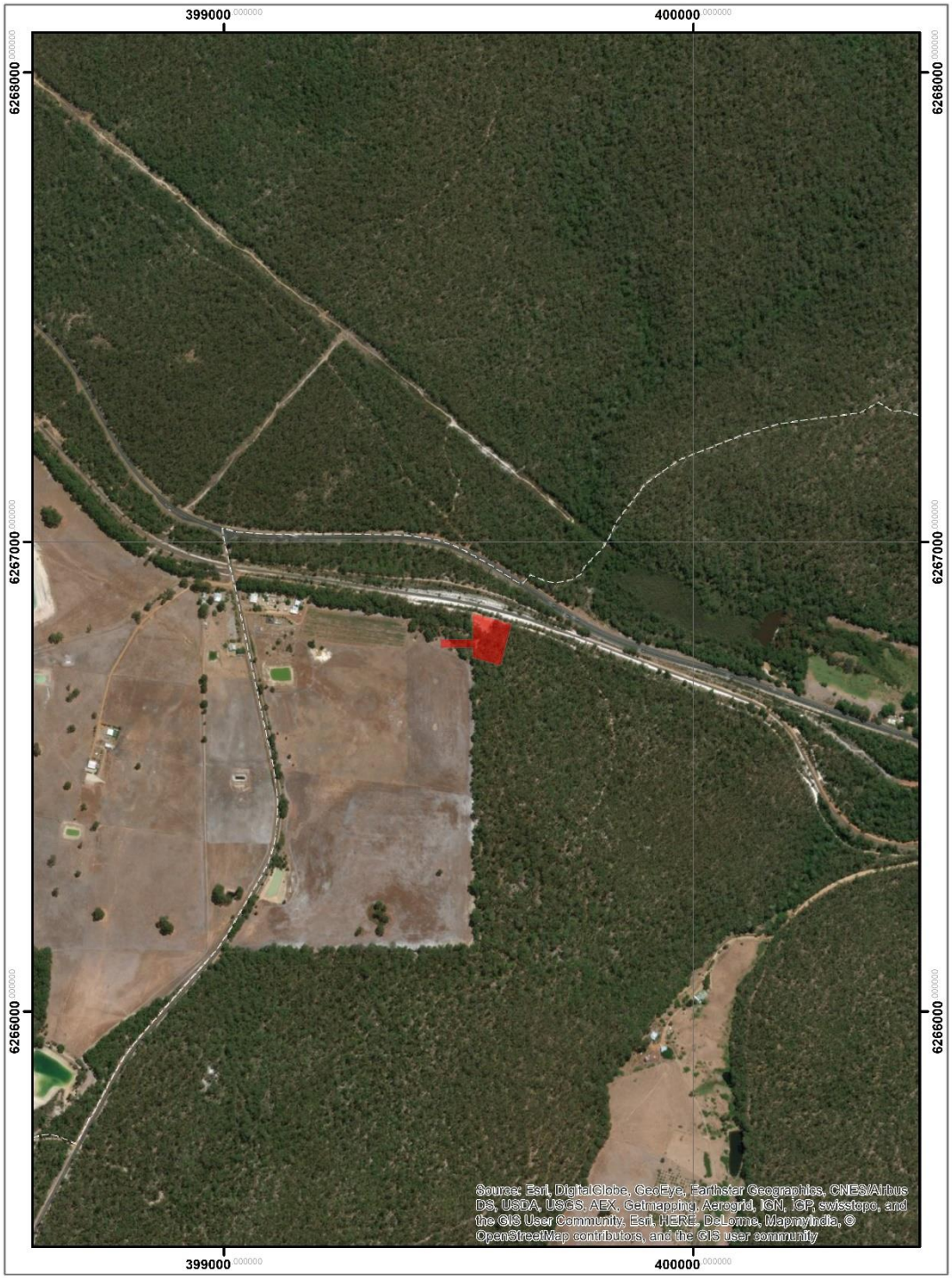
Department of Parks and Wildlife. (2015). *FEM047 Phytophthora Dieback Interpreter's Manual for lands managed by the department.* Unpublished.

Mattiske, E., & Havel, J. (1998). *Regional Forest Agreement Vegetation Complexes.* Unpublished report for Department of Conservation and Land Management.

Water Corporation. (n.d.). *Warren-Blackwood regional water supply scheme*. Retrieved from https://www.watercorporation.com.au/water-supply/ongoing-works/warren-blackwood-regional-water-supply-scheme

10 Appendix – Phytophthora occurrence map

Map 1 - Balingup Tank Site



Map 2 - Mullalyup Tank Site

Map 3 - Kirup Dam Bypass

Map 4 - Northern Alignment

Map 5 - Southern Alignment Part A

Map 6 - Southern Alignment Part B

11 Appendix – Vegetation Structures

Table 3 - Vegetation structures in Project Area

Code	Vegetation structure	Description		
		Over-storey	Mid-storey	Herbs and shrubs
BL	Balingup	Open Forest of *Eucalyptus marginata* subsp. *marginata* and *Corymbia calophylla*	*Banksia grandis* and *Persoonia longifolia*	*Macrozamia riedlei, Bossiaea ornata, Pteridium esculentum, Hibbertia hypericoides, Leucopogon capitellatus, Leucopogon verticillatus, Hibbertia amplexicaulis* and *Opercularia hispidula* var. *pauciflora*
BLf	Balingup	Open Forest of *Corymbia calophylla* and *Eucalyptus marginata* subsp. *marginata* with *Eucalyptus patens* on lower slope	*Mirbelia dilatata* approaching the size of a small tree, on lower slope	*Hibbertia hypericoides, Acacia lateriticola, Xanthorrhoea preissii, Hakea lissocarpha, Leucopogon capitellatus, Hypocalymma angustifolium, Macrozamia riedlei, Lepidosperma squamatum* and *Leucopogon propinquus*
BT	Bridgetown	Woodland of *Corymbia calophylla* on deeper soils to Heath on shallow soils	No second storey	*Xanthorrhoea preissii, Leucopogon capitellatus, Leucopogon propinquus, Leucopogon verticillatus, Hakea lissocarpha* and *Calothamnus quadrifidus*
KR	Kirup	Open Forest of *Eucalyptus marginata* subsp. *marginata*	Strong development of *Xylomelum occidentale,* less *Banksia grandis*	*Bossiaea linophylla, Acacia extensa, Pteridium esculentum, Hibbertia hypericoides, Phlebocarya ciliata, Philotheca spicata, Gompholobium tomentosum, Hibbertia racemosa, Opercularia hispidula var. pauciflora* and *Conostylis serrulata*
ML	Mumballup	Open Forest of *Melaleuca rhaphiophylla* and *Eucalyptus rudis* on river banks/ flats, *Eucalyptus patens* and *Corymbia calophylla* on terraces	Minor development of *Banksia littoralis* and *Paraserianthes lophantha* subsp. *lophantha*	*Taxandria linearifolia ms, Trymalium floribundum, Astartea fascicularis, Gahnia trifida, Lepidosperma tetraquetrum, Pteridium esculentum, Viminaria juncea* and *Hypocalymma angustifolium*
QW	Queenwood	Open Forest of *Eucalyptus marginata* subsp. *marginata* and *Corymbia calophylla*	*Banksia grandis* and *Persoonia longifolia*	*Acacia extensa, Acacia lateriticola, Hibbertia hypericoides, Bossiaea eriocarpa, Bossiaea ornata, Lepidosperma squamatum, Leucopogon capitellatus,*

				Patersonia umbrosa var. xanthina and *Styphelia tenuiflora*
D1	Dwellingup	Open Forest of *Eucalyptus marginata* subsp. *marginata* and *Corymbia calophylla*	*Allocasuarina fraseriana, Banksia grandis* and *Persoonia longifolia*	*Acacia browniana, Hovea chorizemifolia, Leucopogon propinquus, Lasiopetalum floribundum, Leucopogon verticillatus* and *Macrozamia riedlei*
CC1	Catterick	Open Forest of *Eucalyptus marginata* subsp. *marginata* and *Corymbia calophylla*	*Banksia grandis* and *Banksia littoralis*	*Acacia extensa, Adenanthos obovatus, Leucopogon australis subsp. acutifolius, Hypolaena exsulca, Pericalymma ellipticum, Johnsonia lupulina, Hibbertia hypericoides* and *Tetraria octandra*