

## Roe 8 Highway Extension

Botanical analysis and report prepared for the Urban Bushland Council WA  
September 2013

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### Flaws in the vegetation unit analysis and conservation significance assessment of vegetation mapped in the study area (Section 6.2 AECOM, 2011)

There are **three major concerns** about how AECOM (2011) analysed the conservation significance of ALL of the vegetation in the Study Area. These concerns are best illustrated by the unscientific way that the Roe Swamp vegetation data was analysed (as explained below). A lack of scientific rigour and a failure to access essential, regional/contextual floristic data and to include this in the vegetation conservation value analysis, lead AECOM (2011) to discount the high conservation value of the rare vegetation in Roe Swamp as “Well Reserved” and “Low Risk” despite this vegetation having overwhelming floristic indications of being a Threatened Ecological Community (Endangered) that is currently listed under the EPBC Act.

**Further investigations** and analyses are required to validly survey, record and assess the conservation values and assess the risks posed by the proposed development, particularly in the area of Roe Swamp. Apart from the shortfalls in the flora and vegetation study, as introduced above, there is an acknowledged and serious gap in the stratigraphic/ hydrological and invertebrate fauna data for the centre of Roe Swamp and other wetlands in the study area (Syrinx and VCSRG, 2011; Phoenix Environmental Sciences, 2010) and this gap requires to be addressed by further field investigations to resolve this issue. The required investigations (botanical, stratigraphic /hydrological and faunal) are also briefly outlined below.

**Concern 1:** There was no attempt made by AECOM (2011) to actually classify any of the vegetation they surveyed by appropriate methods (e.g. numerical analysis) in the context of all of the Floristic Community Types (FCTs) of the Swan Coastal Plain that have been defined in the regional dataset of Gibson et al. (1994) Swan Coastal Plain Survey and the Supplementary Data in the System 6 and Part 1 Update Programme to the latter (Department of Environmental Protection, 1996, 1998 and 2000).

Instead, AECOM state that they analysed their vegetation data and assigned it to FCTs (Appendix E) by inference against only FCTs (1a-30c) of Gibson et al. (1994). This is not a rigorous method as it does not provide a measure of statistical significance for the results obtained, as would be available if valid multivariate methods for such analyses had been used (e.g. a similarity matrix constructed from the combined AECOM, Gibson et al. (1994) and DEP (1996, 1999 and 2000) data; followed by a cluster analysis on this matrix; and then a SIMPROF test to determine the significance of the resulting clusters). A dendrogram showing the statistically significant clustering of vegetation units (produced by applying the methods above) would also have illustrated the results of the analysis in a way that would have communicated outcomes more clearly to regulators and the public.

**Concern 2:** Using the inference method, AECOM (2011) assigned FCTs to many of their vegetation units on the basis of very low levels of correspondence (16-30%) between the taxa they recorded in their mapping units and the taxa of high consistency that Gibson et al (1994) presented in their Table 12 to describe FCTs.

It is notable that, of all the vegetation units in the Study Area assigned to FCTs by AECOM (2011), the Roe Swamp vegetation units supported the highest flora conservation values of the entire Study Area (*i.e.* numerous taxa of Priority listed taxa and taxa of other conservation

significance). This should have alerted even inexperienced botanists to assess their analysis results more cautiously. However AECOM (2011) proceeded to assign the Roe Swamp vegetation units hosting these rare assemblages to FCT 11 (a well reserved and common FCT) on the lowest levels of correspondence (16-19%) with FCT 11 in Gibson *et al.* (1994) of any FCT in this study.

The vegetation units defined and mapped by AECOM (2011) in Roe Swamp were ErCtS, ErMpAfS, ErMpGeS, ErMpH, MpBaS and TBS.

In Appendix E in AECOM (2011), it can be seen that only **16%** of species recorded in Vegetation Unit ErCtS by AECOM were flora taxa of high consistency in Floristic Community Type 11 (see also Appendix 1, Table A1, below).

Similarly there was only **19%** correspondence between species recorded in Vegetation Unit ErMpAfS in AECOM (2011) with Floristic Community Type 11.

There was only **16%** correspondence between species recorded in Vegetation Unit ErMpGeS in AECOM (2011) with Floristic Community Type 11.

There was only **18%** correspondence between species recorded in Vegetation Unit ErMpH in AECOM (2011) with Floristic Community Type 11.

There was only **30%** correspondence between species recorded in Vegetation Unit MpBaS in AECOM (2011) with Floristic Community Type 11.

The TBS Vegetation Unit was not assigned to a FCT as AECOM (2011) considered it to be “degraded” despite it supporting a native sedge (*Baumea articulata*/ *Baumea vaginalis*) assemblage that is very rare on the Swan Coastal Plain. *Baumea vaginalis* is rare on the SCP with only seven records on the SCP and some of these records being old historical collections from areas, such as the suburb of Subiaco, where this vegetation has now been totally removed (WA Herbarium, 1998-). The coincidence of these two *Baumea* species in the well-developed sedgeland of an extant wetland is very significant. The only known FCT where both of these species coincide is Floristic Community Type S17: *Eucalyptus rudis*- *Taxandria linearifolia* (= *Agonis linearifolia*) wetlands in Bassendean Dunes.

This assessment of the vegetation units of Roe Swamp by AECOM (2011) effectively tried to “shoe-horn” the high conservation value/rare vegetation of Roe Swamp into the Well Reserved and Low Risk, Floristic Community Type 11 that obviously bore very little floristic similarity to the fine mosaic of vegetation (including many species that are rare on the SCP) that occurs in Roe Swamp. This was done, most probably, because of the lack of experience of AECOM (2011) in vegetation analysis, inappropriate and cursory analysis method used and a failure to consider the supplementary data of very important Swan Coastal Plain FTCs contained in Department of Environmental Protection (1996).

**Concern 3:** AECOM (2011) totally failed to consider essential information contained in the System 6 and Part 1 Update (Department of Environmental Protection, 1996 and 1998-2000) that became available after Gibson *et al.* (1994) was published. AECOM (2011) assessed the vegetation units in the Study Area against the Gibson *et al.* (1994) regional dataset ONLY. Therefore the analysis was carried out against only the FCTs (1a - 30c), as documented in Appendix E (AECOM, 2011).

In the Department of Environmental Protection (1996 and 1998-2000) updates, several Supplementary FCTs of the Swan Coastal Plain were identified and several of these have since

been listed as Endangered under the Federal EPBC Act. One of these Supplementary FCTs bears a striking floristic resemblance to the vegetation of Roe Swamp. This FCT is:

Floristic Community Type S17: *Eucalyptus rudis*- *Taxandria linearifolia* (= *Agonis linearifolia*) wetlands in Bassendean Dunes.

FCT S17 is listed in Table 6, page 29, Volume 2 of the Bush Forever Report (Government of Western Australia, 2000) as Rare in the Perth Metropolitan Region. It is recognised as one of the Seasonal Wetlands Group of FCTs.

**FCT S17 is also currently listed as a Threatened Ecological Community (Endangered) under the EPBC Act as: *Assemblages of Organic Mound (Tumulus) Springs of the Swan Coastal Plain***

The additional data contained in Department of Environmental Protection (1996 and 1998-2000) Updates should have been used by AECOM (2011) in their assessment of the conservation significance of vegetation units in the Study Area (and particularly in their assessment of the vegetation of Roe Swamp).

## **B. Background information of the EPBC Act listed Threatened Ecological Community: *Assemblages of Organic Mound (Tumulus) Springs of the Swan Coastal Plain.***

There are very few remaining springs that have retained their native vegetation on the Swan Coastal Plain (Department of Environment and Conservation, 2005). The four known locations of these springs, to date, are all at the interface of the Bassendean Dunes and the Pinjarra Plain north of the Swan River in the Ellenbrook-Bullsbrook area. The springs are characterised by complex hydrology and stratigraphy that maintain this restricted habitat. They provide a permanently moist refuge (buffered against climatic change by the fine scale hydrology of these habitats) for specific assemblages of flora and invertebrate fauna that are unique, rare or uncommon in the warm Mediterranean climate of Perth. The relictual invertebrate fauna of these habitats may, historically, have had a wider distribution in the past (Department of Environment and Conservation, 2005). There is a high level of heterogeneity and endemism in the fauna associated with the individual springs; common groups include Ostracoda, Nematoda, Acarina, Amphipoda, Cladocera, Copepoda, Decapoda, Oligochaeta, Annelida, Tardigrada, Turbellaria and Insecta.

The Floristic Community Type of these springs was not sampled in Gibson *et al.* (1994) but was recorded later by the Department of Environmental Protection (1996 and 1998-2000) as a supplementary FCT:

S17: *Eucalyptus rudis* - *Taxandria linearifolia* (= *Agonis linearifolia*) wetlands in Bassendean Dunes.

These springs often include the following overstorey species *Banksia littoralis*, *Eucalyptus rudis*, *Melaleuca preissiana* and *Taxandria linearifolia*. Common understorey species include the shrubs *Astartea scoparia* and *Taxandria linearifolia*, Bracken Fern (*Pteridium esculentum*) and sometimes another fern *Cyclosorus interruptus* (which is rare in WA except for the humid Kimberley region) and the club moss *Lycopodium serpentium*. The ground layer of this TEC often comprises an

assemblage of liverworts (non-vascular plant species) that may include *Riccardia aequicellularis*, *Jungermannia inundata*, *Goebelobryum unguiculatum* and *Hyalolepidozia longiscypha*.

Many of the understorey plant species recorded from the TEC occurrences can be considered as indicator species for this habitat as, apart from their occurrences in the TEC springs (and in more humid regions of Western Australia, particularly the Warren region) they are rare on the Swan Coastal Plain. These indicator species include the two listed Priority Species *Cyathochaeta teretifolia* (P3) and *Tetraria* sp. Chandala G J Keighery 17055 (P2), *Aotus cordifolia*, *Baumea rubiginosa*, *Baumea vaginalis*, *Cyclosorus interruptus*, *Gastrolobium ebracteolaum* and *Taxandria linearifolia*.

[See Appendix 2, below, for a more complete TEC flora list that includes current nomenclature and also shows the taxonomic synonyms under which some of these species were previously known].

The Roe Swamp vascular plant assemblage is conspicuously similar to the assemblages found in the currently listed TEC occurrences. However, unlike some of the listed TEC occurrences in which the vegetation is somewhat degraded and species-depauperate, Roe Swamp includes most of the otherwise regionally uncommon, plant species that are associated with the TEC, all together in one swamp. Only *Hibbertia perfoliata* and *Cyclosorus interruptus*, found in some (but not all) of the spring occurrences are absent from the vascular flora of Roe Swamp.

For example, Roe Swamp includes *Aotus cordifolia*, *Baumea vaginalis*, *Cyathochaeta teretifolia*, *Gastrolobium ebracteolaum*, *Taxandria linearifolia* and the very uncommon *Tetraria* sp. Chandala G J Keighery 17055. [Significant areas of the understorey of Roe Swamp are in fact dominated by the sedges *Cyathochaeta teretifolia* and *Tetraria* sp. Chandala G J Keighery 17055, however this was not recognised in AECOM (2011) or Syrinx Environmental and V & C Semeniuk Research Group (2011) due to inexperience of personnel deployed in the field for the flora surveys].

Roe Swamp also includes a host of the more common species of the SCP that are also associated with the TEC including *Astartea scoparia* (= *Astartea fascicularis*), *Banksia littoralis*, *Baumea articulata*, *Baumea juncea*, *Eucalyptus rudis*, *Lepidosperma longitudinale*, *Melaleuca preissiana* and *Pteridium esculentum* (AECOM, 2011).

The aquatic invertebrates, detailed stratigraphy/hydrology and non-vascular plants of Roe Swamp were not surveyed in the current surveys of Roe Swamp (Phoenix Environmental Sciences 2010; AECOM, 2011; Syrinx and V & C Semeniuk Research Group, 2011).

The aquatic invertebrates and stratigraphy/hydrology of the centre of Roe Swamp were not surveyed (Phoenix Environmental Sciences 2010; Syrinx and V & C Semeniuk Research Group, 2011) due to (respectively) very dry weather and the lack of permission to drill in central parts of the wetland due to indigenous issues. There are however initial indications from Phoenix Environmental Sciences (2010) and Syrinx and V & C Semeniuk Research Group (2011) respectively, that Roe Swamp includes deep peat layers and exists within a complex stratigraphic/hydrological setting (at the interface of the Bassendean Dunes and Spearwood Dune limestone) where springs similar to those in the TEC may be present.

### **C. Additional Investigations Now Required**

Additional investigations, as listed below, are required in (at least) Roe Swamp with regard to investigating the occurrence and extent of the EPBC-listed Endangered TEC [*Assemblages of*

*Organic Mound (Tumulus) Springs of the Swan Coastal Plain*] in this area as the first step in assessing the impacts of the proposed road extension works.

1. The flora and vegetation of Roe Swamp require re-survey at Level 2 and field mapping at a fine scale (e.g. 1:2,500) by specialist Swan Coastal Plain wetland botanists. These botanists should be capable of recognizing (in the field) all of the rare and poorly-known Cyperaceae and other significant and often uncommon vascular flora taxa associated with freshwater springs (including *Aotus cordifolia*, *Baumea articulata*, *Baumea rubiginosa*, *Baumea vaginata*, *Cyathochaeta teretifolia*, *Gastrolobium ebracteolatum*, *Taxandria linearifolia* and *Tetraria* sp. Chandala GJ Keighery) that occur in this wetland.

A targeted survey and mapping of these taxa (at the fine scale that has been determined to be necessary in the currently known TEC occurrences) to define potential areas of FCT S17 in Roe Swamp should be conducted prior to a quadrat-based field survey. This preliminary mapping will assist in identifying the fine scale patterning of vegetation in Roe Swamp so that quadrats to sample the flora (towards a multivariate classification of the vegetation) can then be appropriately placed. The survey should also include a survey of the liverwort and moss flora as these are often important in FCT S17.

Voucher specimens of all taxa recorded should be collected and lodged in the WA Herbarium for verification.

The data from the quadrat survey above should be analysed via multivariate analysis against **ALL** available FCT data of the SCP in order to classify the vegetation of Roe Swamp and assess its conservation significance.

2. Although there is some anecdotal evidence of deep peat layers in Roe Swamp and Melaleuca Swamp (Phoenix Environmental Sciences, 2010) there is NO detailed stratigraphic and hydrological data available from central Roe Swamp and most of the other wetlands in the study area (Section 5.1, p.18, Syrinx Environmental and VCSRG, 2011) because drilling in the wetlands was not permitted because of proximity of these areas to restricted Aboriginal Sites. Therefore there is a serious lack of data in the PER with regard to the wetland-to-upland relationships and factors maintaining the wetland at Roe Swamp. This deficit must be addressed at a fine scale and in the detail required to investigate potential TEC springs at Roe Swamp, to assess how the TEC vegetation is (hydrologically) maintained at Roe Swamp and to estimate the potential impact on these values of the proposed development.

The specific vegetation assemblages indicating the presence of springs in the central /northern Roe Swamp and potentially other areas require investigation in the same detail as the work in Syrinx Environmental and VCSRG (2011) and Semeniuk (2007) to determine the hydrological mechanisms that may be maintaining these springs.

The aquatic invertebrates of Roe Swamp (that were not investigated by Phoenix Environmental Sciences in 2010 due to very dry weather) also require to be surveyed in detail. In order to design an appropriate invertebrate survey, the zoologists should be aware of the subtle and fine scale botanical and stratigraphic/ hydrological habitats of this area. Therefore the faunal survey should be carried out subsequent to, or with knowledge of the results of the proposed additional fine scale botanical mapping and stratigraphic/ hydrological work. The methods used in such a faunal survey, the taxonomic skills and resources available to the survey, and the analysis methods used should be appropriate for the potential detection of the taxa similar to those known from other aquatic invertebrate data of the EPBC Listed Endangered TEC: *Assemblages of Organic Mound (Tumulus) Springs of the Swan Coastal Plain*.

## References

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## APPENDIX 1

**Table A1: Flora taxa of high consistency in FCT 11 and the paucity of shared taxa between Roe Swamp vegetation units defined in AECOM (2011) and FCT 11. [NB: The Roe Swamp vegetation units include many more taxa than those listed below. Only the taxa which are shared with FCT 11 are listed below in columns 3, 4, and 5].**

*Taxa of high consistency* are defined as those occurring in 50% or more quadrats in any one community type sampled by Gibson *et al.*, 1994.\* Indicates a naturalized alien taxon (weed).

Taxa of high consistency in FCT 11 (From Table 12, Gibson <i>et al.</i> , 1994)	Roe Swamp ErCtS	Roe Swamp ErMpAfS	Roe Swamp MpBaS
*Lagurus ovatus			
Carex preissii			
*Lysimachia arvensis (= *Anagallis arvensis)			*
*Sonchus oleraceus	*		*
Dianella revolute			
*Ehrharta longiflora	*		*
*Bromus diandrus			*
Caladenia latifolia			
Daucus glochidiatus			
*Trifolium glomeratum			
Ficinia nodosa (= Isolepis nodosa)			
*Crassula natans			
Acacia saligna			
Baumea juncea			
Lepidosperma longitudinale	*	*	*
Eucalyptus rudis	*	*	*
*Cynodon dactylon	*		
Gahnia trifida			
Lobelia anceps (= Lobelia alata)			
Melaleuca raphiophylla		*	*
Triglochin huegelii (= Triglochin procerum)			
Sporobolus virginicus			
Melaleuca teretifolia			*
Melaleuca incana			
Cotula coronopifolia			
Aphelia cyperoides			
Centrolepis aristata			
Burchardia multiflora			
Astartea scoparia (= Astartea aff. fascicularis)	*	*	*
*Cicendia filiformis			
*Cyperus tenellus			
*Monopsis debilis			
*Juncus capitatus			
Schoenus rigens			
*Parentucellia viscosa			
Melaleuca viminea			
Meeboldina coangustata (= Leptocarpus coangustatus)			
Calothamnus lateralis			
*Briza maxima		*	*
*Romulea rosea			*
Drosera glanduligera			
Siloxerus humifusus		*	
*Lolium rigidum			
Kunzea glabrescens (= Kunzea ericifolia)	*	*	*
Jacksonia furcellata			
Melaleuca preissiana	*	*	*
Schoenus (= Schoenus rodwayanus)			
Hypocalymma angustifolium		*	*
Thysanotus multiflorus			
Acacia pulchella			*
Xanthosia huegelii			
Dasyogon bromeliifolius			
Patersonia occidentalis	*		*

Waitzia suaveolens			
Hemiandra pungens			
Acacia stenoptera			
Dampiera linearis	*	*	
Hypolaena exsulca			
Thysanotus thyrsoideus			
Schoenus brevisetis complex			
Corymbia calophylla (=Eucalyptus calophylla)			
Lepidosperma sp. (BJK&NG 232)			
Eucalyptus marginata subsp. marginata			*
Astroloma pallidum			
Caladenia flava			
Drosera stolonifera			
Gompholobium tomentosum			*
Trachymene pilosa			*
*Gladiolus caryophyllaceus	*		*
Total number of taxa in Roe Swamp unit shared with FCT 11	11	10	20

## APPENDIX 2

### Native Flora recorded in the Organic Mound (Tumulus) Springs of the Swan Coastal Plain Threatened Ecological Community.

Compiled from Department of Environment and Conservation (2005); taxonomy updated and aligned with current nomenclature of WA Herbarium (1998- ) on 24.9.13.

#### 1. Vascular Plants

##### **Cyperaceae**

- Baumea articulata*
- Baumea juncea*
- Baumea rubiginosa* (= *Baumea riparia*)
- Baumea vaginalis*
- Cyathochaeta teretifolia*
- Lepidosperma effusum* (= *Lepidosperma ?gladiatum*)
- Lepidosperma longitudinale*
- Tetraria* sp. Chandala G J Keighery 17055 (= *Tetraria capillaris*)

##### **Dennstaedtiaceae**

- Pteridium esculentum*

##### **Dilleniaceae**

- Hibbertia perfoliata*

##### **Droseraceae**

- Drosera macrantha*
- Drosera pulchella*

##### **Fabaceae**

- Aotus cordifolia*
- Gastrolobium ebracteolatum* (= *Oxylobium lineare*)

##### **Juncaceae**

- Juncus holoschoenus*



**Juncaginaceae**

*Triglochin huegelii* (= *Triglochin procerum*)

**Lobeliaceae**

*Grammatotheca bergiana*

**Lycopodiaceae**

*Lycopodium serpentinum*

**Myrtaceae**

*Taxandria linearifolia* (= *Agonis linearifolia*)

*Astartea scoparia* (= *Astartea fascicularis*)

*Eucalyptus rudis*

*Melaleuca lateritia*

*Melaleuca preissiana*

**Proteaceae**

*Banksia littoralis*

**Thelypteridaceae**

*Cyclosorus interruptus*

**2. Non Vascular Plants**

*Goelobyrum unguiculatum*

*Hyalolepidozia longiscypha*

*Jungermannia inundata*

*Riccardia aequicellularis*