up to 24% is relatively high for the Swan Coastal Plain and due in part to high hydraulic conductivity of the Bassendean sands and the shallow water table.

The Jandakot Mound has a transmissivity ranging from 200 - 1000m^2/day, an average annual fluctuation of approximately 0.64m and ultimately discharges into either the Swan River (15150 m^3/day), Canning River (7000 m^3/day), the Ocean (66450 m^3/day), Karnup Drain (1700 m^3/day), Southern River (3000 m^3/day) or Lake Forrestdale (6200 m^3/day).

WA atlas indicates that the groundwater level is around 16m AHD with the hydraulic gradient moving from east to west and south west (Figure 4).

The Mortimer Road site is part of the Peel main drain system as outlined in the DoWs (2009) *Jandakot drainage and water management plan* (Figure 7). The Peel sub drain O begins at the northern part of the property at its highest point and runs west around 2 km before entering the main drain.

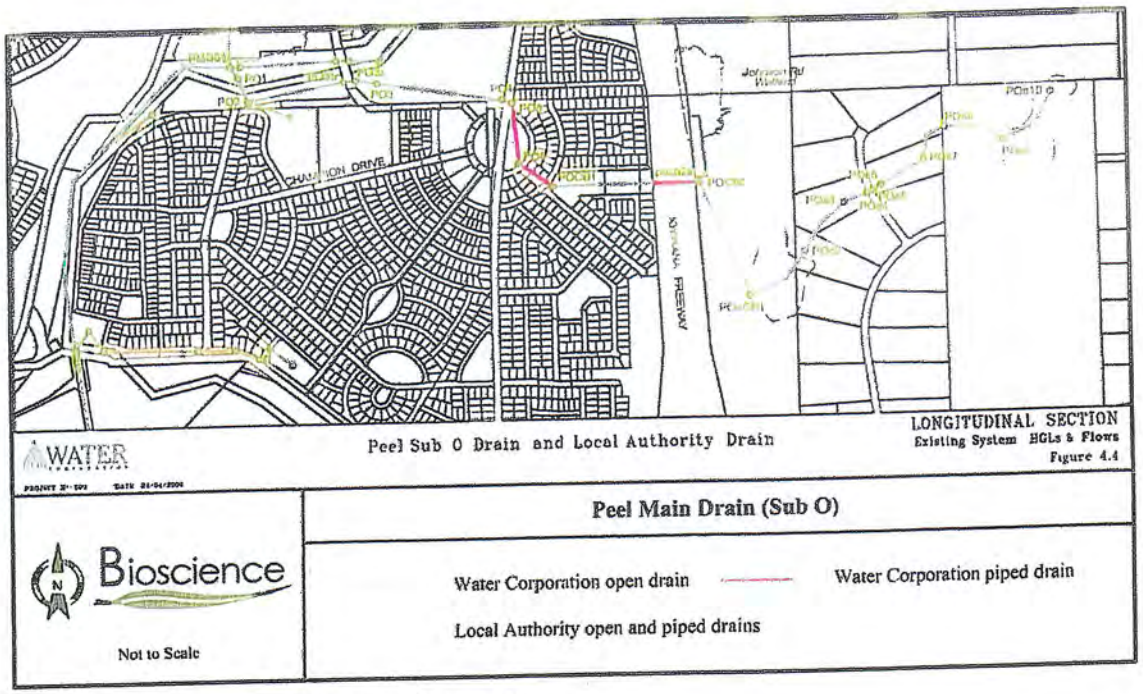

Figure 8: DoW Peel Main Drain – Sub drain O

3.6. Vegetation

The study area is within the Swan Coastal Plain Biogeographic Region of the South-west Botanical Province (Thackway and Cresswell, 1995, Paczkowska and Chapman, 2000), an area that extends from Jurien Bay to the north to Dunsborough to the south, and west of the Darling Scarp.

3.6.1. Vegetation Complexes and Floristic Community Types

The Bush Forever Site Number 273 is located north-east of the study area (Figure 8) and depicts the likely vegetation complexes that reside within the property. According to the *Bush Forever* site description (DEP, 2000) only one complex exists within site number 273; the Bassendean complex (Central and South).

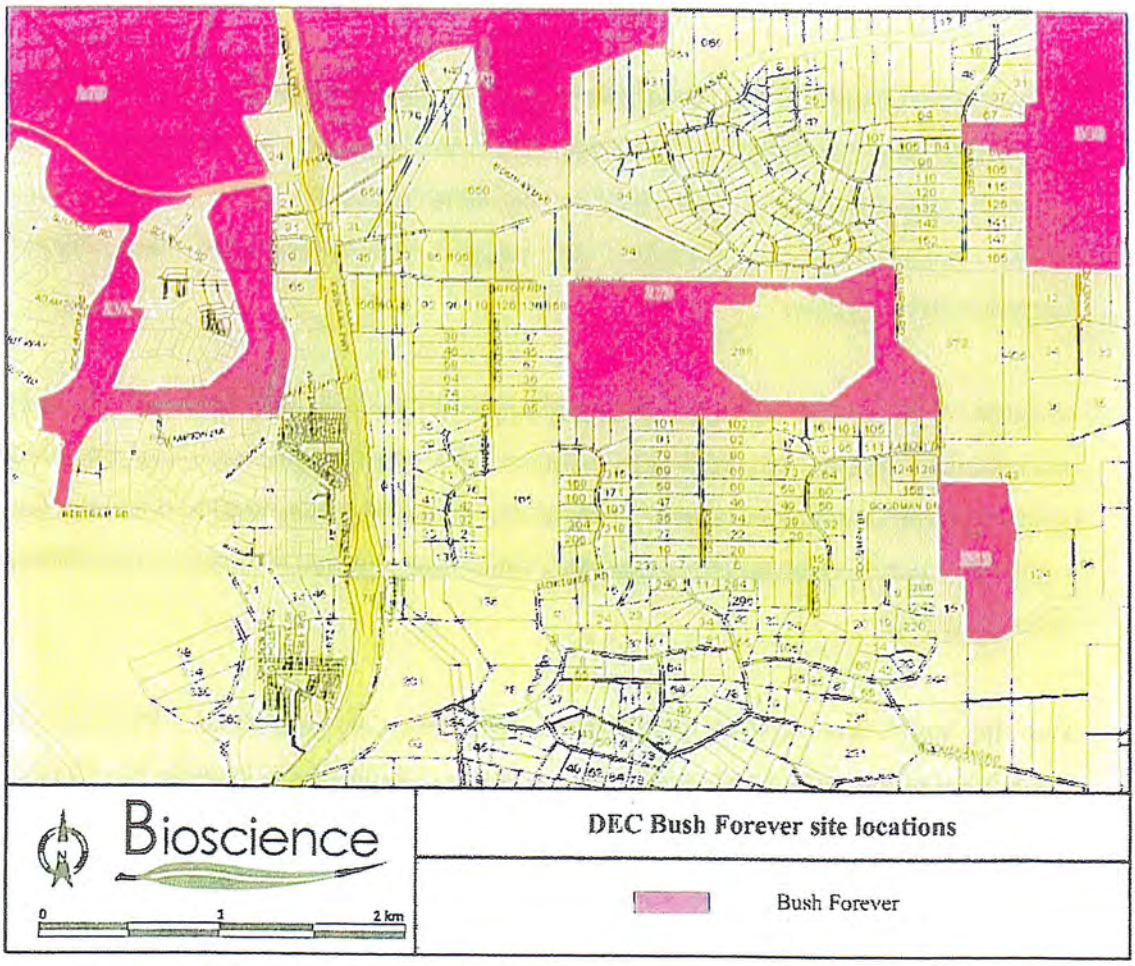

Figure 9: DEC Bush Forever site locations

In addition to the vegetation complex in the *Bush Forever* site description, Gibson *et al.* describes three Floristic Communities Types within two supergroups occur in proximity to the site; including,

Supergroup 2: Seasonal Wetlands

- 4 *Melaleuca preissiana* damplands

Supergroup 3: Uplands centred on Bassendean Dunes and Dandaragan Plateau

- 21a Central *Banksia attenuata — Eucalyptus marginata* woodlands
- 23a Central *Banksia attenuata – B. menziesii* woodlands

4. WETLAND ASSESSMENT FIELD WORK

4.1. Hydrology and Soil Investigations

In order to investigate the soil and hydrology of the area classified by DEC as wetland, a drilling program was undertaken in August 2005. An auger-core drill rig equipped with a Geoprobe sampling system was used to dig holes 4m below the surface where core samples were recovered, examined and logged, and sub-samples were taken for laboratory investigation.

Locations were chosen based on geomorphology of the area, and positioned to capture cross sections through the demarked wetland area. Mechanical core augering using a Geoprobe sample collection system is the preferred method over manual core augering as it provides *in situ* representative samples intact and reduces the risk of soil blending within the profile.

After the holes were drilled, piezometers made from 50 mm slotted PVC pipe were inserted below the minimum groundwater level to a depth of 4m (bottom 3m slotted and end capped) with 0.5m above the surface. The annulus around the screened interval was packed with gravel. Piezometer tops were capped and locations were logged by GPS (Figure 10).

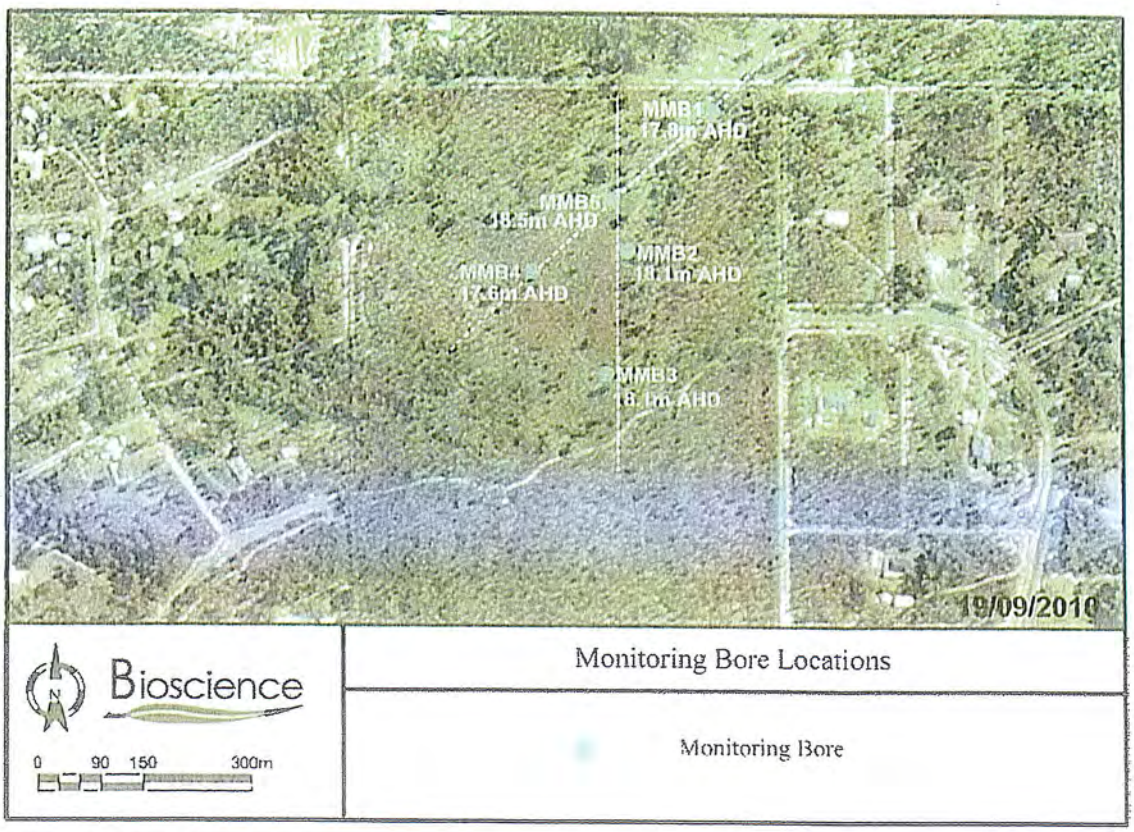

Figure 10: Bore Locations

4.2. Soil Profiles

Each drill hole presented a very similar soil profile consisting of a shallow A horizon (100 – 150mm) of grey sand overlying white medium/coarse grained white sand typically to a depth of about 1m. Sand then became uniform grading coarse yellow to brown sand to 4m (Appendix 1).

A weakly indurated layer 200mm deep was found at one site only (hole 1). This area is outside the boundary of what is currently classified as CCW. There was no evidence in any soils collected of sediment layers, or of organic deposition.

4.3. Hydrological Data

Piezometer water level data was recorded for 6 months in 2005, then monthly from October 2007 until May 2011 (Figure 9). Groundwater levels were closest to the surface

during August and began to recede after this time. Groundwater was closest to the surface at MMB4 during 2008 reaching a maximum of 1519mm below the surface.

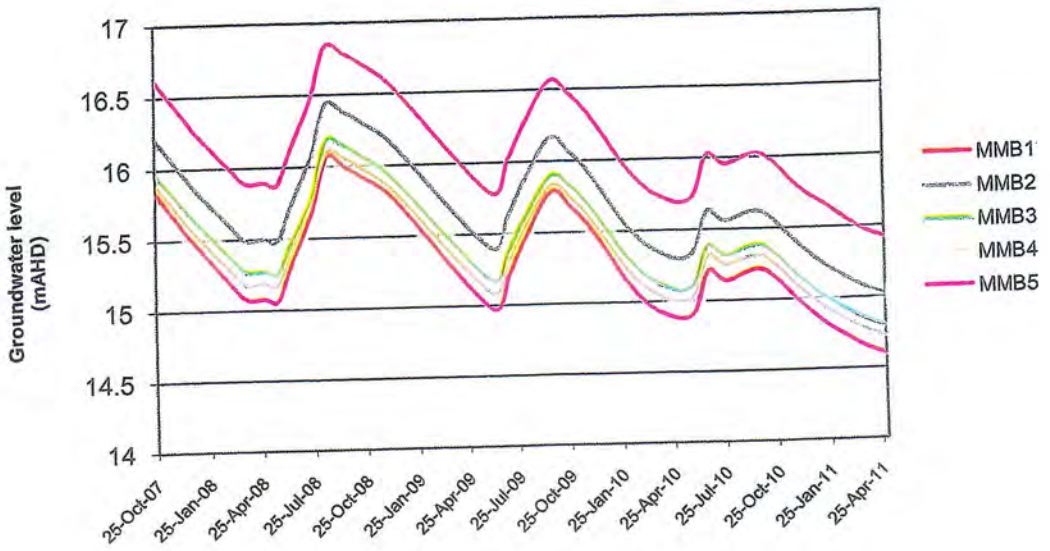

Figure 11: Groundwater levels October 2007-May 2011

This data correlates with local groundwater data of surrounding monitoring bores (DoE, 2005) that suggest levels fluctuate annually about 1m reaching minimum depth around August. However, despite having above average rainfall in 2008 the groundwater reaches no closer than 1519mm below the surface. This is inconsistent with the Hill et al (1996) wetland classification which suggests that in order to be classified as a dampland the soil should become waterlogged through the capillary rise of water or raising of the water table. It is unlikely that capillary action would have an effect of more than 10-20cm in the medium/coarse sands found throughout the area.

To determine the influence of the particular season on data collected on site, it was analysed against the closest long term monitoring bores logged by the Department of Environment for at least 35 years. The closest long term monitoring bores are around 1 – 2.5 km away and as such do not give a direct indication of the local hydrology but rather give an overview of regional hydrological change.

Eight monitoring bores within a 4km radius (location in Figure 12)were examined for average annual groundwater level. Results show that there is a general decline from

approximately 0.1m to 0.95m in average annual groundwater levels across 5 monitoring bores (3038, 3057, 3069, 3093, and 3094). Three of the eight monitoring bores increased from approximately 0.3m to 0.38m (3044, 3045, and 3070) however, although monitoring bore 3070 has increased in average annual groundwater level, the annual maximum groundwater level has decreased 0.34m in the past 10 years compared with the previous decade.

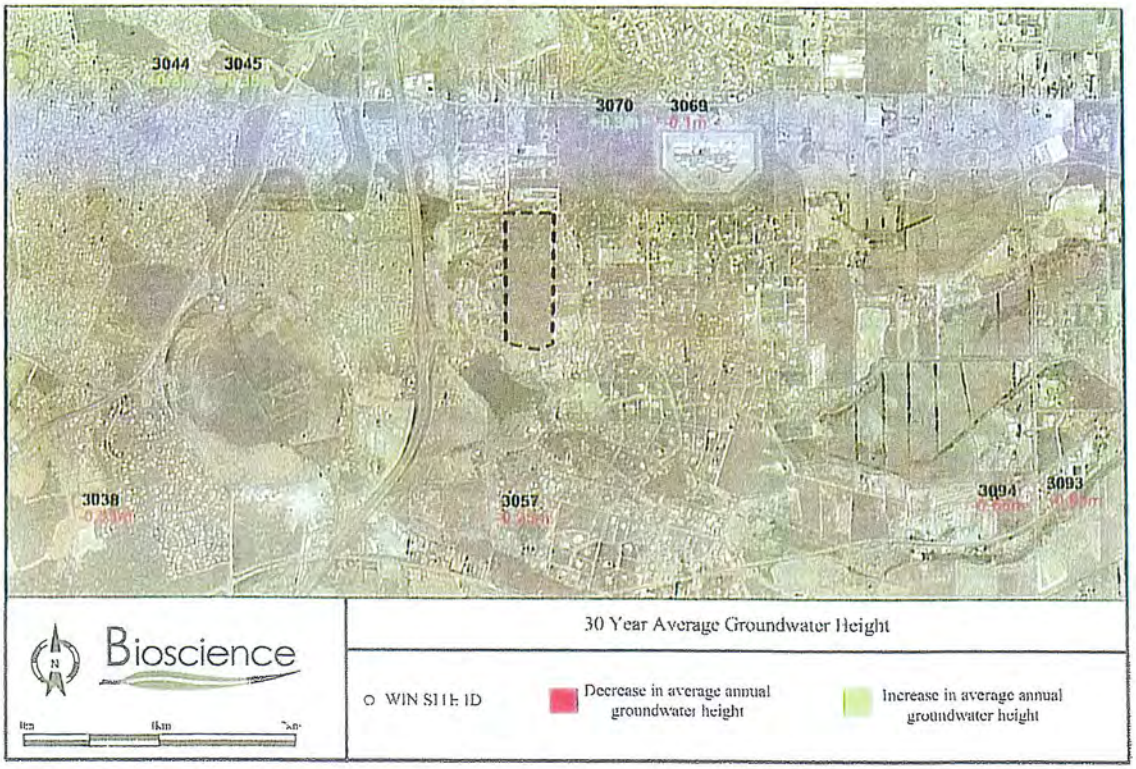

Figure 12: Annual average groundwater levels of surrounding monitoring bores

To determine whether any significant changes to this site have occurred, archived aerial photographs of the site since 1953 were examined. Although the majority of available photographs were taken in summer, there are ample for the wet months of June through September. None of the photographs, including those prior to any substantial clearing in the area, show any evidence that the site has ever been inundated in the last 58 years. It is also worth noting that the wetland area boundary has become much less definitive over time (Appendix 4).

4.4. Soil Data

Soil samples were selected from recovered drilling cores to test for the presence of Actual Acid Sulphate Soils (AASS) and Potential Acid Sulfate Soils (PASS). As the soils were invariably sand with very low organic matter, only those samples which occurred in darker brown horizons were tested except for Hole 1, where the entire profile was tested.

Tests involved measuring field pH and pH after oxidation with peroxide, according to the "Field Test" guidance issued by DEC for assessing Acid Sulfate Soils.

Table 1: Soil pH before and after oxidation with H_2O_2

Sample	pH_{KCl}	pH_{H2O2}	H_2O_2 Reaction
1.2	4.45	4.07	Nil
1.3	4.66	4.28	Nil
1.4	4.84	4.28	Nil
1.5	5.14	4.43	Nil
1.6	5.4	3.89	Nil
1.7	5.64	4.69	Nil
1.8	6.24	5.34	Nil
1.9	6.43	4.74	Nil
2.5	4.91	4.36	Nil
3.6	5.12	4.13	Nil
4.6	5.94	4.36	Nil
5.5	5.42	4.02	Nil

Acid Sulfate Soil is judged by a lowering of pH by more than 2 units after reaction with hydrogen peroxide, and extent of reaction with peroxide. As shown in Table 1, none of the soils tested showed any evidence of acid sulphate conditions.

It is also noteworthy that hole 1 soil shows a progressive rise of soil pH with depth (podzolisation) rather than a sudden rise at a particular point as would be expected from saturated soil, where waterlogging changes redox potential and under anaerobic (reducing) conditions, pH typically shows a sharp rise.

4.5. Vegetation

4.5.1. Detailed Site Investigation

Bioscience undertook a detailed vegetation survey which met the requirements of EPA Guidance 51. Six 10m quadrats were clearly marked out covering each vegetation uni and one 100m transect were studied in detail (Figure 13) (Appendix 2). The demarked CCW was assessed using two quadrats. Quadrat one (MR01) surveyed a 10 x 10 m representative area of the centre of the wetland, whilst quadrat four (MR04) surveyed a 10 x 10 m representative area of the transitional zone between wetland and dry land vegetation along the edge of the wetland boundary. A REW wetland on the western boundary (MR03) was also investigated for comparison.

Survey results show that three vegetation subtypes are represented within lot 123 including;

- 4 *Melaleuca preissiana* damplands
- 21a Central *Banksia attenuata — Eucalyptus marginata* woodlands
- 23a Central *Banksia attenuata – B. menziesii* woodlands

This is comparable to the bush forever site 273 to the north of the subject area.

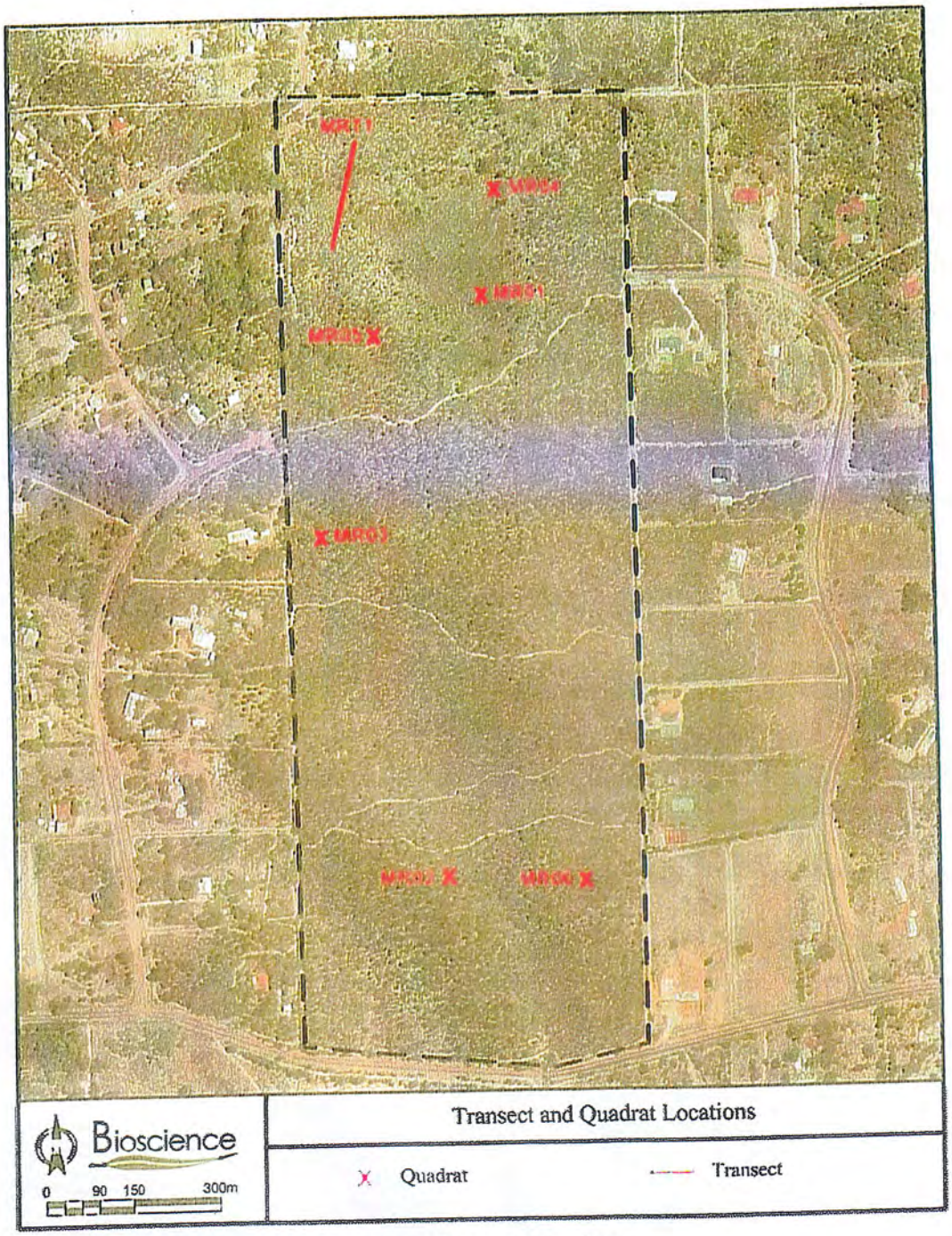

Figure 13: EPA Guidance 51 Quadrat and Transect Locations

Results indicate that some wetland species do exist within the area demarked as CCW. However, this was to be expected as, based on geomorphology (i.e. that the area is flat) it may have had some wetland features over 60 years ago. However; dryland species such as *A. fraseriana* and *C. calophylla* are now well establishing within the area.

Wetlands do not become drylands overnight resulting in a high likelihood that some wetland evidence will remain within the CCW. The only evidence supporting the presence of a wetland is vegetation, which is only one third of the criterion required to satisfy the identification of a wetland. The progression from wetlands to drylands begins with the reduction and eventual absence of water due to altered hydrological regimes, reduced rainfall, and increased evaporation. Once the water is absent from the soil anaerobic conditions turn to aerobic conditions eliminating the presence of hydritic soils. Once the changes in hydrology and soil have occurred the vegetation will begin a succession from wetland vegetation to dryland vegetation, the rate of which is determined by their minimum water requirement and competition with more adapted dryland species. It is worth noting that there have been no studies on vegetation changes over time in wetlands becoming drylands and as a result there is no expected time scale at which the vegetation changes will occur.

4.5.2. Patn Analysis

Statistical pattern analysis (PATN) was used to analyse similarities between each of the community types within the subject area. Bray and Cutis similarity index and nearest neighbour analysis show a distinct dissimilarity between the CCW and REW areas and *Banksia* / *Eucalyptus* areas (Figure 14). However there is still a clear distinction between the REW and the CCW areas. Due to the fact that the REW represents a functioning wetland the dissimilarity between it and the said wetland supports the evidence previously highlighted that the CCW wetland was once a wetland however due to a reduction in water table level is now functioning as a dryland.

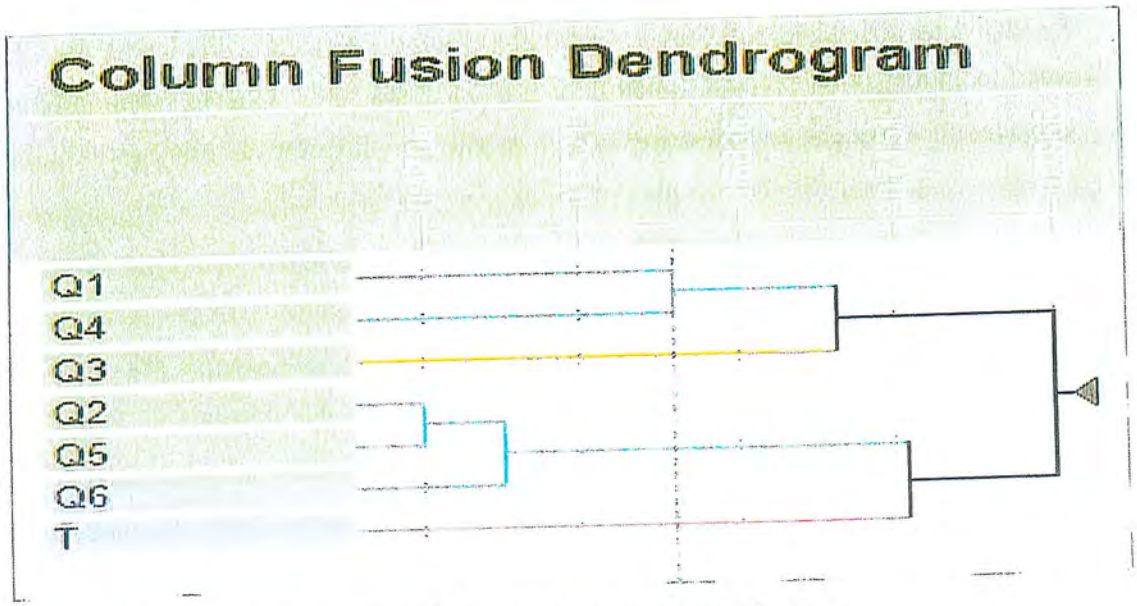

Figure 14: Bray and Curtis nearest neighbour pattern analysis dendrogram

4.5.3. Vegetation Condition

The site appears to be in very good condition with weed incursions largely restricted to the southern end of the property and along the edges of tracks and boundaries. There has also been some disturbance associated with clearing timber (jarrah), the dumping of rubbish and vehicles. According to the Bush Forever condition rating the site is generally very good to pristine with some southern areas in average to poor condition. Fires do not appear to be very regular.

Within the demarked CCW area *M. preissiana* are sparse and older trees appear to be in decline. Little or no regeneration of the species appears to have occurred in the last 20 years. There is evidence of recruitment of *A. fraseriana* and *C. calophylla* encroaching on the area and this suggests there has been a period of prolonged reduction in water table levels.

In 2006, high resolution digital photos were taken facing north, south, east and west from each of the 5 piezometers installed through the CCW area. In 2011, a further set was taken from the same positions (Appended as a CD). These attest to the general decline of wetland species and increasing dominance and general health of upland species.

5. FINDINGS

5.1. Geomorphic Classification

Under the current state legislation the three wetland management categories are:

- Conservation Category Wetlands (CCW) – Wetlands supporting a high level of ecological attributes and functions
- Resource Enhancement Wetlands (REW) – Wetlands which may have been partially modified but still support substantial ecological attributes and functions
- Multiple Use Wetland (MUW) – Wetlands with few important ecological attributes and functions remaining

The subject area is within the Bassendean Soil Complex according to the Western Australian Geological Survey (Gozzard, 1986a & Gozzard, 1986b). Under the Geomorphic Dataset (Hill et al, 1996) the area is classified as a dampland. Under the current classification system, this would suggest the soil experiences intermittent waterlogging either due to the existence of "perched" watertable or the lifting of the watertable to the soil surface.

Soil analysis data from the site is consistent with that of the Bassendean complex. There is little evidence of a confining ferruginous hardpan that would otherwise be expected in the event of a perched watertable (Davidson, 1995). There is no presence of wetland morphological indicators or evidence of hydritic conditions, suggesting that the CCW classification was based purely on vegetation features rather than the soil becoming waterlogged due to watertable rise.

The data collected from monitoring bores on site, and its relatedness to surrounding deep monitoring bores indicates this area is not a wetland due to the fact that that the watertable rose to a maximum of 1519mm below the surface (which occurred during a greater than average rainfall year). Historical data from the closest monitoring bores show that in the wettest years of the 30 year record, the highest groundwater levels recorded are only 300mm above the average maximum which signifies that even in a very heavy rainfall year the groundwater would not rise to greater than 1219mm below the surface.

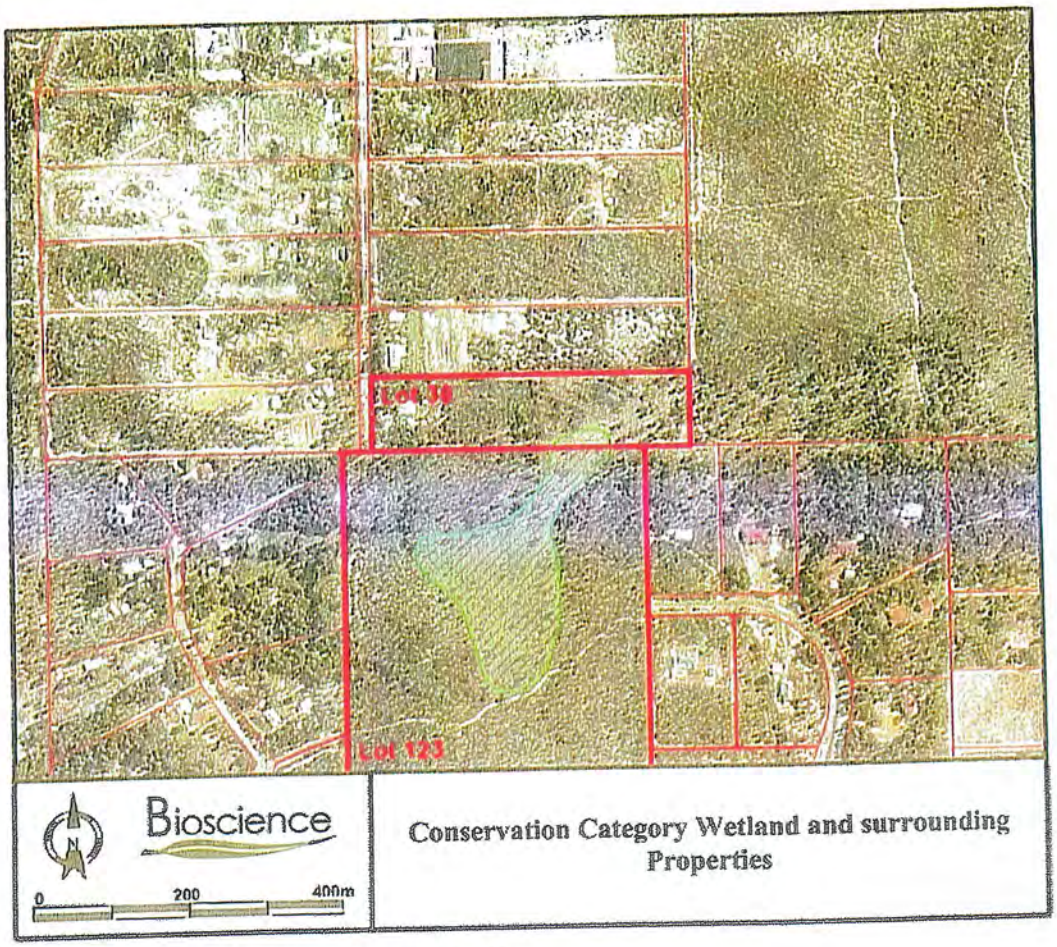

Figure 15: CCW and surrounding properties

The current owner of the Landgren Road property has advised the eastern half of the property including the said wetland was once cleared for market gardening although it has not been used for this purpose for about 10 years. Native regrowth has largely been limited to areas of lower elevation consisting mostly of *Pericalymma ellipticum, Astartea sp.* and sedges (a formal floral assessment has not been undertaken). Sparse *Banksia-Eucalypt* woodland surrounds the wetland with dense populations of non-native grasses (esp. *Ehrharta calycina*) throughout. The western half of the property is characterised by *Banksia-Eucalypt* woodland, part of which has been cleared to accommodate the building envelope.

Local residents suggest that the wetland as a whole has not experienced inundation for at least 10 years. There is some suggestion that this is a result of changes in local drainage to accommodate residential development. A better understanding of this will be obtained in the proposed drainage plan required by the Draft Jandakot Structure Plan.

Results of the Bulletin 686 reveal a conservative score of 11 was recorded for natural attributes. Likewise for human-use, despite being relatively secluded, the wetland has few redeeming features and scored only 7. The area has no value in terms of passive or active recreation (Appendix 3).

Under the Bulletin 686 assessment the combination of these attributes alone would classify the wetland as Multiple Use. This is further strengthened by the fact that past land use and level of disturbance suggest there are no rare and endangered species on the site, there is no significant effect on real estate values and there are no heritage values – there is an Aboriginal Heritage site registered for the south end of the Mortimer Road site, but this has no effect on the wetland in question.

6. DEVELOPMENT POTENTIAL

The Mortimer Road site is currently zoned for Special Rural Development under the Kwinana Town Planning Scheme No. 2 (1992). Under this zoning there is a requirement to limit block sizes to 2-4 hectares with a building envelope of 2000m^2.

Under the Jandakot Structure Plan the land earmarked as future Urban, anticipating housing development for the area surrounding the CCW. Based on present development standards that may mean housing at a rate of about 12 dwellings per hectare for residential land.

Preservation of the CCW would likely require a default allowance of approximately 200m to buffer it from any development. The basis for such a distance is detailed in the t draft publication from WAPC *Guidelines for the Determination of Wetland Buffer Distances* (2005). However, most importantly this guideline unequivocally states the importance of agreeing that wetlands exist as a first step in determining buffer distances.

"Acknowledgment of the existence of a wetland is the first step in the determination of a wetland buffer. This step does not require any specific definition of the wetland area. The outcome is agreement that a wetland of some form exists at a particular location." (*ibid*, p.7)

The presence of CCWs would have a major impact on development plans. For example housing envelopes or access driveways cannot be placed within the wetlands or buffer zones.

It is noteworthy that the landowner has preserved the bushland on Lot 123 intact for over 50 years with the intention of eventually developing it in a way which maximises the preservation of native vegetation.

7. CONCLUSIONS

The current wetland definitions are clear on wetlands being areas where the soil it wet. The classification system for wetland management categories is inadequate and has been subject to revision for over a decade without any final version being made public. In this site, the primary criterion for defining a dampland (i.e. the soil undergoes intermittent waterlogging) is not satisfied. There is no evidence of hydritic soils being present. Although the area does support a number of key plant species common to low-lying areas and/or wetlands, most are in poor condition and in decline with encroaching and healthy dryland vegetation.

Despite vegetation not being a defining feature under Hill et al (1996) classification, it is our experience that this becomes the defining characteristic that determines the preservation (or otherwise) of land considered wetland, in the absence of clear hydrological and soil data. We have collected and presented such data here. According to the definitions provided by Hill and by Tiner, the data clearly and unequivocally means the area is not a wetland. Because it is not a wetland, Bulletin 686 is not an appropriate mechanism for classifying the areas conservation value; however a Bulletin 686 was conducted for Lot 38 Landgren Road and scored very low making at best a classification of Multiple Use.

The original response received from the DoE (2006) outlines three distinct wetland identifying categories;

"Hill et al (1996) recognises that wetlands are identified by the presence of three wetland indicators: the presence of water/waterlogging, vegetation typical of wet conditions and sediment or hydritic soils"

The Mortimer road wetland has no presence of water/waterlogging, some flora typical of wet conditions (although it also contains obligate upland species), and no sediment or hydritic soils. So by this definition the CCW UFI 6679 does not satisfy the requirements of a wetland.