

**A Jarrah-Mountain marri woodland
community restricted to yellow sands in the
Happy Valley area of the Whicher Scarp**

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For Strategen

on behalf of *Bemax Resources Pty Ltd*

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DRAFT

Contents

1. SUMMARY	2
2. INTRODUCTION	2
2.1. The “yellow sand” plant community	3
2.2. Off-lease surveys to find new areas of the “yellow sand” plant community.....	4
2.3. Objective of this project.....	5
3. METHODS	5
4. RESULTS.....	6
4.1. Co-occurrence of “yellow sand” plant community species	6
4.2. Vegetation structure and floristics of the “yellow sand” plant community	8
4.3. Mapping the “yellow sand” plant community	10
5. DISCUSSION	11
6. REFERENCES	12

TABLES

1. Definition of the yellow sands” community indentified in Bennet Environmental Consulting Pty Ltd (2003)	3
2. Co-occurrence expressed as a percentage of releves of 5 plant species characteristic of the “yellow sand” plant community within the Happy Valley mining leases.....	7

FIGURES

1. The locations of 130 releves assessed during the project.....	6
2. Hierarchical clustering diagram of floristic data from 55 releves.....	10

3. SUMMARY

The vegetation survey and assessment reported here has established that the “yellow sand” plant community mapped in the Happy Valley South mining lease as **EmChXoBgRc-DnSIHhSwDI** by BEC&OEC (2006) and labelled Floristic Group sub-unit C2b by Smith (2008b) extends more than 3 km south of the mining leases and that more than 80 ha of the community exists outside the lease. As would be expected for a Whicher Scarp plant association in a region where there is great alpha- and beta-diversity in plant species there is a fair bit of variation within the group. However, this study and a previous one (Smith, 2008b) have demonstrated that the “yellow sand” plant community has several characteristic plant species that together with its almost invariable occurrence on “yellow-grey” or “yellow-brown” sands or sandy-loams of moderate depth means that it is a distinct plant community that is easily characterized and recognized in the field.

4. INTRODUCTION

Bemax Resources Ltd’s Happy Valley mineral sands project comprises two deposits, “Happy Valley North” and “Happy Valley South”. Together they form the Happy Valley Mining Lease Area as referred to in this report. The “Happy Valley North” (HVN) deposit occurs south of Gavins Road in Argyle State forest block and the “Happy Valley South” (HVN) deposit occurs 1.5 km SW of HVN, half of the deposit overlying Argyle State forest block with the remainder occurring on privately owned land. In the application to mine the area of its mining leases in State forest Bemax Resources has committed to minimising the area of native vegetation cleared during mining, restricting clearing to the perimeter of the ore body and critical infrastructure areas. The area of native vegetation proposed to be cleared at the HVN and HVS project areas would be 42 ha and 60.5 ha respectively, with 43.8 ha in State forest.

In relation to the proposal to mine in State forest at Happy Valley Bemax Resources (previously Cable Sands Pty Ltd) has commissioned a series of vegetation surveys (summarised in Bennett Environmental Consulting and Onshore Environmental Consultants [BEC & OEC], 2006) that have sought to;

- identify aspects of the flora and vegetation that have conservation significance,
- to develop a reasonably reliable conceptual model of the relationships between landforms, soils, vegetation and flora, and, to produce a vegetation map of the local area that reflects the above relationships.

4.1. The “yellow sand” plant community

The Department of Environment and Conservation (DEC) has expressed concerns that the proposed mining at Bemax Resource’s Happy Valley mining leases would impact adversely on a plant community that it considered to be “quite unique, floristically diverse and of value because it is considered to be habitat for the DRF *Daviesia elongata* subsp. *elongata*.”

Daviesia nudiflora, a characteristic species of the community, was also at the southern end of its range at Happy Valley, the nearest populations being near Perth almost 200 km away. The community on the Happy valley mining leases occurred on well-drained yellow¹ sandy soils within the Kingia, Whicher Slopes and Whicher Valley landforms.

The community had apparently first been identified in Bennett Environmental Consulting Pty Ltd (2003) as part of the mapped vegetation type **EmBaCh**: Open forest of *Eucalyptus marginata* subsp. *marginata* and *Corymbia haematoxylon* over Low Woodland of *Banksia attenuata* over a Low Shrubland dominated by *Adenanthos meisneri* and *Stirlingia latifolia*. The mapping unit was defined in the following way (Table 1);

Strata	Significant species
Dominant trees	<i>Banksia attenuata</i> , <i>Corymbia haematoxylon</i> , <i>Eucalyptus marginata</i> subsp. <i>marginata</i> , <i>Nuytsia floribunda</i> , <i>Xylomelum occidentale</i>
Dominant shrubs > 1 m tall	<i>Hakea ruscifolia</i>
Dominant shrubs < 1 m tall	<i>Adenanthos meisneri</i> , <i>Banksia sphaerocarpa</i> , <i>Daviesia nudiflora</i> , <i>Banksia dallanneyi</i> , <i>Hibbertia hypericoides</i> , <i>Stirlingia latifolia</i>
Herbs	<i>Phlebocarya ciliata</i>

Table 1. Definition of the yellow sands” community identified in Bennet Environmental Consulting Pty Ltd (2003).

At the time the known extent of the “yellow sand” plant community was about 27 ha. The original layout of the pit and equipment and operational areas would have affected 71% (19.2 ha) of the “yellow sand community”; a proposed alteration to the location of the equipment/operational areas reduced the impact on the then known extent of the community to 61% (16.6 ha) (Strategen, 2008).

Bennett Environmental Consulting and Onshore Environmental Consultants Pty Ltd [BEC & OEC] (2006) mapped this community as **EmChXoBgRcDnSIHhSwDI** and described it as;

“Low Woodland A of *Eucalyptus marginata* subsp. *marginata* over Open Low Woodland B of *Corymbia haematoxylon*, *Banksia grandis* and *Xylomelum occidentale* over Open Dwarf Scrub C of *Daviesia nudiflora* subsp. *nudiflora*, *Ricinocarpos cyanescens* and *Stirlingia latifolia* over Dwarf Scrub D of *Hibbertia hypericoides*, *Synaphea whicherensis*

¹ Munsell colour described as 2.5Y to 10YR (Strategen, 2006)

and *Dryandra lindleyana* subsp. *lindleyana*” on “grey/orange/yellow” sand of the mid-slopes.

Numerical classification² of 40 quadrats established by BEC & OEC (2006) by T.E. Griffin separated the vegetation of the Happy Valley mining lease area into 15 floristic groups or vegetation units. The quadrats situated within the mapping unit described above fell within Group 1 of Griffin’s analysis. This floristic group was described as;

“Low Forest A to Low Woodland A of *Eucalyptus marginata* subsp. *marginata* over low Woodland B of *Corymbia haematoxylon* over Open Scrub of *Banksia grandis*, *Banksia attenuata*, *Xylomelum occidentale* and *Persoonia longifolia* over Low Scrub B of varying species and Dwarf Scrub C dominated by *Stirlingia latifolia* and *Hibbertia hypericoides* in grey sand³..... Additional taxa that characterize this group are: *Pentapeltis peltigera*, *Isopogon sphaerocephalus*, *Boronia humifusa* and *Dasyopogon hookeri*.”

Smith (2008b) identified an additional 20 ha of the “yellow sand” community within the Happy Valley South mining lease. He produced a description of the community, identified using hierarchical clustering of releve data, which he labelled Floristic Group sub-unit C2b as;

Woodland of *Eucalyptus marginata* over Low Woodland A of *Corymbia haematoxylon* over Low Woodland B of *Banksia grandis* and *Xylomelum occidentale* on yellow-brown loamy sands on the Whicher Scarp (sandy slopes) and *Kingia* (lateritic sandy gravels) landforms.

Other characteristic species: *Banksia dallanneyi*, *Dasyopogon hookeri*, *Daviesia nudiflora*, *Hakea cyclocarpa*, *Hakea ruscifolia*, *Hibbertia hypericoides*, *Ricinocarpos cyanescens*, *Stirlingia latifolia*

Common species: *Adenanthos barbiger*, *Adenanthos meisneri*, *Hakea amplexicaulis*, *Lepidosperma leptostachyum*, *Leucopogon pendulus*, *Synaphea whicherensis*, *Xanthorrhoea gracilis*

4.2. Off-lease surveys to find new areas of the “yellow sand” plant community

DEC required Bemax Resources to undertake additional surveys off the mining leases to ascertain whether the “yellow sand” plant community occurred elsewhere. The report of a survey carried out by Bennett Environmental Consulting Pty Ltd (BEC, 2007) demonstrated

² By hierarchical clustering using PATN software.

³ The soil colour for most of the quadrats placed in this group was given as “yellow” or “yellow/orange”.

that the community was “widely distributed” in State forest to the south of the Happy Valley mining lease. BEC (2007) established eleven 10 m x 10 m floristic quadrats in State forest south of the Happy Valley leases. The vegetation in which 9 of the 11 quadrats were placed was chosen on the basis of evident similarities to the “yellow sand” plant community in the mining leases area. Eight of the eleven quadrats contained *Daviesia nudiflora*, and of these 8 quadrats 3 also contained the DRF species *Daviesia elongata* subsp. *elongata*. The soil in 7 of the quadrats with *D. nudiflora* was described as “yellow” and one as “grey/yellow”.

Hierarchical clustering of the floristic data from the 8 extra “yellow sand” quadrats with that from 40 quadrats from within the mining leases showed that while two of them clustered closely with the “yellow sand” plant community within the mining lease the other 6 formed a distinct group at the first level, though they did cluster together at the second level (BEC, 2007).

Previous to the survey for areas of the “yellow sand” plant community reported by BEC (2007) the same consultants had carried out a survey in the same area for three of the floristic elements of the community, viz.; *Daviesia elongata* subsp. *elongata*, *Daviesia nudiflora* and *Ricinocarpos cyanescens* (BEC, 2004). This survey identified several new populations of *D. elongata* subsp. *elongata*, all growing on “yellow-orange” sand and “many thousands” of *D. nudiflora* plants, growing both on “yellow-orange” and grey sands.

4.3. Objective of this project

The objective of this project was to locate and map the extent of other occurrences of the “yellow sand” community (similar to the mapping unit **EmChXoBgRcDnSIHhSwDI**) in State forest immediately south of the Happy Valley mining leases.

5. METHODS

The presence or otherwise of the “yellow sand” plant community was initially determined by the presence of *Daviesia nudiflora* on “yellowish” soils. Topsoil colour was subjectively classified in the field into the following categories: grey, grey-brown, yellow-grey and yellow-brown- the last two being regarded as “yellowish”.

The locations *Daviesia elongata* subsp. *elongata* and *D. nudiflora* populations (BEC, 2004) and of quadrats placed in yellow sands communities surveyed by BEC (2007) in State forest south of the Happy Valley mining leases were used as starting points for the survey reported here. Transects were walked through the State forest and relevés sited at intervals within the “yellow sand” plant community (as defined above) and in non-yellow sand community vegetation immediately adjacent to it. At each relevé point perennial plant taxa were recorded within an approximate 20 m radius for trees and 10 m radius for understorey

species. The location of the releve was recorded using a GPS unit and also the colour and texture of the topsoil.

The location of the 130 releves assessed during the survey is shown in Fig. 1.

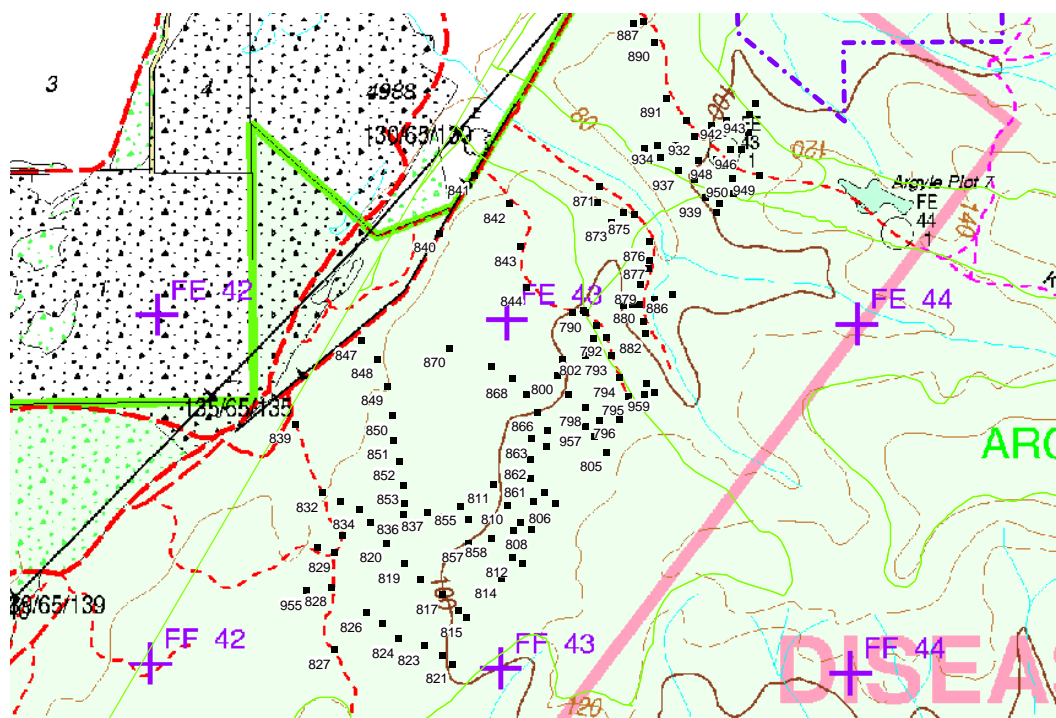


Figure 1. The locations of 130 releves assessed during the project. The location of the southernmost Happy Valley mining lease is shown by the blue dashed line at the top right of the map.

6. RESULTS

6.1. Co-occurrence of “yellow sand” plant community species

One hundred and thirty releves were assessed during the survey. They were all located within Argyle State forest block between 200 m and 3,300 m SW of the southernmost of the Happy Valley mining lease tenements (M70/900). A summary of the quadrats with regard to three of the characteristic species of the “yellow sand” plant community (*Daviesia nudiflora*, *Ricinocarpos cyanescens* and *Synaphea whicherensis*), the presence of *Banksia attenuata* within releves, and the presence of gravel or laterite in the topsoil is given in Table 2.

	DN	RC	HR	SW	BA	LAT
DN	100	78	83	72	38	14
RC	69	100	71	60	42	10
HR	85	82	100	72	43	10
SW	77	72	74	100	26	20
BA	65	83	73	43	100	3
LAT	30	24	21	39	3	100

Table 2. Co-occurrence expressed as a percentage of relevés of 5 plant species characteristic of the “yellow sand” plant community within the Happy Valley mining leases and also their occurrence in relevés where the topsoil was gravelly or where laterite was evident (DN: *Daviesia nudiflora*, RC: *Ricinocarpos cyanescens*; HR: *Hakea ruscifolia*, SW; *Synaphea whicherensis*, BA; *Banksia attenuata*, LAT; gravel/laterite).

As can be seen from Table 1 that 78% of relevés where *Daviesia nudiflora* occurred also contained *Ricinocarpos cyanescens*, 83% contained *Hakea ruscifolia*, 72% *Synaphea whicherensis* and in 38% *Banksia attenuata* was one of the overstorey trees. Sixty seven percent of relevés with *D. nudiflora* also contained both *R. cyanescens* and *H. ruscifolia* and 51% of relevés with *D. nudiflora* contained all three of the other characteristic species; *R. cyanescens*, *H. ruscifolia* and *Synaphea whicherensis* (Data not shown).

In order to further explore the association of plant species within the search area floristic data from 49 of the 130 relevés from this project (27 of the 49 contained *D. nudiflora*), together with 6 relevés (5 of which contained *D. nudiflora*) from the Happy Valley mining leases (Smith, 2008a, 2008b) was subjected to hierarchical clustering using the PC-Ord software (McCune and Metford, 1999; McCune and Grace, 2002).

The clustering formed two main groups at the first level (Fig. 2), Floristic group A was mainly formed from relevés in the two most northern occurrences of the “yellow sand” plant community, as well as 5 of the 6 relevés from the Happy Valley mining lease. Group A lacks *Banksia attenuata* and has a low representation of *Allocasuarina fraseriana*, which also is not present in the Happy Valley mining lease occurrences of the community.

Floristic Group B comprised mainly relevés from the largest, southern occurrence, of the community. No clear pattern emerges with regard to the two sub-groups of Group A at this stage. However Group B is clearly divided into two sub-groups; sub-group B2 has relevés not containing *Daviesia nudiflora* and occurs on grey sands or grey loamy sands and sub-group B1 is mainly comprised of relevés where *D. nudiflora* was present and where topsoil colour was “yellow-grey” or “yellow-brown”.

With regard to the species groups in Figure 2., *Daviesia nudiflora* clusters tightly with *Banksia dallanneyi*, *Hakea ruscifolia*, *Ricinocarpos cyanescens*, *Stirlingia latifolia* and *Synaphea whicherensis*. *Banksia attenuata* and *Daviesia divaricata* tend to cluster together

within sub-group B1 and both are also strongly associated with *Daviesia nudiflora*. At 34 of the 37 releves (92%) where *D. divaricata* was present *D. nudiflora* was also present.

6.2. Vegetation structure and floristics of the “yellow sand” plant community

The “yellow sand” plant community is generally an “open forest” (Specht, 1970; NVIS, 2007) with an overstorey foliage projective cover (FPC) probably in the range of 35 – 45%⁴. However, the method of Muir (1977) has generally been used for describing the vegetation of the Whicher Scarp area (e.g. Bennett Environmental Consulting, 2007; Keighery et al., 2008) and using this method, where the different height classes are described separately, the tallest component of the overstorey is often described as a woodland (that is FPC > 30%). Whereas the *Eucalyptus marginata-Corymbia haematoxylon* dominated vegetation in which the “yellow sand” plant community occurs would be described as an open forest using Specht’s classification the *E. marginata-Banksia attenuata* formation further downslope on the Cartis landform is no doubt a “woodland” using the same classification. Nevertheless, general usage has led to the tree-dominated formations of the Whicher Scarp being thought of as woodlands.

A recent report on the vegetation of the Whicher Scarp (Keighery et al, 2008) has provided for the first time a context in which to place floristically-derived vegetation units from surveys such as this one. The “yellow sand” plant community fits within Major Floristic Group C (“Whicher Scarp woodlands of coloured sands and laterites”) of the Whicher Scarp survey (WHS) classifications. This group is typically associated with laterites or “coloured” sands, often with a finer clay/loam fraction (Keighery et al, 2008, p. 23). More particularly, the “yellow sand” plant community appears to be part of Floristic community type C2: Whicher Scarp Jarrah woodland of deep coloured sands (WHSFCT C3). Two of the Whicher Scarp survey quadrats placed in “Group 1” (section 2.1 above), DAVE01 and DAVE02, are also stated to be part of WHSFCT C3 (Keighery et al., 2008).

The “yellow sand” plant community is obviously a sub-unit of WHSFCT C2 and using the approach of “Zurich- Montpellier school” and the Braun-Blanquet method (Braun-Blanquet, 1964) of vegetation description, where an association is defined by its characteristic species, the “yellow sand” plant community could be termed the “*Daviesia nudiflora-Hakea ruscifolia-Ricinocarpos cyanescens*” association.

⁴ Smith (1994) measured the FPC of a *Eucalyptus marginata-Corymbia haematoxylon* formation in Dardanup forest block 20 km north of Happy Valley and the overstorey was in the range 43-47%.

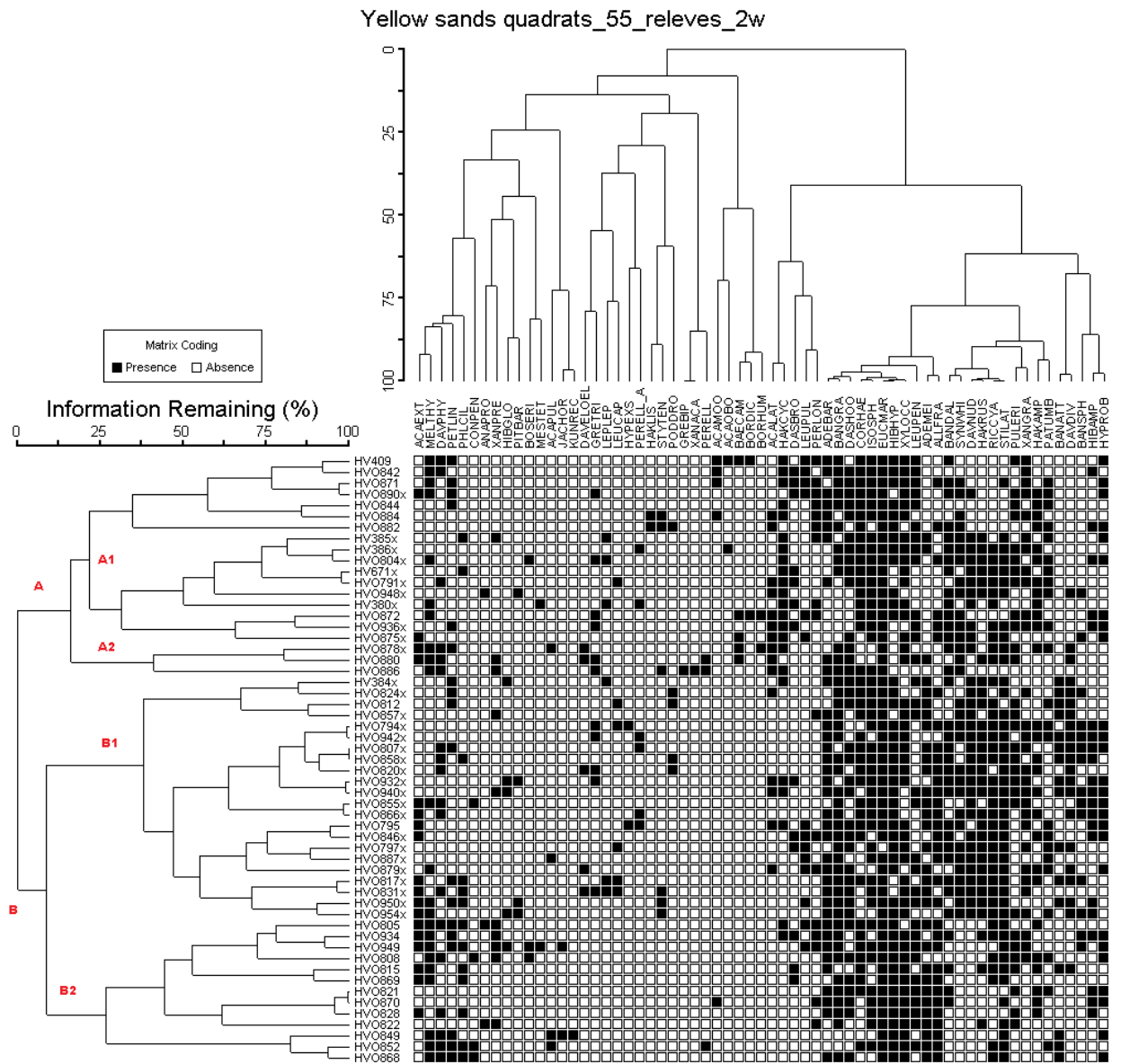


Figure 2. Hierarchical clustering diagram of floristic data from 55 relevés, those with a HV prefix are from Smith (2008a, b) and those with a HVO prefix are from this study.

6.3. Mapping the “yellow sand” plant community

Using the presence of *Daviesia nudiflora* and at least one other of either *Hakea ruscifolia*, *Ricinocarpos cyanescens* or *Synaphea whicherensis* four polygons were drawn to represent occurrences of the “yellow sand” plant community south of the Happy Valley mining leases. These occurrences of the community are shown in Fig. 3.

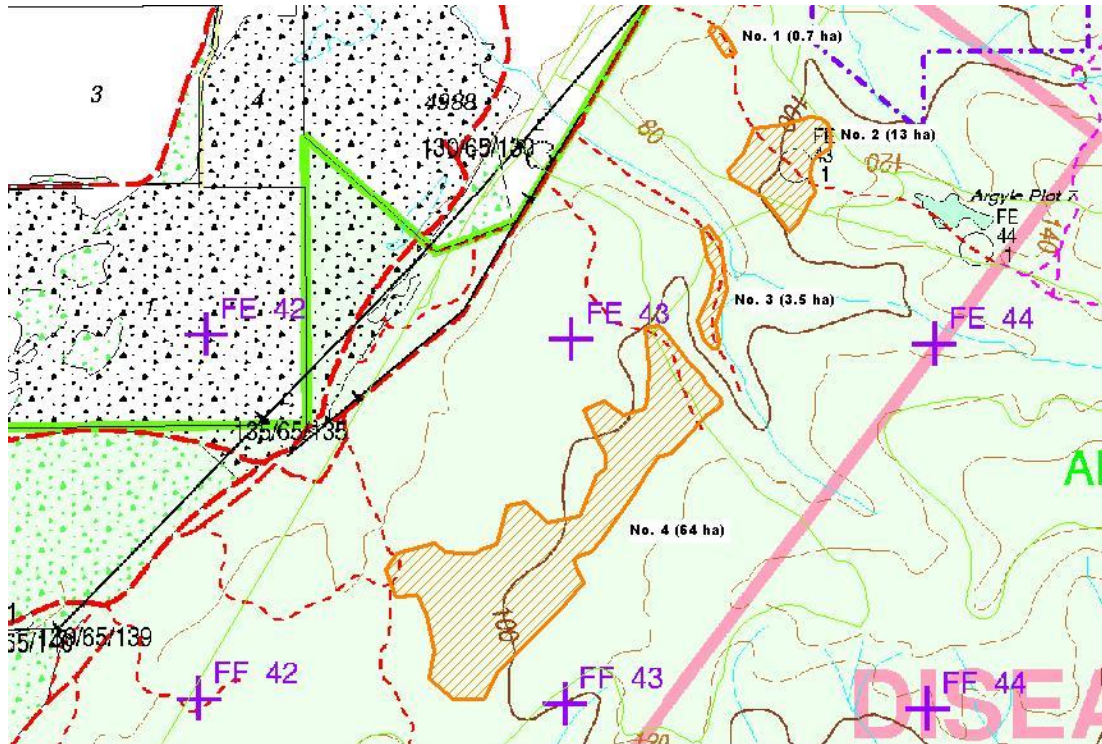


Figure 3. Occurrences of the “yellow sand” plant community in State forest south of the Happy Valley mining leases.

In total approximately 81.2 ha of the “yellow sands” plant community were mapped, which almost triples the known area. Most of occurrences number 1, 2 and 4 are located in areas mapped as Whicher Scarp landform (WsWC2 *Whicher Slopes* land unit), while occurrence number 3 is situated on the Rosa Valleys (GvRO4) and Whicher Valleys (WsWCv) land-units. The two larger occurrences (Nos. 2 and 4) are situated on a gently sloping bench between 90 and 110 m a.s.l. Upslope and downslope of these occurrences there are areas of grey sands, often with laterite outcropping. The “yellow sand” plant community appears to be predominantly associated with deeper (> 1m to laterite) soils (Smith, 2008b) lying in a shallow “trough” over the laterite layer of the Whicher Slopes landform (see geological sections in Strategen, 2006)

Occurrence No. 2 of the “yellow sand” plant community is unusual in that it is located in a shallow valley adjacent to an ephemeral creek on a “pocket” of moderately deep yellow-

brown sandy loam. It is also notable in that it contains a quite large population of the DRF species *Daviesia elongata* subsp. *elongata*.

7. DISCUSSION

The vegetation survey and assessment reported here has established that the “yellow sand” plant community mapped in the Happy Valley South mining lease as **EmChXoBgRc-DnSIHhSwDI** by BEC&OEC (2006) and labelled Floristic Group sub-unit C2b by Smith (2008b) extends more than 3 km south of the mining leases and that more than 80 ha of the community exists outside the lease. As would be expected for a Whicher Scarp plant association in a region where there is great alpha- and beta-diversity in plant species there is a fair bit of variation within the group. However, this study and a previous one (Smith, 2008b) have demonstrated that the “yellow sand” plant community has several characteristic plant species that together with its almost invariable occurrence on “yellow-grey” or “yellow-brown” sands or sandy-loams of moderate depth means that it is a distinct plant community that is easily characterized and recognized in the field.

The WHSFCT C2 community to which the “yellow sand” plant community (the “*Daviesia nudiflora*-*Hakea ruscifolia* -*Ricinocarpos cyanescens*” association) lies between the “Whicher Scarp Jarrah and Mountain marri woodland on laterites” (WHSFCT C3) upslope on the Kingia landform, and the Swan Coastal Plain/North Whicher Scarp *Banksia attenuata* woodland on the Cartis landform downslope. The yellow sands that are characteristic of the community are a transitional soil profile with the clays of the Kingia landform upslope being washed downslope and replaced with sands and gravel from upslope. The yellowish colour, which in places is strong enough for the soils to be termed “orange” is apparently as a result of relatively high iron levels compared to the pale grey Cartis soils downslope (HVN/Oracle, 2003).

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