PRELIMINARY REPORT ON THE MASS COLLAPSE SITE, ADMIRAL ROAD, GORDON BLOCK, JARRAHDALE DISTRICT

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Summary

Multiple jarrah and understorey deaths occurred suddenly over an area of about 2 ha in January 1993. Soil and plant sampling recovered *Phytophthora cinnamomi* from some, but not all, of the affected area. It was not recovered from the root collars, surface or sinker roots above the caprock of six dying jarrah trees. Many xylem vessels in these jarrah roots were occluded, a symptom which can be caused by waterlogging. Drainage into this mass collapse site would have been greater than normal over the previous 2 years as a result of surface runoff from both a major forest road, and an adjacent rehabilitated road, in 1992 there was heavy rainfall in February 1992 and a wetter than average June. As the soil profile is deep gravel over permeable caprock waterlogging appears to be improbable, but observations during the coming winter will show whether this is likely to have happened.

Introduction

In late January 1993 a mass collapse site was noticed down slope from a rehabilitated minesite in Gordon Block, Jarrahdale District. Several people from different organisations have investigated aspects of these deaths and this preliminary report collates their findings. Data have been collected by Abe van der Sande and Winston Kay (Inventory Section), Elaine Davison (Science and Information Division), Giles Hardy (Murdoch University), Ian Colquhoun and Ken McIntosh (Alcoa).

Field observations

Location

This mass collapse site covers about 2 ha to the W and SW of a recently rehabilitated mine site, west of Admiral Road (Alcoa block E3524, CALM BL61) (Fig. 1). It has a mid-slope position, in a gently sloping, SSW facing valley with no surface drainage. Deaths extend down the valley for about 400 m with a maximum width of about 100 m (Fig 2).

Vegetation

The stand is a low quality AB, jarrah marri stand which has been very heavily logged. The main vegetation type is Havel S/P. There are no wet site indicator species in the area where jarrah deaths have occurred, but *Baeckea camphorosmae* and *Hypocalymma angustifolium* occur down slope where understorey plants have died.

Symptoms

Multiple understorey deaths have occurred throughout the whole area, but jarrah deaths are confined to the top 300 m (Fig 2 areas A and B). Deaths are in all age classes. Marri is not affected. In the upper part of the site (area A) patchy banksia deaths and partial crown deaths of banksias and persoonias are not necessarily typical of a dieback site.

Many of the dead jarrahs at the top of the site had been attacked by borers, because in March, cockatoos had been stripping the bark from branches in the crowns.

Site

Site and dieback history

The area was cut over before 1969. There was some logging in 1984 and fencing materials and firewood were removed in 1987. It is part of cell 86/59 which was interpreted for dieback in Feb. 1987 when it was considered dieback-free. There were no old jarrah deaths in this site at that time. The adjacent area, which is now rehabilitated, was not interpreted. A dieback area WNW of the mass collapse site was present in 1986.

Between 1988 and 1990 during mining, Admiral Road was diverted around the western edge of the mined area through, what is now, the mass collapse site (Fig 1). This diversion was rehabilitated by ripping along the road alignment.

Soils

Soil descriptions are from the backhoe pits (Fig 2 1-5).

Pit 1: Deep, free draining gravel to 3.3 m over very permeable caprock, granitic in origin.

Pit 2: Similar to pit 1, except that caprock is at 2.2 m and iron content appears higher.

Pit 3: Soil profile is similar to pits 1 and 2 but is shallower (1.6 m). Caprock appears less permeable and porous than pits 1 and 2.

Pit 4: Similar to pit 3; soil profile 1.6 m.

Trench 5: Soil profile shallow (0.6-1.2 m), caprock boulders on surface. Caprock is least permeable and porous of all pits, but is still permeable, it shows secondary laterisation and has a very undulating surface. It is probably above a thin dolerite dyke.

Soil pH at 0.1-2.0 m in pit 2 was between 5.6 and 5.8. Soil conductivity below the surface soil was 4.0-9.7 mS m^{-1}.

Hydrology and drainage

There are indications of surface runout and erosion scours occurring from the rehabilitation of Admiral Road (Fig 1). There is also evidence of significant runout from a major forest track upslope (Fig 1). Small erosion scours and accumulation of debris indicate that significant waterflows have either ponded immediately upslope or discharged into the mass collapse site. This site will therefore have been much wetter than in previous years, particularly during winter.

There is no indication of significant erosion scours or surface water ponding in the rehabilitated minesite near the pit boundary. There is no evidence of water leaving the pit after rehabilitation.

Weather

Heavy rainfall on the Swan Coastal Plain in February 1992 is likely to have extended into this area. The isohyet for the 72 hours ending 0900 10.2.92 shows that this area will have had about 100mm of rain. June rainfall at Jarrahdale minesite was 75% higher than average.

Summer temperatures were generally mild, deaths occurred after the first prolonged hot period, 10 days when the daily maximum exceeded 30°C.

Dieback sampling, summer 1993

The area was inspected by dieback interpreters who concluded that there is no connection between an old dieback area 400 m to the WNW and this mass collapse site. They noted an old infection just below pit 4, indicating that this area had been infested for at least 3 years. This area displayed true Pc symptoms in all species, this was not so further upslope.

Plant and soil samples were taken on 10.2 93, 15.2.93, 17.2.93, 24.3.93 and 2.4.93. All samples were processed at Como. In total 31 samples have been taken of which 12 were positive for *Phytophthora cinnamomi* (Table 1). The location of samples taken by Winston Kay and Abe van der Sande are shown on Figure 2, all are in the lower half of the site (areas B and C).

Tree excavations (11.3.93)
Six dying jarrah trees (three growing close together) were pushed over and pits excavated to caprock to sample their root systems (pits 1-4). The crowns, stems, lateral and horizontal root systems were examined for lesions and insect attack.

The crowns and stems were drying out, there were no recent lesions in the branches, stems, or at the root collar. Many of the crowns had borers in them.

Surface roots were in the top 30 cm of soil in all pits. Many of these roots had old lesions on them. There were not many sinker roots in the soil profile, many of those which were present were dead and rotten, no fresh lesions were seen. The soil profile contained many fine (<5 mm) roots which appeared healthy.

Pathology
Root samples were returned to the laboratory for detailed examination and plating onto both selective and non-selective agar.

P. cinnamomi was recovered from the collar of a *B. grandis* dug out of pit 1, it was not recovered from any of the root collars, surface or sinker roots of the excavated jarrah trees. *Cylindrocarpon* , *Cytospora*, *Botryosphaeria*, *Fusarium* and a hyaline, septate non-sporing fungus were recovered from some root lesions, results are summarised in Table 2.

Root anatomy
Root segments from each excavated tree were fixed in FAA in the field. Surface roots were taken from close to the root collar, sinker roots were taken from the soil profile whenever they were excavated. Radial longitudinal sections of the roots were assessed as either live or dead, starch in ray and axial parenchyma noted, and the proportion of non-conducting (tylosed) vessels in sapwood was recorded.

Horizontal roots were at least 0.8 cm in diameter and sinker roots were between 0.6 and 3.4 cm in diameter. All of the 25 surface roots examined were alive but two of the 18 sinker roots were dead. Starch was more abundant in surface roots than sinker roots. Sinker roots had twice as many non-functional (tylosed) vessels as surface roots (Table 3).

Discussion of preliminary results

This site has the characteristics of a mass collapse site because there are many deaths of a wide range of species of all age classes in a discrete area. *P. cinnamomi* is present in the lower part of the site (Fig. 2 areas B and C), but has not been recovered from area A. Deaths in area C are restricted to understorey species, in areas A and B jarrah too has died. Recoveries of *P. cinnamomi* by the Dieback Detection Service have been lower than would be expected from such a high impact site, and are mainly from shallow rooted, understorey species. There have been no recoveries from jarrah (Tables 1 and 2). The dieback infection originated at least 3 years ago, close to the roadway, just below pit 4. There is no connection with an old dieback site upslope to the WNW.

There has been an increase in the water draining into the site over at least the past 2 years. This water has come from the rehabilitated Admiral Road and an old forest track upslope. There is no indication that there has been surface runout from the adjacent rehabilitated minepit. There was heavy rainfall in February 1992 and June was wetter than average. The soil profile is, however, deep, and although caprock in pit 5 may be less permeable than in the other pits, there is no indication of concreted laterite,

and it is certainly not uniformly close to the soil surface (Shea *et al.* 1982). Observations at the site during the coming winter will indicate whether waterlogging occurs.

Within the area jarrah has been under stress for several months prior to the crowns changing colour, as indicated by the presence of borers. There were no root collar lesions (Shearer *et al.* 1981) or root cankers at the surface of the caprock (Shea *et al.* 1982) on the excavated trees. *P. cinnamomi* was not recovered from jarrah root (Table 2). Surface and sinker roots, however, had many occluded vessels in the sapwood (Table 3), and so the roots may have been unable to conduct sufficient water to maintain transpiration. Cavitation occurs and tyloses form in sapwood adjacent to injury and pathogenic invasion, but there was no indication that sinker roots were extensively lesioned. Tyloses will also form in jarrah roots when seedlings are waterlogged (Davison and Tay 1985), but there is no indication that this has occurred although water draining into the site will have increased in the past 2 years.

References

Davison, E. M. and Tay, F. C. S. (1985), The effect of waterlogging on seedlings of *Eucalyptus marginata*. New Phytol. **101**, 743-753.

Shea, S. R., Shearer, B. and Tippett, J. (1982), Recovery of *Phytophthora cinnamomi* Rands from vertical roots of jarrah (*Eucalyptus marginata* Sm). Australas. Plant Pathol. **11**, 25-28.

Shearer, B. L., Shea, S. R. and Fairman, R. G. (1981), Infection of the stem and large roots of *Eucalyptus marginata* by *Phytophthora cinnamomi*. Australas. Plant Pathol. **10**, 2-3.

Future action

At the request of the Executive Director of CALM the site has been protected.

Close off access road and erect signs (Jarrahdale district and Alcoa).
Survey the site (Alcoa).
Blaze trees along the site boundary (Jarrahdale District).
Construct bunds around the excavated pits to prevent surface water running into them (Alcoa).
Install bores to monitor water table over winter (Alcoa).
Establish permanent sample plots to monitor resprouting (Alcoa).
Sample bottom of pits and bottom of rehab. in relation to caprock (Alcoa).
Collate historical data in relation to clearing and stripping the minesite, diversion, re-alignment and rehabilitation of Admiral Road (Jarrahdale district and Alcoa).
Drill site if necessary (Alcoa).
Re-survey site in 1994 (Inventory).

Table 1 **Dieback sampling from the mass collapse site.**

Sample date	Sampled by:	Plant species	Sample number	Result
10.2.93	I. Colquhoun	*Eucalyptus calophylla*		-
		Styphelia tenuiflora		+
		Isopogon sphaerocephalus		-
		Hibbertia huegelii ?		-
		Soil (surface)		–
15.2.93	I. Colquhoun	Soil (surface)		+
		Soil (surface)		-
		Leucopogon nutans		+
		Soil (surface)		–
17.2.93	W. Kay	*Dryandra sessilis*	1	+
		L. nutans	2	+
		Banksia grandis	3	-
		Adenanthos barbigera	4	+
		Persoonia longifolia	5	-
		E. marginata	6	-
		B. grandis	7	-
		B. grandis	8	-
		P. longifolia	9	-
24.3.93	A. van der Sande	*B. grandis*	11	-
		B. grandis	12	-
		?	13	+
		E. marginata	14	-
		Xanthorrhoea preissii	15	+
		B. grandis	16	-
		E. marginata	17	-
		B. grandis	18	-
2.4.93	I Colquhoun	Soil Pit 2 (caprock surface)		+
		Soil Pit 3 (caprock surface)		+
		Soil Pit 4 (caprock surface)		+
		Soil Trench 5 (caprock surface)		+

Table 2 **Recovery of fungi from fresh root lesions of excavated jarrah trees at the mass collapse site.**

Tree	Root type	No. roots examined	No. lesions or root samples plated	Fungi isolated
T1	Surface	25	23	*Cytospora* (2)* *Cylindrocarpon* (1) *Fusarium* (2) Hyaline, septate, non-sporing (4)
	Sinker	5	7	Hyaline, septate non-sporing (2)
T2A	Surface	6	14	*Botryosphaeria* (1) *Cytospora* (3) *Cylindrocarpon* (1) Hyaline, septate non-sporing (4)
	Sinker	8	8	Hyaline, septate, non-sporing(3)
T2X	Lignotuber	1	2	*Cylindrocarpon* (1) *Cytospora* (1)
	Root collar	1	1	*Cytospora* (1)
	Taproot	1	1	*Cylindrocarpon*(1)
T2Y	Lignotuber	1	2	Ascomycete (1)
	Root collar	1	1	*Nodulisporium*-like
	Taproot	1	1	Sclerotial
T2B	Surface	5	3	*Fusarium* (1)
T2C	Surface	4	4	*Cytospora* (1) *Fusarium* (1)
T3	Surface	9	8	*Botryosphaeria* (1) *Cytospora* (2) *Fusarium* (1) Hyaline, septate, non-sporing (3)
	Sinker	6	4	Hyaline, septate, non-sporing (4)
T4	Surface	11	4	*Cytospora* (1) *Cylindrocarpon*(1)

* Number of lesions from which this fungus was isolated.

Table 3 **Proportion of non-functional vessels in the sapwood of surface and sinker roots of excavated jarrah trees at the mass collapse site.**

Tree	Root type	Number of roots examined	Proportion of vessels with tyloses (%)	Proportion of vessels with tyloses (% range)
T1	Surface	6	60.5 (34.5)*	4-99
T1	Sinker	2	95.0 (7.1)	90-100
T2A	Surface	3	16.0 (7.1)	8-32
T2B	Surface	5	37.4 (40.0)	0-86
T2X	Surface	3	12.3 (4.7)	7-16
T2	Sinker	7	67.0 (30.1)	10-100
T3	Surface	5	5.8 (13.0)	0-29
T3	Sinker	4	77.5 (24.6)	42-96
T4	Surface	3	34.0 (26.0)	4-50
T4	Sinker	5	61.0 (12.9)	48-80
All trees	Surface	25	30.6 (32.4)	0-99
All trees	Sinker	18	70.8 (24.1)	10-100

* Standard deviation

FIGURE 1

SURFACE RUNOFF AT ADMIRAL RD SITE

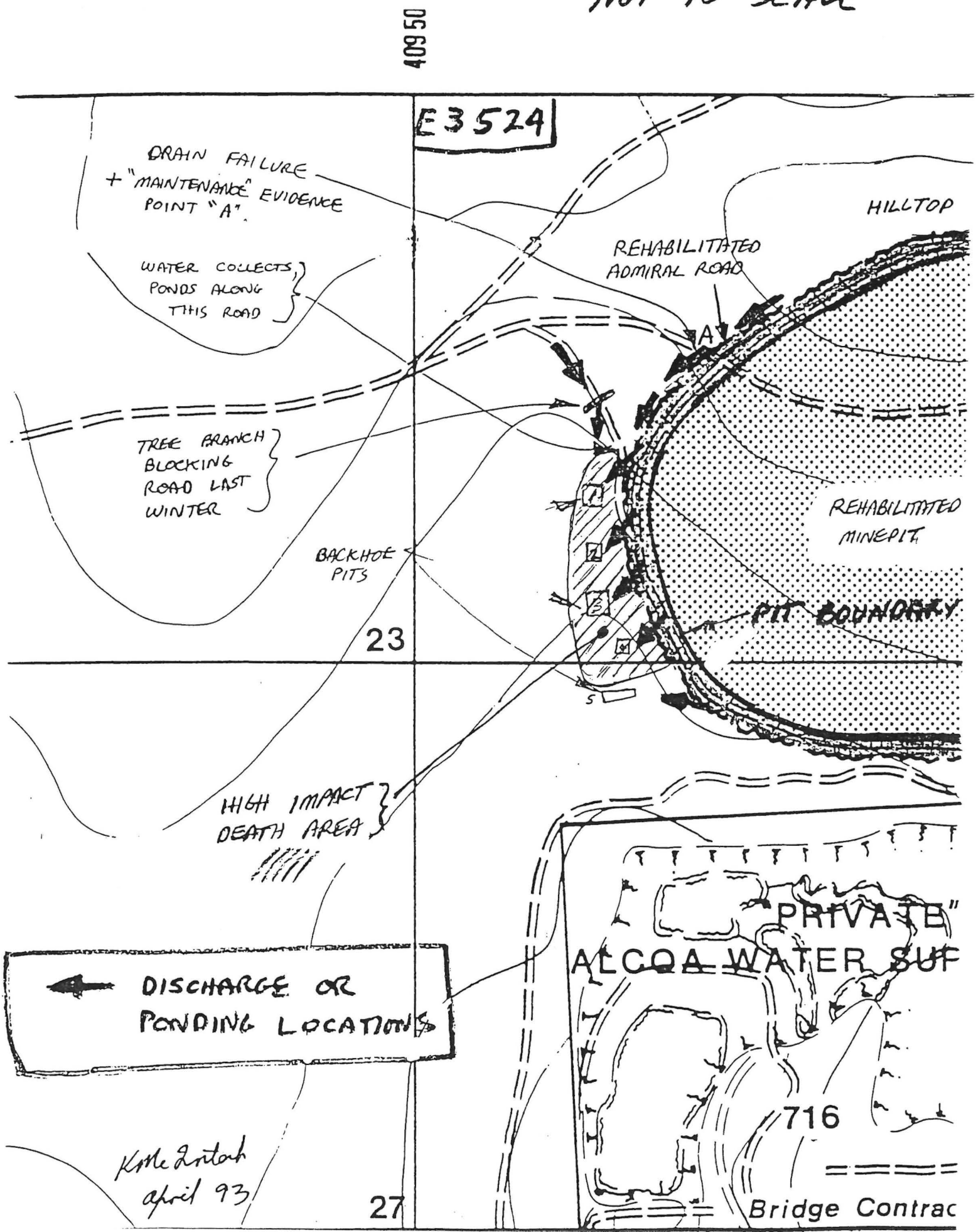

FIGURE 2

OFFBACK SAMPLING AT ADMIRAL RD. SITE

