

# Phytophthora Management Guidelines

Phytophthora Technical Group

2006  
2nd Edition



Government  
of South Australia

# Phytophthora Technical Group

2006

*Bill Doyle*

*City of Playford / Local Government Association*

*Barbara Hall*

*SARDI / PIRSA*

*Edda Keskula*

*Nursery & Garden Industry South Australia Inc.*

*Charlma Phillips*

*ForestrySA*

*Trevor Ranford*

*Apple and Pear Growers Association*

*Tim Reynolds*

*Department for Transport, Energy and Infrastructure*

*Renate Velzeboer*

*Department for Environment and Heritage*



**The Apple and Pear Growers  
Association of SA**



Department for Environment and Heritage  
Primary Industries and Resources SA  
Department for Transport, Energy and Infrastructure

## Acknowledgements

The Phytophthora Technical Group is supported by *Yurrebilla – The Greater Mount Lofty Parklands* an initiative of the Department for Environment and Heritage.

The assistance of the following organisations is gratefully acknowledged:

PIRSA / SARDI

City of Playford / Local Government Association

ForestrySA

Apple and Pear Growers Association of South Australia Inc.

Transport SA/ Department for Transport, Energy and Infrastructure

Department for Environment and Heritage

Nursery & Garden Industry South Australia Inc.

Front Cover photo “Deep Creek” courtesy Department for Environment and Heritage

# Contents

	Page
1. Aim	5
2. Introduction	6
3. Glossary	6
4. History and distribution in South Australia	7
5. Information on <i>Phytophthora</i>	8
5.1 What is <i>Phytophthora</i> ?	8
5.2 Life cycle and spread of <i>Phytophthora</i>	8
5.3 Disease symptoms	9
5.4 Susceptibility	10
6. Management of <i>Phytophthora</i>	11
6.1 Vulnerable areas	11
- 6.1.1 Case Studies	13
6.2 Activities which are at risk of spreading <i>Phytophthora</i>	17
6.3 Management strategies	18
- 6.3.1 Sites of High Conservation Value	24
- 6.3.2 The Use of Phosphite	24
7. References and further reading	25
8. Appendices	27
8.1 Native plant species susceptible to <i>Phytophthora cinnamomi</i> in South Australia	27
8.2 Native plant species that may be susceptible to <i>Phytophthora cinnamomi</i> in South Australia	28
8.3 Signage	29
8.4 Hygiene procedures for vehicles, machinery, equipment and footwear	33

## 1. Aim:

The aim of the Phytophthora Management Guidelines is to provide a framework for the management of *Phytophthora* by Government and non-government organisations, landholders, community groups and individuals, in order to achieve the following goals:

1. To contain and minimise the spread of *Phytophthora* in South Australia.
2. To manage infected areas in such a way as to minimise the effect on the environment and on recreational activities.
3. To protect uninfected areas and minimise the risk of them becoming infected.
4. To promote a “whole of Community” approach to the management of *Phytophthora* in South Australia.

## 2. Introduction

*Phytophthora* causes dieback of native and introduced plants including ornamentals, vines, fruit and vegetables. *Phytophthora* dieback occurs in native bushlands such as open forests, woodlands and heathlands, farmlands, nurseries and gardens. It is a major threat to some of Australia's threatened native species (both animal and plant) and ecological communities. There are 32 species of *Phytophthora* in Australia. Of these, *P. cinnamomi*, *P. citricola*, *P. cryptogea* and *P. megasperma* are the most common with *P. cinnamomi* being the most widespread and destructive species. *Phytophthora cinnamomi* is listed as a key threatening process in Schedule X of the Commonwealth "Environment Protection and Biodiversity Conservation Act 1999". As part of the Commonwealth Government obligations under this Act, a "Threat Abatement Plan for Dieback caused by the root-rot fungus *Phytophthora cinnamomi*" was developed in 2001. This can be viewed at the following web site: <http://www.deh.gov.au/biodiversity/threatened/publications/tap/phytophthora/index.html>

Once an area is infected with *Phytophthora*, eradication is not possible. However, well-developed management plans and appropriate management practices can assist in containing the disease and minimising the likelihood of spread to uninfected areas.

These *Phytophthora* Management Guidelines apply to all species of *Phytophthora*. It is anticipated that all organisations will use these guidelines as a basis for their own management plans and operational procedures. The implementation of the management strategies in these guidelines by Government agencies, private organisations, landholders, clubs and societies and by anyone whose activities take them into *Phytophthora* affected areas is essential if the goals outlined are to be achieved.

## 3. Glossary:

**Confirmed:** Symptoms (see 5.3) of *Phytophthora* infection are present in plants and *Phytophthora* has been confirmed by soil analysis.

**Suspected/Unconfirmed:** Symptoms (visual) of *Phytophthora* infection are present in plants but *Phytophthora* has not been confirmed by soil analysis or has not been tested.

## 4. History and Distribution in South Australia

*Phytophthora* is native to South East Asia. It was probably introduced into Australia shortly after European settlement in the late 1800's. *Phytophthora* is now present in all states of Australia.

In South Australia, *Phytophthora* was first identified in 1969 in the Mount Lofty Ranges. The present known distribution in South Australia includes several Conservation Parks, National Parks, Forest Reserves and many roadside reserves in the Mount Lofty Ranges, Fleurieu Peninsula and on Kangaroo Island. The presence of *Phytophthora* is suspected on Eyre Peninsula. It has not yet been identified on Yorke Peninsula. In the South East, *P. cinnamomi* was identified in the 1970's from nursery stock in Mt Gambier (this nursery site no longer exists) but has not been identified since then, though other *Phytophthora* species are found in several areas.

The risk of *Phytophthora* becoming established is highest in areas with

- greater than 400mm average annual rainfall
- warm, moist conditions (optimum temperature = 15-30°C)
- neutral to acid soils, low in nutrients and organic matter, open textured with few micro-organisms
- poor drainage
- plants that are susceptible to infection (see 8.1)

The South Australian Department for Environment and Heritage (DEH) maintains a database of all known confirmed and suspected *Phytophthora* locations. This database can be accessed by contacting the Ecologist – Plant Dieback at DEH (phone: (08) 8552 0306 or E-mail [Velzeboer.Renate@saugov.sa.gov.au](mailto:Velzeboer.Renate@saugov.sa.gov.au)). New confirmed or suspected infestations should be reported to the Ecologist – Plant Dieback.

## **5. Information on *Phytophthora***

### **5.1 What is *Phytophthora*?**

*Phytophthora* is a microscopic, soil and water borne organism that attacks the roots and basal stem tissue of living plants. It is often referred to as a “fungus”. *Phytophthora* infects the roots and basal stem tissue preventing the uptake of water and nutrients by the plant, causing dieback.

Identification of *Phytophthora* requires a visual inspection and analysis of soil and root samples by qualified scientists.

Once an area is infested with *Phytophthora* it is always infested.

### **5.2 Life cycle and spread of *Phytophthora***

*Phytophthora* produces a mass of thread-like filaments (known as mycelia) that can be transported to new hosts via soil or infected plant material. Under warm, moist conditions, *Phytophthora* reproduces via microscopic fruiting bodies that produce spores. Three types of spores are produced: zoospores, chlamydospores (both vegetative spores) and oospores (sexual spores). The most important spores in the spread of *Phytophthora* are:

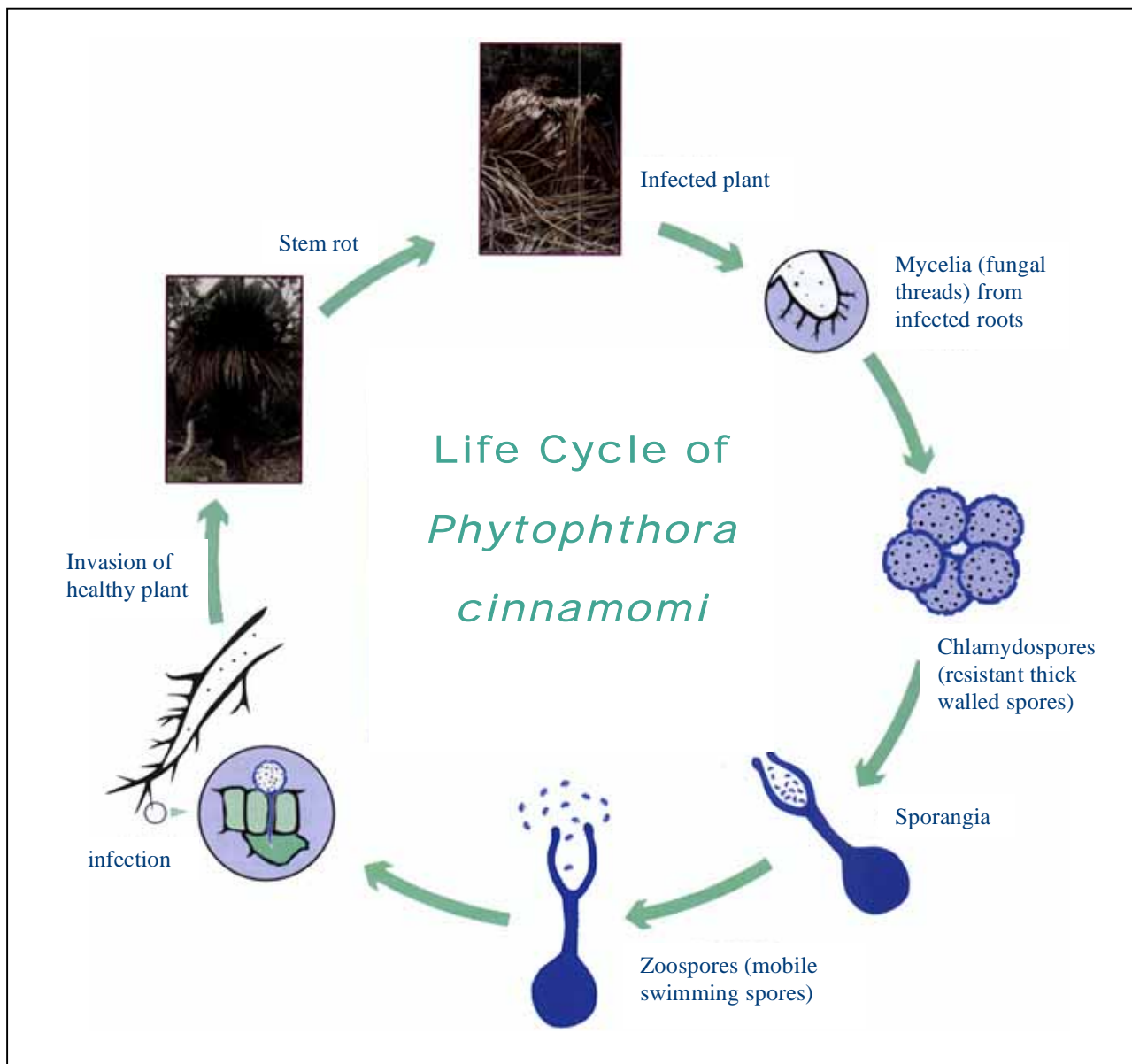
- zoospores - these are short-lived (approximately 48 hours) and are released in large numbers in moist conditions. They are able to move through the soil in ground water and surface water and infect susceptible plants
- chlamydospores - these can survive in soil and in plant tissue for many years. They are hard-coated and can easily withstand long periods of dry conditions. They germinate when conditions are favourable (warm and moist).

Any movement of soil, water and/or plant material has the potential to spread *Phytophthora* to new areas.

The most common and fastest means of spread is through movement of infested soil and plant material by humans (see 6.2). *Phytophthora* can also be spread by movement of water (both surface and groundwater), animals and from plant to plant via mycelial growth through the soil from infected roots (a relatively slow method of spread).

Spread is very site-specific depending on the topography of the site and on soil and climatic conditions.





**Fig. 1 Life Cycle of *Phytophthora cinnamomi***  
 Courtesy Department for Environment and Heritage

### 5.3 Disease Symptoms

Plant dieback is common (particularly in native plants) and *Phytophthora* is only one of many possible causes. Other causes include insects (for example lerps), environmental factors (for example drought, nutrient imbalances and salinity), old age, fungi and diseases. Indications that point to the likelihood of dieback being caused by *Phytophthora* include:

1. Disease/death of susceptible plant species - some plants are more susceptible to *Phytophthora* than others and these can be used as "indicator" species to detect the possible presence of *Phytophthora*.

2. Species known to be resistant to *Phytophthora* remain healthy.
3. Diseased plants with general discolouration of foliage, usually red or yellow foliage.
4. Progression of deaths over time. On slopes, deaths progress down the slope.
5. A sharp boundary may be present between diseased and healthy areas.

Disease symptoms vary between plant species. For example, *Xanthorrhoea* species die rapidly and may collapse. In *Banksia* sp. leaves turn reddish. In *Eucalyptus* spp. (*E. baxteri* and *E. obliqua*) there may be sudden deaths or there may be dieback of branches over several years. Affected trees may reshoot (epicormic growth) but will eventually die. The Bush peas, some species of Heath (Epacridaceae) and Myrtle Wattle (*Acacia* spp.) turn yellow, with dieback occurring in warm moist periods during spring, summer (if moist and warm) and autumn. Plants may recover during dry periods in summer or cold periods in midwinter, but dieback occurs again the following spring and autumn.

Note: visual symptoms may take years to develop after the initial infection. They may not develop until the plants are under stress (*Phytophthora* is more active in warm and wet conditions). To confirm the presence of *Phytophthora*, samples of soil and plant roots must be analysed in the laboratory. However, even if laboratory analysis does not confirm the presence of *Phytophthora*, this does not necessarily mean it is absent. If the presence of *Phytophthora* is suspected, always treat the area as if its presence has been confirmed.

## **5.4 Susceptibility**

Species that are highly susceptible to *Phytophthora* have no resistance and once infected rapidly die. These species are often used as indicator species, as they are generally the first to show symptoms of infection. The best indicator species for the disease in native plants in South Australia is the Grass-tree (*Xanthorrhoea* spp.). Other susceptible species are given in Appendix 8.1.

Within a plant genus there may be considerable variation in resistance – for example in the genus *Eucalyptus*, most species in the subgenus *Symphomyrtus* and subgenus *Corymbia* (Gums, Boxes and Ironbarks) are relatively tolerant but most species in the subgenus *Monocalyptus* (Ashes, Stringybarks and Peppermints) are susceptible.

Few plants are truly resistant to *Phytophthora*. *Phytophthora* is capable of infecting the roots of most species - but some plants are able to contain the pathogen once it penetrates the roots and prevent it from invading the rest of the root system and plant collar. These plants survive but may show mild dieback symptoms or no symptoms at all. Other plants, such as grasses and sedges, are able to rapidly produce new roots to replace those infected by the pathogen and so are able to withstand infection.

## 6. Management of *Phytophthora*

There is NO cure for *Phytophthora* – Once an area is infested with *Phytophthora* it is always infested. It is not possible to control the spread of *Phytophthora* by native animals nor is it always possible to control spread via soil moisture or surface water once *Phytophthora* is present in an area. However it is possible, and most important, to control the spread of *Phytophthora* by humans. Management strategies involve modifying /adapting human behaviour and activities to minimise the spread of *Phytophthora* to uninfected areas by:

- modifying activities
- controlling access
- adopting hygiene procedures

### 6.1 Vulnerable Areas

**Vulnerable areas** are those areas where susceptible vegetation is present and where environmental conditions (such as average annual rainfall of 400mm or more and neutral to acid soils, see also page 6) are such that there is the potential for *Phytophthora* to become established.

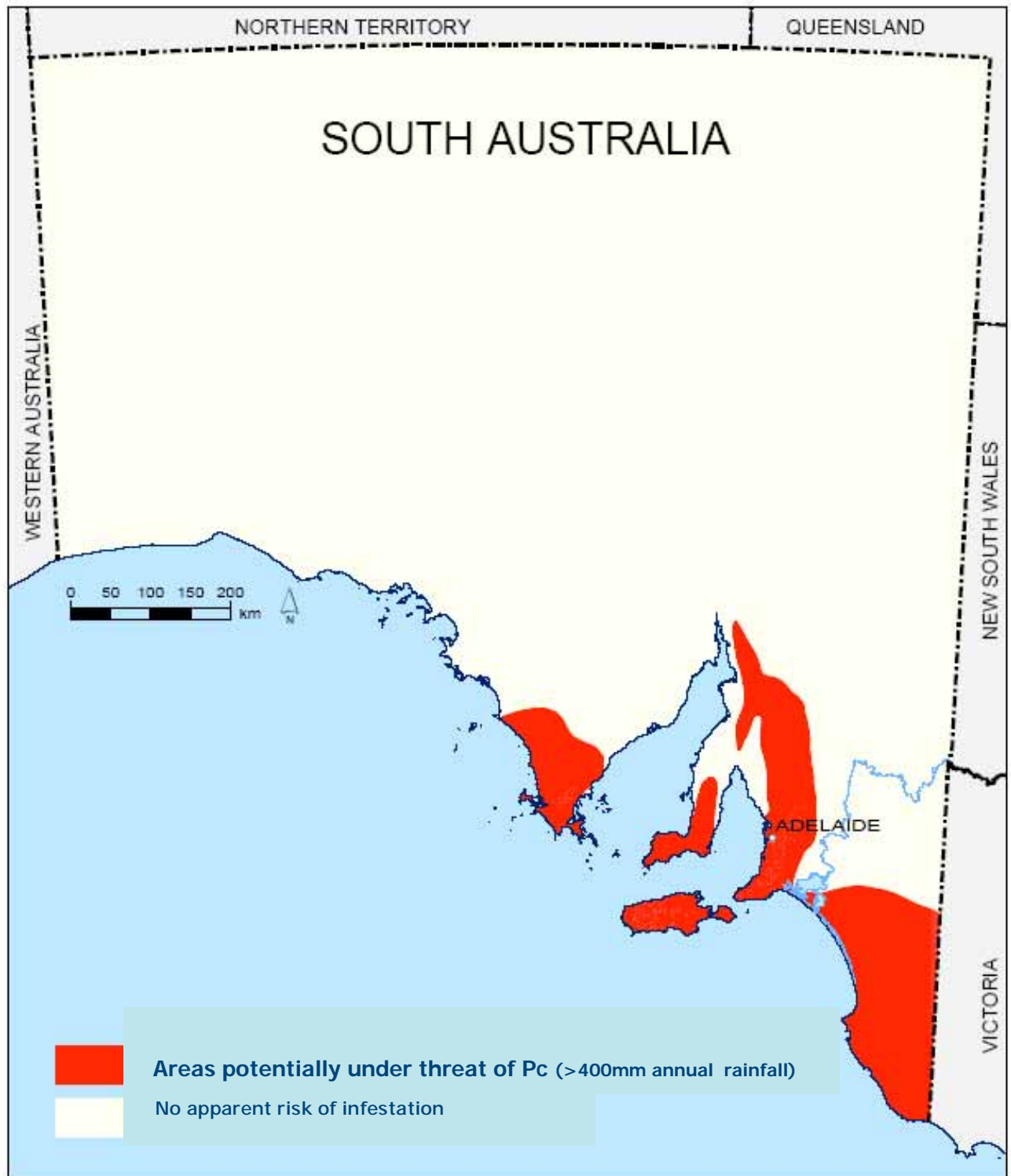
Figure 2 shows those areas of South Australia, which receive 400mm or more average annual rainfall.

- Areas vulnerable to *Phytophthora* include:
  - The Mount Lofty Ranges
  - Fleurieu Peninsula
  - Kangaroo Island
  - Lower Eyre Peninsula

There are some areas in South Australia, which receive 400mm, or more average annual rainfall but where *Phytophthora* is unlikely to become established due to non-conductive soil types (mainly limestone and sandy soils) being present. However these areas may contain isolated pockets of conductive soil types where *Phytophthora* could become established.

- Such areas include:
  - Yorke Peninsula
  - Upper and Lower South East

**Non-vulnerable Areas** are those areas where there is no apparent risk of *Phytophthora* infestation as vegetation is tolerant and/or environmental conditions are not conducive to establishment of *Phytophthora* (eg less than 400mm average annual rainfall). These are all other areas of South Australia not mentioned above.



**Fig.2 Vulnerable Areas map** (Courtesy DEH)

### 6.1.1 Case Studies

One of the aims of the *Phytophthora* Management Guidelines is to provide a framework for organisations to use as a basis for their own management plans and operational procedures. Several organisations, including the Department for Transport, Energy and Infrastructure (DTEI) (formerly Transport SA), Adelaide Hills Council, SA Water, Electricity Trust of South Australia (ETSA) and the Department for Environment and Heritage (DEH) in South Australia have already developed Standard Operating Procedures for activities in *Phytophthora* areas. Different approaches have been used in the following two case studies.

#### **Case Study 1. The Department for Transport, Energy and Infrastructure**

The Department for Transport, Energy and Infrastructure (DTEI) approach is a conservative one and assumes that *Phytophthora* is present all through the Vulnerable areas. Testing to confirm the presence of *Phytophthora* is no longer conducted due to cost and difficulty of sampling for confirmation of infestation. DTEI has adopted hygiene procedures in all Vulnerable areas (as defined in the *Phytophthora* Management Guidelines) in South Australia.

DTEI has developed an Operational Instruction for all activities undertaken by DTEI staff, contractors to DTEI or lessees of property under the responsibility of DTEI, including:

- routine maintenance;
- construction;
- field inspection and survey; and
- landscaping and land management works.

DTEI recognizes High, Medium and Low Risk Areas as shown in Fig 3.

- *High Risk Areas* are those areas where *Phytophthora* is known to be present or has the likelihood of becoming established.
- *Medium Risk Areas* are those areas where *Phytophthora* has not yet been recorded but have the potential to for *Phytophthora* to become established.
- *Low Risk Areas* are all other areas.

The DTEI Operational Instruction includes Control Principles and Procedures to reduce the risk of spreading *Phytophthora* both within and from High Risk Areas. The procedures apply to activities within quarries, pits, water storages, natural watercourses and all other areas outside transport corridors as well as to activities within transport corridors and cover:

- Planning
- Clean-down
- Vehicle movement
- Earthworks and patrol grading
- Drains
- Plant lay-down areas
- Vegetation control
- Vegetation removal and pruning
- Borrow pits and quarries
- Water supplies
- Plant nursery stock
- Hygiene breakdowns

DTEI has also identified specific roadside reserves within the Adelaide Hills, Fleurieu Peninsula and Kangaroo Island where hygiene and control procedures apply.



Produced by Transport Information Management Section 22 September 2000

**Phytophthora Risk Areas**

- Nil or very low risk
- Moderate risk
- High risk

- Region Boundaries
- TSA Maintained Roads

**Phytophthora (Dieback) Risk Areas  
in South Australia**

The information and data are provided herein as an information resource only. Whilst all reasonable care has been taken in the preparation of this information, Transport SA is not able to warrant the accuracy of this information and accepts no responsibility for any loss, injury or any other liability incurred by any person that arises as a result of the use of this information by any person or organisation.



**Fig.3 Phytophthora (Dieback) Risk Areas in South Australia** (Courtesy Department for Transport, Energy and Infrastructure 2005)

## **Case Study 2. The Department for Environment and Heritage**

The Department for Environment and Heritage (DEH) approach differs from that of DTEI in that the strategies adopted by DEH for *Phytophthora* management depend on the Risk Management Zone and the proposed activity in that zone. Activities such as earthworks, carried out in High Risk Management Zones require stricter *Phytophthora* management than those carried out in Low Management Risk Zones.

DEH has developed an Operating Procedure to protect the integrity of natural areas by minimising the risk of *Phytophthora* infestation and spread to areas within and outside land managed by DEH and other lands at risk from *Phytophthora* infestation. These procedures apply to all activities undertaken by DEH staff, contractors and volunteers. Such activities include:

- Road construction and maintenance
- Travel on sealed and unsealed roads and tracks
- Walking trail construction and maintenance
- Landscaping
- Vegetation and pest plant management
- Fire management
- Biological surveys and research
- Recreation

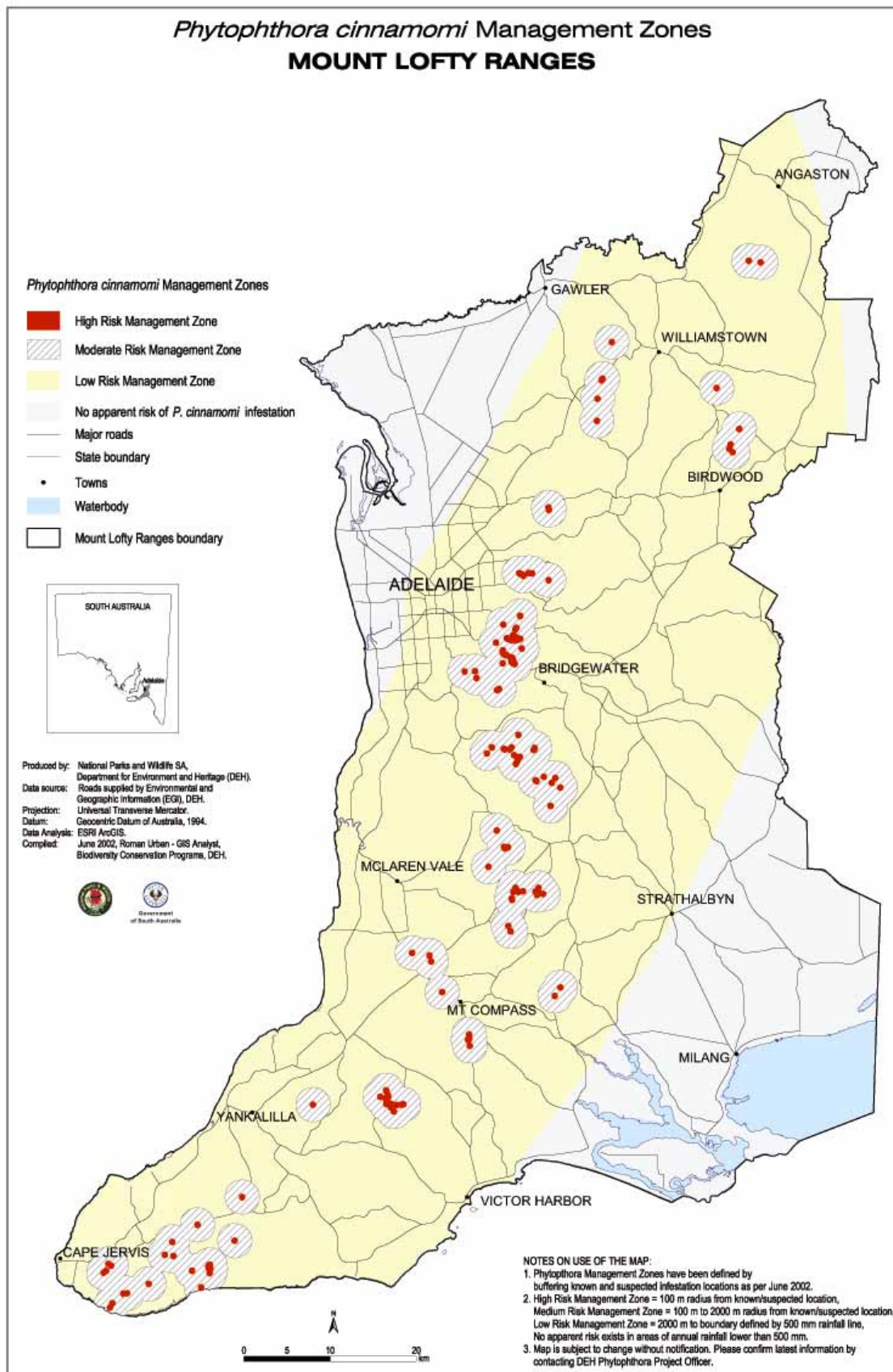
As part of these procedures, DEH has designated *Phytophthora* Risk Management Zones at a Regional and Park level. These zones are based on the presence or absence of *Phytophthora* and are all located within vulnerable areas.

The DEH zones are:

- *High Risk Management Zone* - zone where *Phytophthora* is confirmed (by laboratory testing) or is suspected (from a visual inspection – indicator plants showing typical symptoms of infection). (This zone includes a 100m buffer zone).
- *Moderate Risk Management Zone* - zone where *Phytophthora* is not yet suspected or confirmed but has the potential to be infected, based on the presence of susceptible plant species, appropriate environmental / climatic conditions and proximity to a confirmed *Phytophthora* infestation. This zone is within 2kms of a High Risk Management Zone.
- *Low Risk Management Zone* - *Phytophthora* is not suspected or confirmed. This zone is outside the Moderate Risk Management Zone but still within the Vulnerable area.
- *Sites of High Conservation Value* where extreme care must be taken to ensure *Phytophthora* is not introduced into these areas.

Risk Management Zones within the Mount Lofty Ranges Vulnerable Area are shown in Fig. 4. The Operating procedure includes details of hygiene measures, principles and procedures for each Risk Management Zone.





**Fig. 4 Risk Management Zones within the Mount Lofty Ranges Vulnerable Area.** (Courtesy: *Phytophthora* Threat Management – (Standard Operating Procedure) 2002 DEH)



## **6.2 Activities that are at Risk of spreading *Phytophthora***

All activities that involve movement of soil, water and plant material (whether deliberately or accidentally) have the potential to cause the spread of *Phytophthora*. Moist soil and plant material readily adhere to machinery, equipment, tyres, tools, hooves, footwear and camping equipment. Such activities include:

- **Earthworks**
  - construction and maintenance of roads and trails (including walking, horse riding and mountain bike trails)
  - landscaping
  - construction and maintenance of firebreaks, powerlines etc
  - forestry operations
  - management of drainage
- **Movement of machinery, equipment, vehicles, livestock**
  - between sites and along roads and tracks
  - logging operations
  - forest management
  - management of powerlines etc
  - pest and pest plant management
  - off-road vehicles – (4WD's, trail bikes etc)
  - movement of livestock
- **Recreational activities**
  - bushwalking
  - orienteering and associated activities
  - bike riding
  - horseriding
  - motorbike riding
  - 4-wheel driving
  - camping
- **Revegetation Activities**
  - plant propagation
  - movement of planting stock
  - planting out operations
  - movement of machinery, vehicles and equipment
- **Nursery Activities**
  - plant propagation
  - movement of planting stock
  - planting out operations
- **Fire Management / Emergency Services Activities**
  - construction and maintenance of firebreaks
  - fire management and rescue practices

### 6.3 Management strategies

Management strategies are aimed at minimising the spread of *Phytophthora* to ensure it remains localized and is not spread to surrounding uninfested areas. These strategies should be appropriate to the vulnerability of the site (see Section 6.1) and the proposed activity. Contractors should also be required to adhere to these strategies. It is important to recognise that management strategies can only be implemented according to available resources.

**NOTE:** Any sites where a *Phytophthora* infestation is suspected should be treated as if the presence of *Phytophthora* has been confirmed at that site.

Management Strategies involve the following:

- A. Modifying behaviour:
  - Plan activities in advance
  - Work in uninfested areas first before moving into infested areas
  - Postpone activities in wet conditions
  - Disturb the soil as little as possible
- B. Controlling access
  - Restrict movement of people, vehicles and equipment
- C. Adopting hygiene procedures
  - Washdown of vehicles, machinery, footwear
  - Travel only on designated roads and tracks
  - Ensure raw materials are free of *Phytophthora*
  - Ensure water and effluent does not drain towards vegetation
  - Do not remove water, soil or plant material from the infested area
  - Provision of washdown stations as appropriate
- D. Ensuring awareness of *Phytophthora*
  - Erect signs as appropriate
  - Provide information on *Phytophthora* and its spread, as appropriate



**Fig. 5 Entrance to Kyeema CP**

Activity	Management Strategy
<p><b>Activities involving earthworks</b></p> <p><b>Activities involving movement of machinery, equipment, vehicles, stock</b></p>	<p><b>A. Modify behaviour</b></p> <ul style="list-style-type: none"> <li>- Plan all activities in advance. Ensure <i>Phytophthora</i> status of the area is known.</li> <li>- Avoid working in wet conditions. Restrict activities to times when dry soil conditions exist (generally from November – March, but may vary from year to year). Postpone activities in wet weather.</li> <li>- Work in uninfested areas first before moving to infested areas.</li> </ul> <p><b>B. Control access</b></p> <ul style="list-style-type: none"> <li>- Restrict movement of people, vehicles and equipment. It may be necessary to quarantine areas, either permanently or temporarily (for example when the soil is moist).</li> </ul> <p><b>C. Adopt hygiene procedures</b></p> <ul style="list-style-type: none"> <li>- Ensure vehicles, machinery, equipment and footwear are free of mud, soil and plant material.</li> <li>- Travel only on designated roads and tracks. Avoid entering surrounding bushland.</li> <li>- Ensure all materials used, including rubble, sand and gravel, are free of <i>Phytophthora</i>. If in doubt, look for visual symptoms of <i>Phytophthora</i> infestation in vegetation surrounding the quarry or gravel pit and/or have soil/gravel samples tested in the laboratory.</li> <li>- Ensure all water used is free of <i>Phytophthora</i>. Disinfect water obtained from dams and streams with chlorine (2ppm for 20 minutes). Water from domestic supplies, deep bores or rain water does not usually require treatment unless stored in containers exposed to soil organic matter.</li> <li>- Do not remove any soil or plant material.</li> <li>- Restrict soil movement. Replace at original site if possible.</li> <li>- Ensure water and effluent does not drain towards vegetation.</li> <li>- Avoid sites prone to flooding and ponding.</li> <li>- Provide hygiene stations as appropriate.</li> </ul> <p><b>D. Ensure awareness of <i>Phytophthora</i></b></p> <ul style="list-style-type: none"> <li>- Erect signs as appropriate.</li> <li>- Educate staff as to the importance of <i>Phytophthora</i> and their role in preventing its spread.</li> <li>- Provide information to relevant organisations / contractors / landholders as to their obligations to prevent the spread of <i>Phytophthora</i> and the location of <i>Phytophthora</i> infestations.</li> </ul>

Activity	Management Strategy
Recreational activities	<p><b>A. Modify behaviour</b></p> <ul style="list-style-type: none"> <li>- Restrict activities to times when soil conditions are driest (generally November – March, but may vary from year to year) in <i>Phytophthora</i> infested areas.</li> <li>- Postpone activities in wet weather</li> </ul> <p><b>B. Control access</b></p> <ul style="list-style-type: none"> <li>- Restrict/control access of off-road vehicles, bicycles, horses, bushwalkers particularly in areas where <i>Phytophthora</i> is present.</li> <li>- Re-route trails in <i>Phytophthora</i> infested areas to uninfested areas.</li> <li>- Upgrade roads and tracks in <i>Phytophthora</i> infested areas.</li> <li>- Travel only on designated roads and tracks and restrict vehicles, bicycles, horses, people to designated picnic and camping areas.</li> <li>- Avoid entering surrounding bushland.</li> </ul> <p><b>C. Adopt hygiene procedures</b></p> <ul style="list-style-type: none"> <li>- Locate tracks and camping sites carefully (at lower part of the landscape, but avoid boggy areas), especially with respect to drainage</li> <li>- Avoid sites prone to flooding and ponding</li> <li>- Provide wash down stations with instructions as appropriate and encourage people to use them.</li> </ul> <p><b>D. Ensure awareness of <i>Phytophthora</i></b></p> <ul style="list-style-type: none"> <li>- Educate public, club members etc of the importance of <i>Phytophthora</i> and their responsibilities in minimising the risk of spread.</li> <li>- Refer to the relevant <i>Phytophthora</i> fact sheets available from the DEH website:  <a href="http://www.environment.sa.gov.au/biodiversity/plantsand.html">http://www.environment.sa.gov.au/biodiversity/plantsand.html</a></li> <li>- Obey any signs or directions given for minimising the risk of spreading <i>Phytophthora</i>.</li> </ul>

Activity	Management Strategy
<b>Revegetation Activities</b>	<p><b>A. Modify behaviour</b></p> <ul style="list-style-type: none"> <li>- Plan all activities in advance. Ensure risk status of the area is known.</li> <li>- Postpone activities in wet weather</li> <li>- Comply with all management strategies for the relevant areas in which activities are to be carried out.</li> <li>- Control pest plants with minimum disturbance to the soil.</li> </ul> <p><b>B. Control access</b></p> <ul style="list-style-type: none"> <li>- Travel on designated roads and tracks where possible.</li> <li>- Minimise the number of tracks made into the surrounding bushland.</li> </ul> <p><b>C. Adopt hygiene procedures</b></p> <ul style="list-style-type: none"> <li>- Comply with all hygiene measures regarding movement of vehicles, machinery, equipment and footwear.</li> <li>- Supply hygiene stations or hygiene kits as appropriate.</li> <li>- Any equipment being reused (eg mattocks, stakes and tree guards) must be cleaned and disinfected.</li> <li>- Select plant species that are local and suitable for the risk status of the area. For example, plant species that are tolerant to <i>Phytophthora</i> in <i>Phytophthora</i> infested areas.</li> <li>- Ensure plants are purchased from nurseries that adhere to the Nursery Industry Accreditation Scheme, Australia (NIASA) "Best practice guidelines". (See references).</li> <li>- Only purchase and plant plants that look healthy.</li> </ul> <p><b>D. Ensure awareness of <i>Phytophthora</i></b></p> <ul style="list-style-type: none"> <li>- Know the location of <i>Phytophthora</i> confirmed and suspected sites before commencing revegetation projects.</li> <li>- Ensure all participants (including volunteers and contractors) are aware of the risks of spreading <i>Phytophthora</i> and their responsibilities in minimising these risks.</li> </ul>

Activity	Management Strategy
<p><b>Nursery Activities</b></p> <p>NOTE: Nurseries represent a high risk for the spread of <i>Phytophthora</i> with the movement of soil and plant material. Strict hygiene is necessary as <i>Phytophthora</i> can cause serious losses in nurseries.</p> <p><b>Beware:</b> Using fungicides may suppress symptoms without eradicating <i>Phytophthora</i>.</p>	<p><b>A. Modify behaviour</b></p> <ul style="list-style-type: none"> <li>- Adopt Nursery Industry Accreditation Scheme Australia (NIASA) Best Management Practice Guidelines.</li> </ul> <p><b>B. Control access</b></p> <ul style="list-style-type: none"> <li>- Restrict access to nursery and propagation areas as appropriate.</li> </ul> <p><b>C. Adopt strict hygiene procedures</b></p> <ul style="list-style-type: none"> <li>- Pasteurise or fumigate any high risk media components</li> <li>- Disinfect all machinery and equipment (and footwear) before entering the site.</li> <li>- Store potting mix in a covered area, on a hard dry surface.</li> <li>- Elevate plants at all times to prevent contact with soil and waste water (see NIASA Guidelines). Do not sit plants on gravel. It is preferable to elevate them on benches at least 75cm above ground level.</li> <li>- Use water that is clean and free from <i>Phytophthora</i>. If in doubt use treated water. Recommendation: treat water with chlorine at the recommended label rate (2ppm or 2mg/L pool chlorine or 1 part household bleach to 4 parts water with a minimum contact time of 20 minutes).</li> <li>- Avoid over watering.</li> <li>- Manage drain runoff both from within and from outside the nursery to minimise contamination.</li> <li>- Ensure adherence to the NIASA Best Management Practice Guidelines 2003. See <a href="http://www.ngia.com.au/">http://www.ngia.com.au/</a></li> </ul> <p><b>D. Ensure awareness of <i>Phytophthora</i></b></p> <ul style="list-style-type: none"> <li>- Ensure all staff is aware of the importance of <i>Phytophthora</i> and their responsibilities in minimising the risk of spread.</li> </ul>

Activity	Management Strategy
<p><b>Fire Management / Emergency Services Activities</b></p> <p>In bushfire and other emergency situations the primary objective is the saving of life and property and it may not always be possible to implement appropriate hygiene procedures. However in non-emergency situations such as training, mopping up, firebreak maintenance, prescribed burning and other activities it is important to comply with <i>Phytophthora</i> management strategies.</p>	<p><b>A. Modify behaviour</b></p> <ul style="list-style-type: none"> <li>- Obtain information on location of <i>Phytophthora</i> infested sites.</li> <li>- Pre-plan to ensure clean earthmoving equipment is available during the fire danger season.</li> <li>- Maintain firebreaks and plan pre- fire season activities in <i>Phytophthora</i> infested areas for the dry months (usually November – March, but may vary from year to year).</li> <li>- Minimise soil disturbance.</li> <li>- Consider drainage when constructing firebreaks.</li> <li>- Adopt alternatives to the use of heavy machinery in emergency situations if possible.</li> </ul> <p><b>B. Control access</b></p> <ul style="list-style-type: none"> <li>- Keep movement of all vehicles and machinery and people to a minimum.</li> <li>- Restrict vehicles and people to designated roads and fire access roads and tracks wherever possible.</li> <li>- Avoid constructing fuel breaks in sites prone to flooding and ponding.</li> <li>- Ensure water used in fire fighting operations is free of <i>Phytophthora</i>. If in doubt, disinfect water with an appropriate disinfectant at the recommended rate.</li> <li>- Locate fire suppression control lines on well-formed hard surfaced roads and determine location pre-fire.</li> </ul> <p><b>C. Adopt hygiene procedures</b></p> <ul style="list-style-type: none"> <li>- Adopt low impact fire management practices that do not disturb the soil, such as hydro mulching, mowing and slashing.</li> <li>- Locate staging areas and incident management control areas outside <i>Phytophthora</i> infested areas.</li> <li>- Assign cleardown areas for vehicles, machinery and equipment as appropriate.</li> <li>- Adopt hygiene procedures for vehicles, equipment, machinery and footwear.</li> <li>- Avoid wet and muddy sites and conditions during training and operations if possible.</li> <li>- Avoid the construction of mineral earth fire suppression constructed lines. If mineral lines are required ensure that they are to provide adequate drainage and to minimise ponding of water on road surfaces.</li> </ul> <p><b>D. Ensure awareness of <i>Phytophthora</i></b></p> <ul style="list-style-type: none"> <li>- Ensure all staff and volunteers are informed and aware of <i>Phytophthora</i> and procedures to be followed in minimising the risk of spread.</li> <li>- Ensure up-to-date information about <i>Phytophthora</i> infestations is available and communicated to personnel operating at fire-fighting operations, preferably pre-fire season.</li> </ul>

### 6.3.1 Sites of High Conservation Value

Sites of High Conservation Value are those sites that contain one or more of the following:

- A highly diverse range of species for the type of vegetation
- Significant remnant vegetation
- Few pest plant species and are generally undisturbed
- Threatened or rare plant species that are susceptible to *Phytophthora*
- Threatened or rare plant communities that are susceptible to *Phytophthora*
- Habitat, critical to the survival of threatened or rare animal species, that is susceptible to *Phytophthora*
- A high number of endemic plant species

Sites of High Conservation Value should be identified and management should focus, not only on minimising the spread of *Phytophthora*, but also on preventative measures to ensure *Phytophthora* is not introduced into these areas. Access should be discouraged and restricted at all times and appropriate signs should be erected.

### 6.3.2 The Use of Phosphite in Native Plant Communities

Research conducted interstate has shown that applications of phosphite can have significant protective effects, which may be important in the preservation of plant species and communities (Ref 11). Spraying infected plants with low levels of phosphite during the active growth months can induce resistance against *Phytophthora*. Phosphite has a low toxicity for mammals and breaks down quickly in the soil (Ref 7). However, phosphite does have some detrimental effects that include phytotoxicity, growth abnormalities, and reduced reproductive capacity. There are also large differences in levels of control between plant species. Thus a balanced approach needs to be adopted when using phosphite for the management of *P. cinnamomi* in natural ecosystems. It is necessary to take into account the beneficial and detrimental effects of phosphite and the possible loss of plant species if the fungicide is not used (Ref 11). In South Australia, two trials involving phosphite have been conducted on Kangaroo Island and both showed high levels of phytotoxicity. More research is required to fully determine its limitations, the effect on beneficial soil organisms and optimal methods of use (Ref 7).



## 7. References and Further Reading

1. Department of Conservation and Land Management (CALM) 2000: *Phytophthora cinnamomi* and disease caused by it. Volume 1. Management Guidelines
2. Department for Environment and Heritage (SA) 2002: *Phytophthora* Threat Management (Standard Operating Procedure). 48pp.
3. Department for Environment and Heritage (SA) 2002: *Phytophthora* Horse Riding Guidelines. 2pp.
4. Department for Environment and Heritage (SA) 2003: *Phytophthora* Bushwalking Guidelines. 2pp.
5. Department for Environment and Heritage (SA) 2003: *Phytophthora* Plant Propagation Guidelines. 2pp.
6. Department for Environment and Heritage (SA) 2004: *Phytophthora cinnamomi* causing dieback in plants. 17pp.
7. Department of the Environment and Heritage (Australian Government) 2004: *Phytophthora* root rot. 2pp.
8. Dieback Working Group 2000: Managing *Phytophthora* Dieback - Guidelines for Local Government. 42 pp.
9. Environment Australia – Biodiversity Group 2001: Threat Abatement Plan for Dieback Caused by the Root-rot Fungus *Phytophthora cinnamomi*. 40 pp.
10. Griffith-Jones, Tonia 2001: *Phytophthora* root disease. Land for Wildlife Notes. LW0042 Department of Natural Resources and Environment. Victoria
11. Hardy, GESTJ., Barrett, S. and Shearer, BL.: The future of phosphite as a fungicide to control the soilborne plant pathogen *Phytophthora cinnamomi* in natural ecosystems. *Australasian Plant Pathology* 30 (2) 133-139
12. Lee, TC and Wicks, TJ (1977): *Phytophthora cinnamomi* in native vegetation in South Australia. *Australian Plant Pathology Society Newsletter* 6(2): 22-23

13. Marks, GC and Smith, IW 1991: The Cinnamon Fungus in Victorian forests – History, distribution, management and control. Lands and Forests Bulletin No 31. Department of Conservation and Environment Victoria.
14. Nursery and Garden Industry of Australia (2003): (Publisher) Nursery Industry Accreditation Scheme, Australia (NIASA) Best Management Practice Guidelines. 3<sup>rd</sup> edition. 72 pp.
15. Old, KM (1979): *Phytophthora* and Forest Management in Australia. CSIRO. 114pp.
16. Podger, FD & Brown, MJ (1989): Vegetation damage caused by *Phytophthora cinnamomi* in disturbed sites in temperate rainforest in Western Tasmania. Australian Journal of Botany 37: 443- 480.
17. Podger, FD and Vear, KR 1991: Management of *Phytophthora* and disease caused by it: A revision of Department of Conservation and Land Management Policy Statement No.3 of January 1991. also Policy statement No.3 of December 1998.
18. Pratt, BH & Heather, WA, (1973): The origin and distribution of *Phytophthora cinnamomi* Rands in Australian native plant communities and the significance of its association with particular plant species. Australian Journal for Biological Science 26: 559-573.
19. Statewide Operational Coordination Group (2000): *Phytophthora* (Dieback) Control Operational Instruction 21.3. Transport SA. 19 pp.
20. Vickery, FJ (1997): The distribution of *Phytophthora cinnamomi* on Kangaroo Island. PhD Thesis, University of New England (Armidale). 107 pp.
21. Weste, G. (1991): The role of *Phytophthora* species in endangering native flora and fauna. ESP Project No. 61. Australian National Parks & Wildlife Service. South Australia: 84-95.
22. Zuvela, P, Colquhoun, I and Vear, K (2001): Hitting back at Dieback - Spreading success instead. Dieback Working Group, WA. 8 pp.

## 8. Appendices

### Appendix 8.1

#### ***Native plant species susceptible to Phytophthora cinnamomi in South Australia.***

*Phytophthora cinnamomi* is considered a threat to more than 1000 plant species worldwide. While it is still uncertain exactly how many species in Australia are affected, it is expected to be in the hundreds. The table below is showing plant species that are known to be susceptible in South Australia.

**NOTE: These plant species show symptoms of chlorosis, wilt, dieback and death.**

***Phytophthora cinnamomi* has been isolated from the roots of these species.**

Family	Species name (Ref)	Common name
Casuarinaceae	<i>Allocasuarina verticillata</i>	Drooping Sheoak
Dilleniaceae	<i>Hibbertia</i> spp.(b)	Guinea-flower
Epacridaceae	<b><i>Acrotriche halmaturina</i></b> (c)	<b>Pink Ground-berry</b>
	<i>Epacris impressa</i> (a)	Common Heath
	<i>Leucopogon virgatus</i> (a)	Common Bearded-Heath
Fabaceae	<i>Pultenaea daphnoides</i> (d)	Large Leaved Bush-Pea
	<i>Pultenaea involucrata</i> (a)	Mount Lofty Bush-Pea
	<b><i>Pultenaea trifida</i></b> (c)	<b>Kangaroo Island Bush-Pea</b>
Mimosaceae	<i>Acacia myrtifolia</i> (a)	Myrtle Wattle
Myrtaceae	<i>Eucalyptus baxteri</i> (a)	Brown Stringybark
	<i>Eucalyptus obliqua</i> (a)	Messmate Stringybark
	<i>Leptospermum juniperinum</i> (a)	Prickly Tea-Tree
Proteaceae	<b><i>Adenanthos macropodiana</i></b> (c)	<b>Kangaroo Island Glandflower</b>
	<i>Banksia marginata</i> (a,e)	Silver Banksia
	<i>Banksia ornata</i> (b)	Desert Banksia
	<i>Banksia serrata</i> (b)	Saw Banksia
	<b><i>Grevillea quinquenervis</i></b> (c)	<b>Five-veined Grevillea</b>
	<b><i>Grevillea rogersii</i></b> (c)	<b>Rogers Grevillea</b>
	<i>Isopogon ceratophyllus</i> (a)	Cone-bush
	<b><i>Petrophile multisecta</i></b> (c)	<b>Kangaroo Island Conesticks</b>
Tremandraceae	<i>Tetradlea pilosa</i> (a)	Pink-eyed Susan
Xanthorrhoeaceae	<i>Xanthorrhoea quadrangulata</i> (a)	Mount Lofty Grass-tree
	<i>Xanthorrhoea semiplana</i> var. <i>semiplana</i> (a)	Tufted Grass-tree
	<i>Xanthorrhoea semiplana</i> var. <i>tateana</i> (b)	Tate's Grass-tree

Plant species in **BOLD** are endemic to Kangaroo Island

(a) Lee & Wicks (1977); (b) Weste (1991); (c) Vickery (1997); (d) Pratt & Heather (1973); (e) Podger & Brown (1989)

## Appendix 8.2

### ***Native Plant Species that may be Susceptible to Phytophthora cinnamomi in South Australia***

**NOTE:** These plant species show symptoms of chlorosis, wilt, dieback and death. *Phytophthora cinnamomi* has been isolated from soil surrounding the roots of these species but NOT from the roots themselves.

Family	Species	Common Name
Compositae	<i>Ixodia achillaeoides</i> subsp. <i>alata</i> (f)	Hills Daisy
Dilleniaceae	<i>Hibbertia riparia</i> (f)	Erect Guinea-flower
	<i>Hibbertia sericea</i> (f)	Silky Guinea-flower
Epacridaceae	<i>Acrotriche fasciculiflora</i> (g)	Pink Ground-berry
	<i>Leucopogon concurvus</i> (f)	Bearded Heath
Fabaceae	<i>Daviesia brevifolia</i> (g)	Leafless Bitter-pea
	<i>Platylobium obtusangulum</i> (g)	Common Flat-pea
Mimosaceae	<i>Acacia paradoxa</i> (f)	Kangaroo Thorn
Myrtaceae	<i>Adenanthos terminalis</i> (g)	Adenanthos
	<i>Kunzea pomifera</i> (f)	Muntries
Proteaceae	<i>Grevillea lavandulaceae</i> (f)	Lavender Grevillea
Rutaceae	<i>Correa pulchella</i> (f)	Salmon Correa
	<i>Correa reflexa</i> (f)	Common Correa

(f) SARDI Personal Communication;

(g) DEH Personal Communication

## Appendix 8.3

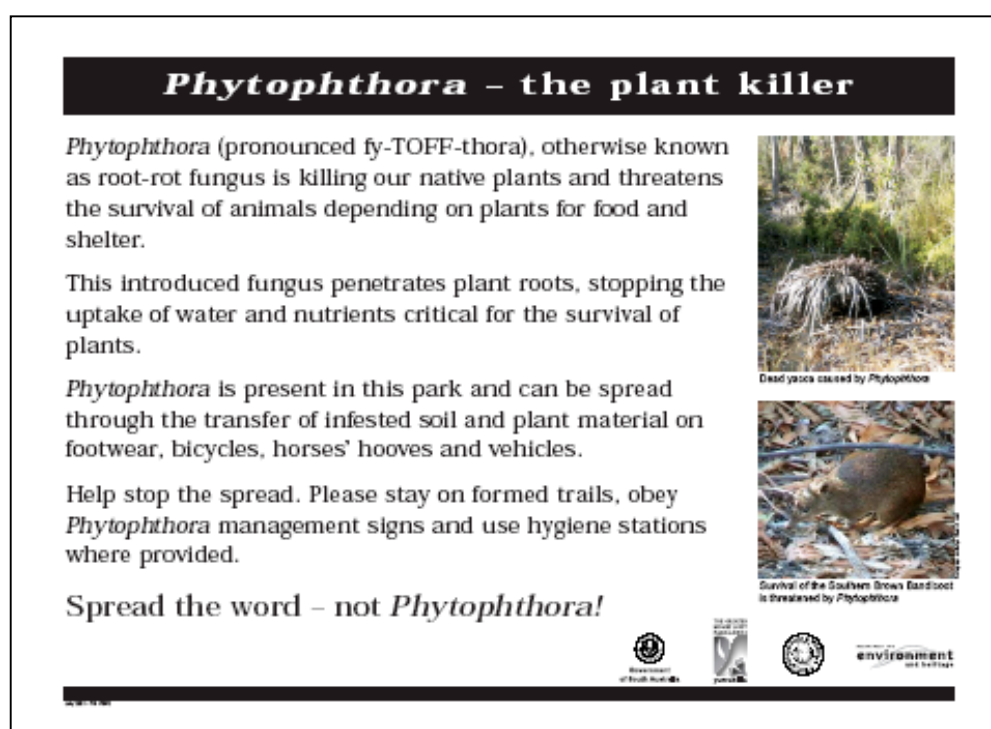
### Signage

Signs are useful management tools to make people aware of *Phytophthora* infestations and management strategies to minimise the spread.

Signs need to be simple and easy to read and must contain all the relevant information.

Several categories of signs are recommended:

- **Information signs:** - These contain general information on *Phytophthora* and are for both information and to warn people they are entering a High or Moderate Risk Management Zone. They may be placed at entrances to parks, forests or on roadside reserves (Figs. 6 and 7).
- **Management signs:** - These are signs at infested sites where *Phytophthora* management is being carried out and where precautions should be taken to minimise the spread of *Phytophthora* from these infested areas. They include:
  - Temporary and permanent closure signs (for example see Fig. 8)
  - Prohibited area signs (for example see Fig. 9) (Gazetted i.e. fines apply for non-compliance)
  - Restricted access signs (for example see Fig. 10)
  - Hygiene station signs (for example see Fig. 11)
- **Marker signs:** These are intended for recognition primarily by staff of road managing agencies or service authorities. They may be discreet markers on roadsides or painted posts, paint marks on trees, or flagging tape marking the boundaries of an infestation (Fig. 12).



**Fig. 6 Information sign – located at the entrance to reserves where *Phytophthora* is present (Courtesy DEH)**

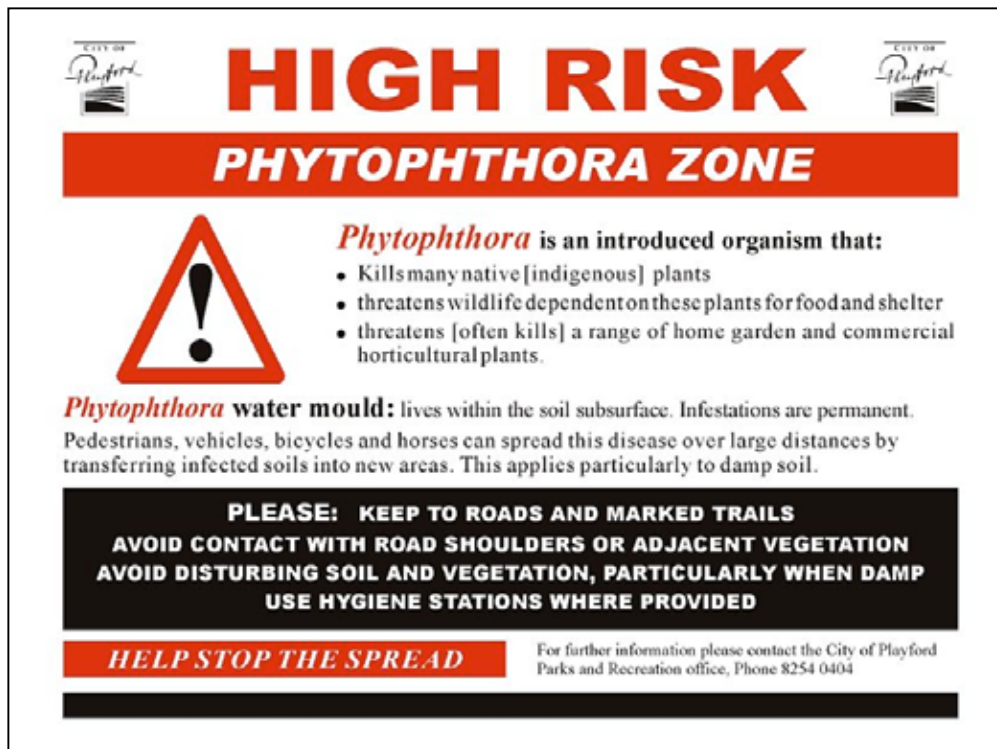
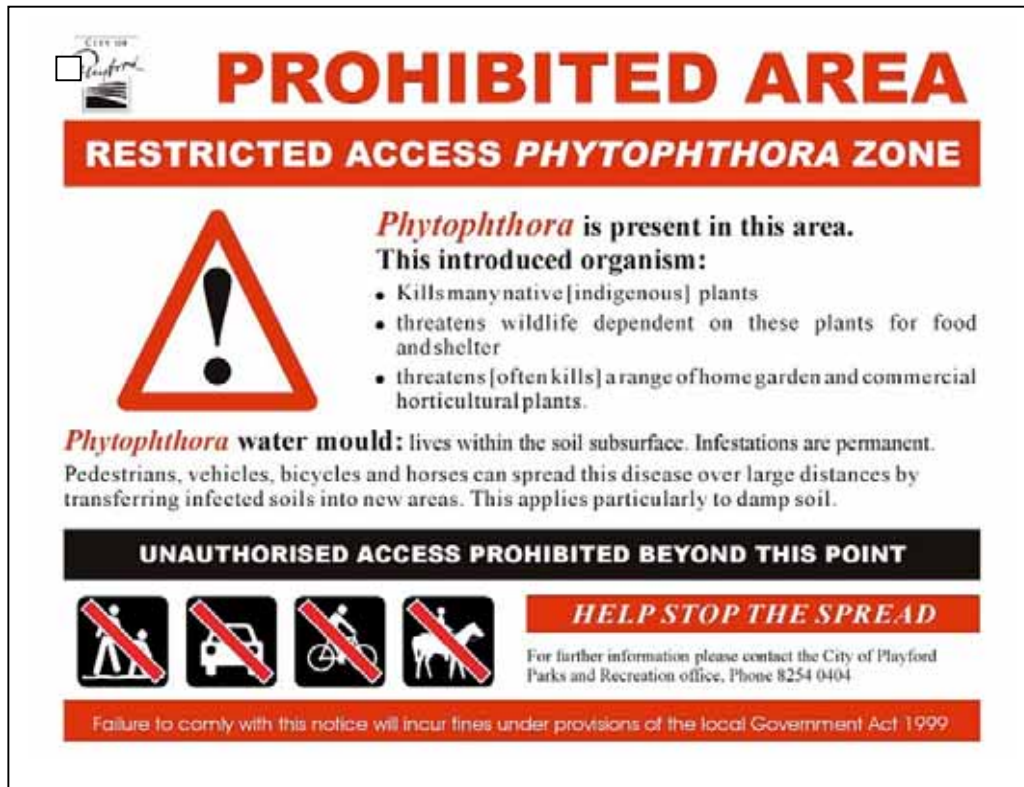


Fig. 7 Information sign – High Risk Zone (Courtesy City of Playford)



Fig. 8 Management sign – Example of a temporary closure sign (Courtesy DEH)



**Fig. 9 Management sign – Prohibited area**  
 (Courtesy City of Playford)

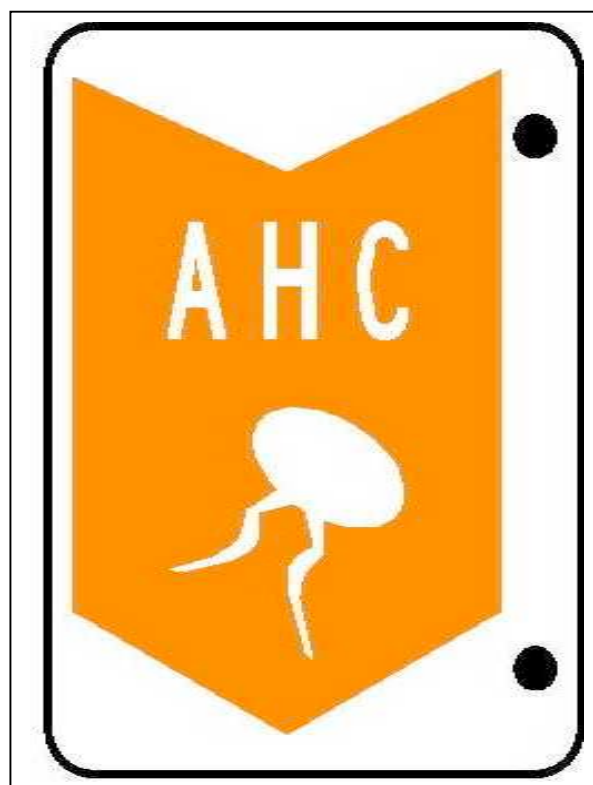


**Fig. 10 Management sign – Restricted Access**  
 (Courtesy DEH)





**Fig. 11 Management sign – Hygiene Station**  
(Courtesy DEH)



**Fig. 12 Marker sign**  
(Courtesy Adelaide Hills Council)



## **Appendix 8.4**

### ***Hygiene procedures for vehicles, machinery, equipment and footwear***

Visual inspections should confirm that vehicles, plant and equipment and footwear, are free of clods of soil, slurry (water and soil mixture) and plant material.

If available, use facilities specifically designed for cleaning vehicles, plant and equipment or footwear, or select a hard, well-drained site (such as a road or compacted rubble), preferably away from native vegetation and just inside the infested zone, so that *Phytophthora* isn't spread to an uninfested area.

#### **The clean down procedure consists of two steps:**

##### **1. Dry brushing to remove mud and soil**

- Remove all mud and soil with a hard brush or other tool.
- For vehicles, machinery and large equipment, pay particular attention to wheels, mudflaps and undercarriage.
- Disinfect where possible. Remember to also disinfect brush or tool used to remove mud and soil.

##### **2. Disinfection to kill any *Phytophthora* that has not been removed by dry brushing**

NOTE: The use of large amounts of water/disinfectant is to be avoided. Disinfection with a light spray is all that is required. Never wash down with water only. Always use a disinfectant.

*Vehicles, machinery and large equipment:*

- Disinfect heavy equipment and vehicles (paying particular attention to wheels, mudflaps, undercarriage and areas that are difficult to access) using a pressurised spray unit containing a disinfectant applied at label rates. For example:
  - **Phytoclean**. (biodegradeable and non-corrosive): Add 1 part of Phytoclean® to 50 parts of water.
- OR
- **Sodium hypochlorite** (pool chlorine). Add 1 part of pool chlorine to 1500 parts of water.
- The use of a pressurised spray unit is preferred as less water will be used and run-off will be minimal.
- Disinfectant should be allowed to penetrate for at least one minute (preferably 10 minutes) before equipment departs.
- Do not drive through washdown effluent.
- Do not allow mud and wash-down effluent to drain into bushland and surface waters, such as rivers, creeks, reservoirs and dams. If necessary, dig a trench to

contain washdown effluent.

- Use vehicles that are easy to clean, such as machines with rubber tyres rather than tracks.

*Footwear, small equipment and hand tools:*

1. Disinfect the entire sole of your footwear using a spray bottle with disinfectant (methyated spirits (70-100%) or household bleach (1 part bleach to 4 parts water)
2. Allow the sole to dry for approximately one minute.
3. Step forward to avoid recontaminating footwear
4. Repeat steps 1-3 for the other boot
5. Disinfect the brush used to remove soil

Disinfect small equipment and hand tools using the spray bottle and disinfectant.

Footwear can also be disinfected using a footbath containing disinfectant. This is useful when large groups of people need to disinfect their footwear at one location.

Ensure soil has been removed from footwear before entering footbath to ensure disinfectant remains activated. Do not leave footbath unattended where children and animals may come in contact with the chemical.

**SUMMARY OF HYGIENE PROCEDURES**

	Hygiene procedure	Disinfectant / rate	Comments
Vehicles, machinery, large equipment	- dry brushing - disinfection	<b>Phytoclean</b> – 1 part to 50 parts water OR <b>Sodium Hypochlorite</b> (pool chlorine) 1 part to 1500 parts water	- pay particular attention to wheels, mudflaps, undercarriage and other areas difficult to access - remember to disinfect brush or tool used in dry brushing
Small equipment, hand tools, footwear	- dry brushing - disinfection with spray bottle	1 part <b>household bleach</b> to 4 parts water OR <b>Methyated spirits</b> (70-100%)	- all soil should be removed before disinfecting - avoid recontaminating footwear - remember to disinfect brush or tool used in dry brushing
Footwear	- dry brushing - disinfection with footbath	<b>Phytoclean</b> – 1 part to 10 parts water OR 1 part <b>household bleach</b> to 4 parts water	- all soil should be removed before disinfection - useful for large groups of people

