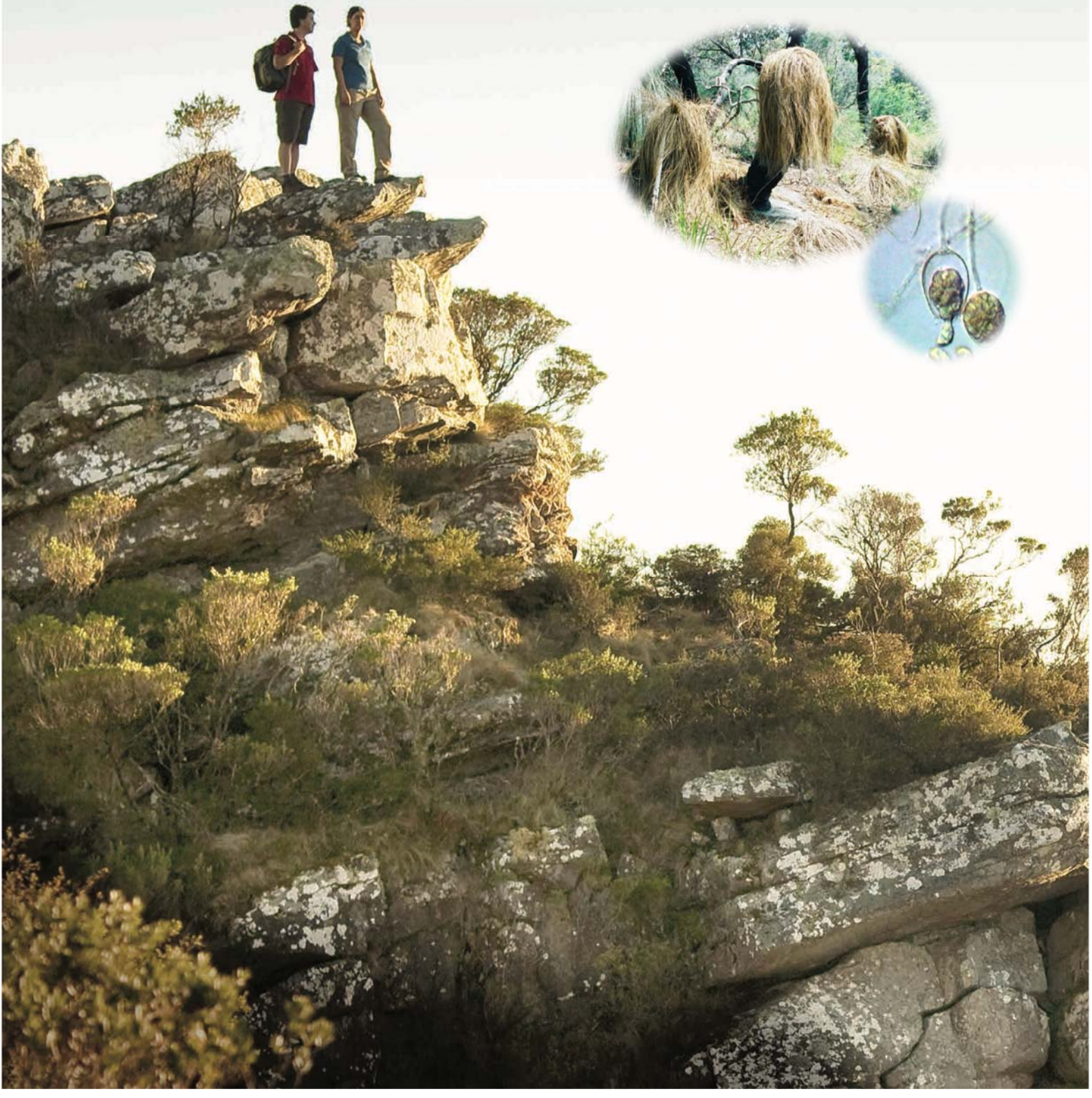
Phytophthora Threat Abatement Plan for the Grampians Peak Trail

Guidelines to minimise the risk of spread of Phytophthora during construction and operation of the Grampians Peak Trail



Executive Summary

The Grampians Peaks Trail (GPT) has been designed to be a world-class, long-distance walking experience, showcasing the beauty and majesty of Grampians (Gariwerd's) natural and cultural landscapes. Visitors undertaking the 160 kilometre, multi-day walk will experience one of the great icon walks of Australia, representing a "must do" walking experience with an estimated visitation of 23,000 people per year by 2020. The trail traverses through many varied vegetation types from heathlands, to moist ferny gullies, from low-lying wetlands to montane woodlands. During the planning stage of the trail, *Phytophthora cinnamomi* (PC) was highlighted as a potential threat to susceptible vegetation along sections of the GPT, and as such a 'Threat Abatement Plan' (GPT TAP) has been developed to minimise this risk.

Phytophthora cinnamomi (Rands) is an exotic microscopic plant and soil-borne fungal-like plant pathogen known to cause dieback and death of susceptible plants in native forests across thousands of hectares of vegetation communities in Australia. It was listed in 2000 as a 'key threatening process' under Section 183 of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999, and is currently subject to a National Threat Abatement Plan (National TAP). It has also been listed twice as a 'potentially threatening process' under the Victorian Flora and Fauna Guarantee Act 1988 (FFG Act). It has over the last 50 years, had a significant impact on susceptible vegetation in the Grampians and the wildlife that depend on them. However, while it is widespread across the Grampians, significant patches of healthy susceptible vegetation remain that need to be protected from further introduction. Furthermore at least 32 other species of *Phytophthora* occur in various parts of Australia some of which are also known to cause significant damage to native vegetation, although currently not to the same extent as *P. cinnamomi*. Their potential impact to vegetation in the Grampians is unknown.

Operational and recreational activities along the GPT have the potential to spread PC and other soil-borne pathogens and plant pests (weeds) into uninfested areas. These activities include road and track construction, environmental restoration activities and recreational activities including hiking. This risk increases with the use of dirty machinery, tools and equipment, or plants and materials that are not certified to be free of pathogens. Once introduced to susceptible vegetation communities, eradication is not feasible with current technology. Overseas and local visitors that the GPT will attract, also have the potential to spread PC and introduce other new exotic plant pests not currently present in the Grampians National Park.

Management of PC is targeted at protecting highly susceptible vegetation through hygiene procedures that promote an ***'arrive clean and leave clean'*** attitude to construction and the ongoing operation of the GPT. It is also targeted at the use of appropriate revegetation methods that provides opportunity for selection for resistance to the pathogen from within susceptible species. This management approach also has the added benefit of controlling the pathway for introduction of other potential soil-borne pathogens and plant pests.

This GPT TAP outlines basic operational procedures to be taken to minimise the risk of spread of PC along the GPT during its construction and ongoing operation. This is to be achieved mainly through:

- mapping of disease symptoms with soil/plant testing where required, in EVCs containing highly susceptible target species along the proposed trail alignment,
- determining if disease free areas identified in the mapping are protectable into the future and
- taking appropriate hygiene measures before entering disease free areas that are located in areas considered to be protectable.

Adhering to these procedures will mitigate the risk to environmental/ecological health of the vegetation communities and ensure public confidence in the efforts to protect and promote biosecurity along the GPT.

Revision register

Date of issue	Amendment details
14 August 2017	First draft
6 September 2017	Second draft

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Images front Cover.:

Main Background from Grampians Peak Trail Master Plan 2014. Parks Victoria (2014)
Phytophthora cinnamomi vegetative hyphae and sporangia courtesy of Ian Smith
Invasion front of *Phytophthora cinnamomi* in Heathy Woodland at Wilsons Promontory courtesy of David Cahill.

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1. Purpose

This plan outlines basic operational procedures to minimise the risk of spread of the soil-borne plant pathogen *Phytophthora cinnamomi* (PC) along the Grampians Peak Trail (GPT) during its construction and operation. The estimated 23,000 overseas and local visitors per year by 2020 that the GPT will attract (Parks Victoria 2014) also have the potential to spread PC and to introduce new exotic plant pathogens and plant pests not currently present in the Grampians National Park. This highlights the need for educational material and wash-down stations at trail entrances, to ensure an **'*arrive clean and leave clean*'** attitude to hiking along the GPT. This management approach also has the added benefit of controlling the pathway for introduction of other potential soil-borne pathogens and plant pests and the principles and actions can be easily applied to all Trails across the Grampians National Park, not exclusively GPT.

2. Main Objectives

Operational and recreational activities along the GPT have the potential to spread PC that is already widespread through the National Park, into areas causing significant damage to susceptible vegetation communities and the wildlife that depend on them (Appendix 1). These activities include road and track construction associated with the GPT, environmental restoration activities and recreational activities including hiking once the construction is completed. This risk increases with the use of dirty tools and equipment, or plants and materials that are not certified to be free of pathogens. Furthermore the risk of introduction increases with the amount of infested soil that may be inadvertently carried on people, machinery and equipment during construction of the GPT. Parks Victoria staff and associated contractors are potentially the greatest risk to moving PC to sensitive areas. Once introduced to susceptible vegetation communities, eradication is not feasible with current technology.

The main objectives of this plan are to minimise the establishment and spread of PC into areas of uninfected susceptible vegetation:

1. During construction of the GPT;
2. During the operation of the GPT; and
3. To provide recommended emergency treatment where hygiene measures fail.

This is to be achieved by:

1. mapping of disease symptoms with soil/plant testing where required, in EVCs containing highly susceptible target species along the proposed GPT alignment;
2. determining if disease free areas identified in the mapping are protectable into the future;
3. prescribing protocols for construction contractors to follow;
4. taking hygiene measures before entering disease free areas;
5. encouraging compliance of hygiene measures by providing education and awareness material for park managers and visitors on the identification and impacts of PC on native flora and fauna; and
6. providing potential options for restoration of affected areas.

3. Scope

1. This document describes the MINIMUM biosecurity precautions to be taken by Parks Victoria staff and other government agencies and utilities, their contractors and volunteers, when undertaking field-work and operations along the GPT, where PC poses a significant risk to vegetation communities and the wildlife that depends on them.
2. This plan takes into account specific actions in other plans such as the National Recovery Plan for Grampians Pincushion-lily *Borya mirabilis* (Kohout and Coates, 2010), the Smoky Mouse (Menkhorst and Broome, 2006) and the Southern Brown Bandicoot (Brown and Main, 2010, DoE, 2016).

4. Controlling Pathways

Controlling the pathways (sources) for PC introduction and spread is a major priority for disease management. The primary pathways for potential introduction to the GPT are:

1. use of **infested gravel** in road and track constructions;
2. **infested soil** adhering to earth moving equipment and other machinery, vehicles, equipment and footwear for which adequate hygiene and wash-down procedures have not been taken. Earthmoving equipment and heavy machinery tend to carry large amounts of soil adhering to their wheels and tracks, and therefore are considered to be a major potential vector of PC;
3. regular GPT **management activities** such as road, culvert and track construction and maintenance, and fire management and suppression, are therefore high-risk activities for pathogen transmission (DSE 2008, 2010);
4. use of **infected nursery stock**. Nursery and garden-derived plants infected with PC potentially pose a significant pathway through revegetation and landscaping activities in natural settings. Plant nurseries that have inadequate hygiene procedures including some community-based nurseries, may unwittingly harbour infected plants as tolerant hosts which can still be infected without showing symptoms. Susceptible plants may also not show symptoms because of plant husbandry practices that mask the presence of the pathogen. These practices include temporary suppression with fungicides, temporarily induced plant resistance with other chemicals or provision of additional shade and water to help plants survive the stress due to infected root systems; and
5. use of **contaminated water** from fire dams or streams for fire suppression and other activities (e.g. irrigation). Spores may be present in streams and dams due to drainage from infested areas

5. Procedures

The term '***arrive clean leave clean'*** is often used to describe hygiene procedures as it is generally accepted that it is easier to keep clean than to get clean. The following procedures are based on the National Best Practise Guidelines (O'Gara *et. al*. 2005c), Victoria's Public Land *Phytophthora cinnamomi* Management Strategy (DSE 2008), and guidelines from NSW OEH (OEH 2016) and the Australian Government (DoE 2015).

5.1. Pre-visit risk appraisal and planning

Prior to undertaking works along the GPT, staff should evaluate the current PC status, and the risk of its establishment in the area to be visited if it was accidentally introduced.

Pre-visit planning includes evaluating the following questions:

1. Is the visit to a high-risk site?

a) Is the site known to be infested with PC and/or is displaying symptoms of PC infection or;
b) Does the site contain susceptible vegetation that needs to be protected from infection? (Table 1, Appendix 2)

To answer this question there is a need to find out if the site has been identified as either of the above, and to become familiar with symptoms of PC (Table 1, Appendix 2).

2. Is the planned activity likely to move soil or plant material, either deliberately or accidentally?

Identify any planned activities with the potential to spread PC. This includes movement of equipment, vehicles and materials to/from/through infested or potentially infested areas.

3. Can the activity be timed to reduce risk by scheduling when PC spore production is lowest?

Consider the environmental envelope (Appendix 1) when PC spore production is at its lowest, and schedule operations so it is less likely for PC to be transmitted. For example, movement along unmade roads with recently laid infested gravel is a risk for transmission of PC if soil is picked up. However, passage on such roads poses minimal risk after surfaces have been exposed to extreme temperatures over hot summers (>35^{o}C for several days, Nesbitt *et. al*. 1979) and where the soil has remained dry.

4. **Is there an alternative procedure that can be used to reduce the risk of PC introduction?**

   During trail construction, alternatives such as boardwalks could be considered that will reduce future maintenance of tracks in wet areas.

5. **Who should be consulted for advice?**

   Determine the PC risk of an activity through liaison with Parks Victoria staff, who will also consult other expertise where required.

6. **What can be done to reduce the risks?**

   See Figure 1, Tables 2-6 and refer to Section 5.3

7. **Can the trail alignment be moved to avoid transition through threatened species?**

   The trail alignment has been modified to reduce any impact:

   - on Grampians Pincushion-lily *Borya mirabilis* as recommended in the National Recovery Plan (Coates *et al*. 2002, Kohout & Coates 2010);
   - on the Smoky Mouse, which is endemic to mainland south-eastern Australia occupying a diverse range of habitats, including Heathy Woodlands, Montane Shrubby Woodland and Rocky Outcrop Shrubland. Within the GNP, Smoky Mouse has been recorded to the south of Halls Gap on the Major Mitchell Plateau, southern Serra Range and Victoria Range. Key threats recorded include direct habitat loss, introduced predators, inappropriate (high frequency) fire regimes, habitat fragmentation and dieback caused by PC (Menkhorst & Broome, 2006). Avoidance of Smoky Mouse habitat has been one of the key considerations in designing the GPT alignment, particularly in the area near Mount William
   - on the Southern Brown Bandicoot, which is widely distributed in the Grampians, with most records to the south of Halls Gap (Brown & Main, 2010, DoE, 2016). The Grampians form of the Southern Brown Bandicoot has been identified as a genetically distinct population, with very reduced geneflow to other nearby populations. It inhabits a range of vegetation types, including heathlands, sedgelands, and woodlands and forests with heathy understories. It is thought to prefer sites with sandy soils, a dense understorey and abundant coarse woody debris. Key threats to the survival of the Southern Brown Bandicoot include habitat loss, habitat modification, habitat fragmentation, frequent burning, degradation of vegetation structure by PC, and predation by foxes and cats. Limiting the extent of trail through the Southern Brown Bandicoot habitat has been another key consideration in designing the GPT alignment, particularly in the area near Mount Christabel. The heathlands associated with the Wannon River have been identified as high value areas for the Southern Brown Bandicoot. The GPT crosses these heathlands near Mount Christabel, and the location of the crossing has been chosen to minimise disturbance (i.e. a section where the heathland narrows).

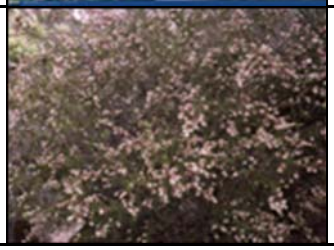
8. **Who should be informed about hygiene measures for activities at this site?**

   Ensure responsibility is assigned to staff, contractors and volunteers for any required pre- and post-entry hygiene measures including sourcing pathogen free material for operations.

5.2. Identification of PC in High Risk Areas

Several plant species in the Grampians have been identified as highly susceptible to PC and when showing symptoms of wilting and death are considered potential indicators of the presence of the pathogen (Table 1., Scott-Walker & Francis, 2012). ***Xanthorrhoea australis* in particular is a key indicator**. Soil and roots taken from under these species, enhances the potential for laboratory isolation of the pathogen from soil. Diseased roots of these plant species may also be tested using DNA test kits that can be carried with a survey team, although the result will only provide identification to genus (Arborcarbon 2017).

Table 1. Plant species considered being indicators of the presence of *Phytophthora cinnamomi*.

Broom Spurge *Amperea xiphoclada var. xiphoclada*		**Silver Banksia** *Banksia marginata*	
Daphne Heath *Brachyloma daphnoides*		**Leafless Bitter-pea** *Daviesia brevifolia*	
Common Heath *Epacris impressa*		**Holly Grevillea** *Grevillea aquifolium*	
Horny Cone-bush *Isopogon ceratophyllus*		**Common Flat-pea** *Platylobium obtusangulum*	
Large-leaf Bush-pea *Pultenaea daphnoides* Rare in Grampians		**Soft Bush-pea** *Pultenaea mollis*	
Rough Bush-pea *Pultenaea scabra*		**Flame Heath** *Stenanthera conostephioides* (*Angophora conostephioides*)	
Grampians Thryptomene *Thryptomene calycina*		**Austral Grass-tree** *Xanthorrhoea australis*	

Images: RBG Victoria: https://vicflora.rbg.vic.gov.au/ Uni. of Melb: http://wpvherbarium.biosciences.unimelb.edu.au/species_list)
ANH: https://www.anbg.gov.au/ Ian W. Smith

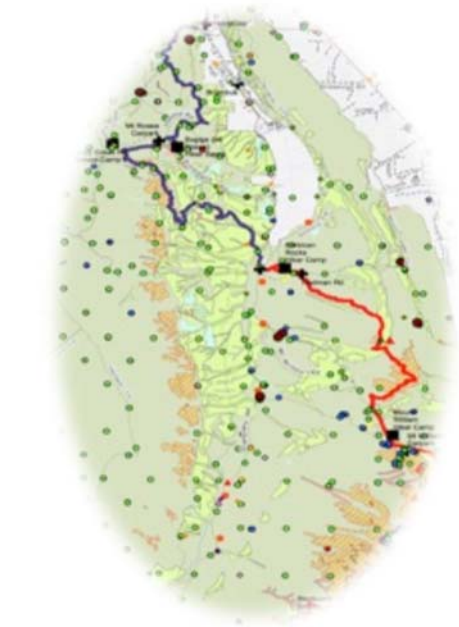


Figure 1. Flowchart for hygiene implementation during construction of the Grampians Peak Trail

5.3. Guidelines for activities in High Risk Areas

The need for undertaking hygiene procedures is dependent on the potential for transmission of PC from infested areas into uninfected susceptible vegetation of high ecological importance that are in a position in the landscape that can be protected (*i.e.* protect the protectable). 'Protectable areas' are defined as uninfected areas, occurring in the vulnerable zone, that have good prospects of remaining uninfected over the next two to three decades (CoA 2014).

Examples of High Risk Areas on the GPT include locations with unique or high value biodiversity assets such as populations of threatened, iconic, keystone or otherwise valued species or vegetation classes that are susceptible to disease.

The potential for transmission is:

1. **Highly significant** for vehicles/plant etc. (vectors) at any time of the year, that disturb soil next to *Phytophthora* infected plants. The risk comes from picking up soil-borne resting spores. The more soil picked up the greater the risk.
2. **Significant** for vectors that pickup soil in the general area over the warmer months, not just next to *Phytophthora* infected plants. The risk comes from picking up motile spores that have potentially risen to the surface. This leads to the recommendations to postpone activities during wet weather, begin activities with clean vehicles/equipment, and avoid wet or muddy areas during operations (O'Gara *et. al.* 2005c).
3. **Minimal** for clean vectors travelling over hard surfaces in cool conditions that don't disturb vegetation and soil, and don't pick up soil.
4. **Significant** for sourcing plants from nurseries that aren't accredited with 'The Nursery Industry Accreditation Scheme Australia' (NIASA 2016)

Staff should use **Figures 1 & 2, Appendix 2** and **Tables 2 to 6** as a guide to activities undertaken along the GPT affected by and containing susceptible vegetation of high risk of disease development.

Table 2. Procedures to be followed by Parks Victoria staff, contractors and other authorised persons and agencies (e.g. survey teams), when visiting areas along the GPT containing susceptible vegetation of high risk of disease development caused by *Phytophthora cinnamomi*.

Procedures to Follow
General
• Check with local Parks Victoria (PV) staff prior to entry, on PC status of vegetation communities along the section of the GPT where visit/works are to be undertaken (Figures 1 & 2, Appendix 2).
• Where possible, schedule visits with a high potential to spread PC, to periods of dry weather when PC spore levels in the soil will be at a minimum.
• Follow hygiene procedures when entering areas as outlined in Section 5.4. Use footbaths/washdown facilities where provided.
• Drive vehicles/ATVs on sealed roads/tracks where possible, and park in well-maintained car parks that pose little risk of potentially infested soil/gravel adhering to the vehicle. When travelling on unsealed roads/tracks, keep vehicles on previously formed roads and tracks that have had uninfested gravel used in their construction and maintenance, and/or have been through several days of summer where high surface gravel temperatures of the road surface will kill PC and considerably reduce the risk of transporting viable spores (Nesbitt ***et. al.*** 1979). No wash-down on exiting the area would be required under these circumstances. If unknown then treat as if infested.
• If the area is known to be infested, and potentially infested soil/gravel has inadvertently adhered to the vehicle/ATV/footware, then washdown procedures as outlined in Section 5.4. should be followed before entering another area of susceptible vegetation of high risk of PC disease development.
• Consider PV supervision of activities in high conservation areas that may pose a significant risk of introduction of PC. This could include visiting groups not familiar with disease protocols.

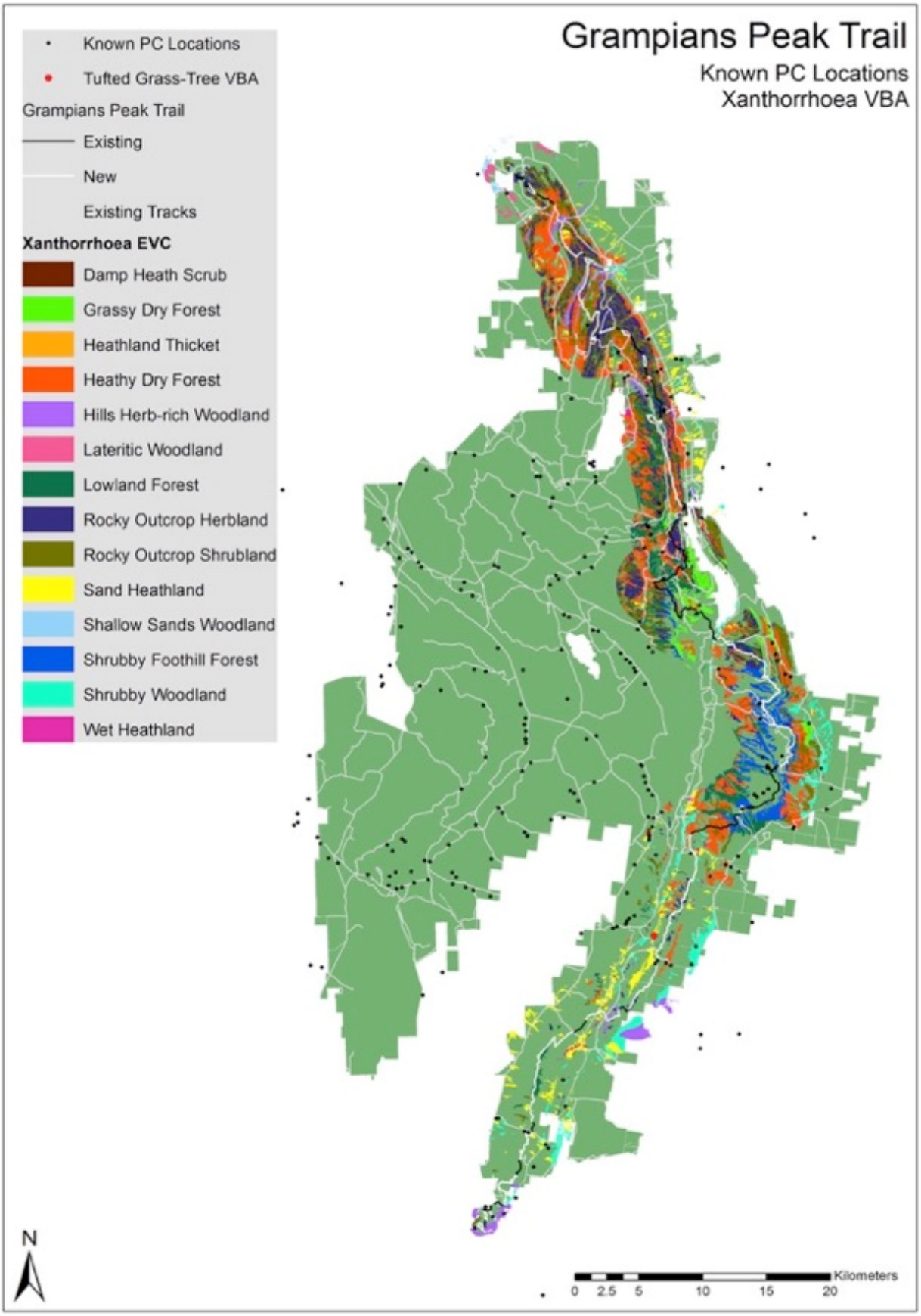


Figure 2. Known isolations of *Phytophthora cinnamomi* along the GPT and overall risk class based on the presence of the highly susceptible *Xanthorrhoea australis* within an EVC (Parks Victoria 2017)

Table 3. Procedures to be followed by Parks Victoria staff, contractors and other authorised persons and agencies during construction of tracks, hiker camps, utility services and their maintenance, and other major earthworks in areas containing susceptible vegetation of high risk of disease development.

Procedure to Follow
General
• As for Table 2 plus;
• Ensure all PV staff and contactors involved with the GPT construction and maintenance have been inducted/trained in the identification of PC symptoms on indicator plant species along the GPT. Consider developing a 'PC induction certificate' to be given to those who complete the training.
• Include PC status in planning and pre-works surveys of the trail route and alignments and their maintenance.
• Where PC status is unknown, PV staff and/or contactor to survey the section of the GPT where works are to be undertaken to evaluate the level of hygiene required to be implemented. Survey results to be included in an updated PC status map of the GPT.
• In infested areas, schedule works preferably and where practical, to periods of dry weather when PC spore levels in the soil will be at a minimum.
• Notify all contractors and suppliers of the hygiene requirements for the section of the GPT where works are to be undertaken. The details should be included in tender and contract documents. The project manager/superintendent should direct them to wash down facilities where required. PV supervisors should be prepared to turn away vehicles/equipment that arrive carrying soil or plant material on tyres, treads, wheel arches, etc. at the cost to the contractor.
• Only use gravel that is sourced from gravel pits tested free of PC. If the gravel supplier does not routinely test their product, arrange for an appropriate laboratory to test the product.
• Use uninfested gravel "in situ" wherever appropriate.
• Site quarries and borrow pits in uninfested areas preferably 500m laterally from nearest infection, and free from overland drainage flowing from infested areas.
• Ensure machinery used in constructing quarries is clean on entry.
• Hiker camps in sensitive areas are to be on elevated platforms – e.g. boardwalks/tent platforms at Bugiga hiker camp (Figure 3)
Area of known PC infestation status
• Use coarse >10mm diameter uninfested gravel to a depth of 75mm on the GPT to prevent pick up of PC spores (NIASA 2016)
• Consider boardwalks in wet areas of the GPT.
• Install signs indicating status of presence of PC, requesting adherence to guidelines for area activities as outlined in Education and Communication (Section 5.8).
• Follow washdown procedures when leaving an infested area as outlined in Section 5.4., where vehicle /plant and equipment are to be moved into an uninfested area or of unknown infestation status.
• Where possible, restrict vehicles to previously formed roads and tracks that have been through at least one summer.
• infected soil extracted during construction of boardwalks/bridges should be disposed within infested areas
Area of known uninfested PC status and high risk of establishment and damage
• Follow guideline as for infested status above except to follow hygiene procedures when entering area as outlined in Section 5.4.
• Install boot wash-down stations along the GPT at the boundary of infected and uninfected susceptible vegetation of high risk of disease development (Figure 4, Section 5.4.). Incorporate regular station maintenance (cleaning and chemical top up) into field staff workplans or maintenance contractors. Disinfectant baths should be refreshed at least monthly and after any heavy rainfall. If chemical baths cannot be regularly maintained, install at least a seat with a wire or stiff plastic brush chained to it.
Area of unknown PC infestation status and high risk of establishment and damage
• Follow guideline as for uninfested and infested status and follow hygiene and washdown procedures when entering and leaving area as outlined in Section 5.4.

Figure 3. Boardwalks / tent elevated platforms at Bugiga hiker camp to reduce impact of camping in vegetation sensitive areas (Images: Parks Victoria)

Table 4. Procedures to follow for visitors hiking along the GPT when traversing through areas containing susceptible vegetation of high risk of disease development caused by *Phytophthora cinnamomi*.

Procedure to Follow
General
• Parks Victoria (PV) to provide information/educational awareness material to hikers prior to entry to the GPT on PC and the status of vegetation communities along the section of the GPT where hiking/camping is to be undertaken. (Section 5.8.3)
• Encourage hikers to follow signage along the GPT and in particular to use footbaths/washdown facilities where provided (Section 5.4).
• Encourage hikers to report the presence of disease along the track via a phone app when available (Section 5.8)

Table 5. Procedures to follow by Parks Victoria staff, contractors and other authorised persons and agencies when undertaking Fire Management in areas containing susceptible vegetation of high risk of disease development caused by *Phytophthora cinnamomi*.

Procedure to Follow
General
• Check with Parks Victoria (PV) staff prior to undertaking fire suppression activities, and prior to entry, on PC status of vegetation communities along the section of the GPT where works are to be undertaken (Figures 1 & 2, Appendix 2).
• Include PC status in planning of fire management activities where possible.
• Where feasible, undertake firebreak construction and maintenance during dry soil conditions. Avoid duplication of existing access points and tracks. Select strategic breaks that are low in the landscape. Construct firebreaks to shed water and dry quickly.
• When planning prescribed or hazard reduction burns, where possible select burn areas bounded by well-formed hard surface roads. Minimise machinery and vehicle movement. Avoid grading boundaries unless necessary. Consider alternatives such as slashing, hand raking and herbicide.
• Water to be used in fire suppression activities should come from chlorinated town water where available. Where fire dams of unknown status are used, then consider using one litre of disinfectant (e.g. Phytoclean) per 1000 litres of water to kill any residual spores.
• Nominate wash down points for incoming and outgoing vehicles and machinery for prescribed burns and, if possible, emergency response fire suppression activities.
• Avoid training and practice sessions in wet soil conditions. All new and existing fire crew members should be trained in PC hygiene protocols
Area of known PC infestation status
• Follow washdown and hygiene procedures when leaving an infested area as outlined in Section 5.4. where vehicle /plant and equipment are to be moved into an uninfested area or of unknown infestation status.
• Where possible, restrict vehicles to previously formed roads and tracks that have been through at least one summer.
• Mow, slash or use herbicide on fire breaks rather than grade
Area of known PC uninfested status and high risk of disease development
• Follow hygiene and washdown procedures when entering area as outlined in Section 5.4.
Area of unknown PC infestation status and high risk of disease development
• Follow hygiene and washdown procedures when entering and leaving area as outlined in in Section 5.4.

N.B. Fire management may be either planned activities or emergency responses requiring the coordination of multiple partner organisations. Heavy equipment, vehicles, people and water are all potential PC vectors. However disease management should not hinder the primary objectives of saving life and property in emergency response situations. Hygiene protocols should be instigated during all planned activities in High Risk Areas such as training, mopping up, prescribed burns etc. **Highly susceptible vegetation can recover from a fire but will be killed by the pathogen if it is introduced.**

Table 6. Procedures to follow by Parks Victoria staff, contractors and other authorised persons and agencies when undertaking regeneration/revegetation in areas of high risk of disease development.

Procedure to Follow
General
• Check with Parks Victoria (PV) staff prior to entry, on PC status of vegetation communities along the section of the GPT where regeneration/revegetation works are to be undertaken (Figures 1 & 2, Appendix 2).
• Where status is unknown, PC sampling of the proposed areas should be considered.
• Notify all contractors, suppliers and volunteers of the hygiene requirements of the site. The details should be included in any tender and contract documents. The project manager/superintendent should direct them to wash down facilities where required. PV supervisors should be prepared to turn away vehicles or equipment that arrive carrying soil or plant material on tyres, treads, wheel arches etc.
• Consider planting only tolerant species in areas conducive for disease development and/or infested.
• Where sowing with susceptible species, use a high stocking rate to encourage selection for resistance (Marks & Smith 1991, DSE 2008)
• Prior to planting, seedlings should be stored off the ground where possible, and/or in areas known not to be infested by PC.
• Where susceptible species are planted, any water used for irrigation should come from chlorinated town water where available, or from sources tested free of the pathogens and/or treated by other methods. Where unknown water sources are used, then consider using one litre of disinfectant (e.g. Phytoclean) per 1000 litres of water to kill any residual spores.
Procurement of seedlings for revegetation
• Ensure seedlings to be planted are acquired from nurseries that are either accredited with 'The Nursery Industry Accreditation Scheme Australia' (NIASA) or have been tested free of PC. NIASA is a national scheme for production nursery (growers) and growing-media (potting mix) businesses, which operate according to a set of National Best Management Practice guidelines that reduces the likelihood of PC transmission (NIASA 2016).
Area of known PC infestation status
• Follow washdown and hygiene procedures when leaving an infested area as outlined in Section 5.4, where vehicle /plant and equipment are to be moved into an uninfested area or of unknown infestation status.
• Where possible, restrict vehicles to previously formed roads and tracks that have been through at least one summer.
Area of known uninfested PC status and high risk of disease development
• Follow hygiene and washdown procedures when entering area as outlined in Section 5.4.
Area of unknown PC infestation status and high risk of disease development
• **Follow hygiene and washdown procedures when entering and leaving area as outlined in Section 5.4.**

Table 7. Procedures to follow when undertaking recreational events along the GPT in areas containing susceptible vegetation of high risk of disease development by PC.

Procedure to Follow
General
• Parks Victoria (PV) staff to check on PC status of vegetation communities along the section of the GPT prior to events being approved (Figures 1 & 2, Appendix 2).
• Consider restricting activities in high conservation areas that may pose an unacceptable risk of introduction of PC to the GPT.
• Include PC status in event planning and pre-works surveys of potential event routes. Where possible, locate events away from areas of susceptible vegetation. Where status is unknown, PC surveillance of the event routes should be considered
• Schedule events preferably to periods when potential PC spore levels will be at a minimum (e.g. during dry periods in summer).
• If events cannot avoid High Risk Areas, ensure event organisers are aware of expected hygiene and washdown procedures as outlined in Section 5.4.
• Where possible, ensure event organisers direct participants to stay on formed tracks that pose little risk of spreading potentially infested soil/gravel.
• Ensure event organisers have informed participants on the status of PC requesting adherence to guidelines for area activities as outlined in Section 5.4.
• Ensure event organisers are aware that at the conclusion of an event an evaluation of compliance with hygiene procedures will be carried out with potential breaches evaluated and penalties potentially applied.

5.4. Washdown Procedures (Hygiene)

Hygiene refers to specific procedures designed to prevent the spread of PC by ensuring that infested soil, water and/or infected plant material are removed from machinery, vehicles, equipment and footwear before they enter uninfested areas (i.e. clean on entry). Location for wash-down stations (brushes and chemical) will be determined along the GPT alignment dependant on the infection status of the vegetation and ability to protect it. Access points (road crossings) of the GPT and Quad bike/ATV access (800mm wide track) for maintenance should be evaluated for the need for wash-down. Brush down only stations may be considered where there is no vehicle access and on sections of rock or boardwalk.

5.4.1. Disinfectants for use in hygiene protocols

Table 8 details the disinfecting agents that can be used for cleaning field equipment and clothes. Note that surfaces should be as clean as possible of soil and organic matter in order for disinfectants to be effective. Quaternary Ammonium disinfectants (e.g. Phytoclean) are generally superior to alcohol alone as they also contain a wetting agent that helps in the penetration of infested soil. When using alcohol, 70% is the most effective killing rate as water is required to enable alcohol to enter a pathogen. Some bleaching agents and caustic soda can be extremely toxic to people if used inappropriately. Always conform to the appropriate Material Safety Data Sheet or product instructions and PPE when preparing and using disinfectants.

Table 8. Recommended disinfectants for use in hygiene protocols for PC .

Equipment to disinfect	Recommended disinfectant	Reference
Footwear, tools, tyres, machinery and items that have contacted soil	• Phytoclean® or equivalent quaternary ammonium disinfectant, (Quats) prepared to product instructions, *or* • 70% methylated spirits (700mL methylated spirits + 300mL water)	Suddaby & Liew 2008

5.4.2. Machinery and Vehicles (Permanent or semi-permanent wash-down facilities)

Permanent or semi-permanent wash-down facilities may be constructed where machinery and vehicles require routine cleaning (Figure 4a, O'Gara *et. al*. 2005c). This may be based at the boundary to uninfested/infested areas, or in depots where vehicles/machinery return to before moving into other uninfested areas. Portable wash-down systems that enable machinery and vehicles to be cleaned at the point of risk for activities, should also be considered where access to these facilities are not readily available (Figures 4b & 4c).

A simple wash- down facility can be created on a dry and compacted area by digging out a wash-bay (20 m long x 7 m wide) and filling it with blue metal (Figure 4d). Machinery and vehicles can be driven onto the blue metal for washing with surface run-off carried away from the wash-bay by drainage channels. To reduce the amount of water required for effective wash-down it is recommended that large clods of dirt be first removed with a hard brush or other tool and high pressure, low-volume water sprayers used to remove remaining material (O'Gara *et. al*. 2005c). The use of 2% Phytoclean (Table 8) in the final rinse can aid in the killing of any residual spores of *Phytophthora*.

The vehicle operator should perform a visual inspection after wash-down, and before proceeding into an uninfested area, to ensure all mud and soil has been removed paying particular attention to tracks, wheels, side-steps, mud-flaps, wheel arches and fire hoses (NRM South, 2010).

5.4.3. Machinery and Vehicles (One-off wash-down facilities)

Where permanent/semi-permanent washdown facilities are either not practical or warranted due to a 'one-off' nature of the activity planned and/or because no heavy plant equipment is involved, then a simple back-pack sprayer or trailer/sprayer or ATV may be used to reduce the hazard of transferring the pathogen to uninfested areas (Figures 4b, 4c & 5a). The amount of soil that may potentially adhere to a vehicle/equipment will determine if a simple backpack sprayer or trailer/sprayer or ATV may be required. To reduce the amount of water required for effective wash-down it is recommended that large clods of dirt be first removed with a hard brush or other tool and high pressure, low-volume water sprayers used to remove remaining material. The use of 2% Phytoclean in the final rinse can aid in the killing of any residual spores. Where little soil is attached then a single spay with 2% Phytoclean in a backpack sprayer without washing off, may be sufficient.

The vehicle operator should perform a visual inspection after wash-down, and before proceeding into an uninfested area, to ensure all mud and soil has been removed paying particular attention to wheels, side-steps, mud-flaps, wheel arches and fire hoses (NRM South, 2010). Where it is considered that insufficient washdown has been achieved then the vehicle should return to a depot for further cleaning.

5.4.4. Non-Vehicular Activities (including staff on foot, contractors and the general public: hikers)

Where high conservation values are at stake on the GPT, even hikers may pose an unacceptable risk of PC introduction and may also be subject to hygiene. Staff, contractors and the general public should use the following procedures when moving on foot through infested or high-risk areas.

Before moving into an uninfested area, remove any soil from footwear/equipment using a stiff brush (Figure 6a). Using a spray bottle, apply 2% Phytoclean or 70% methylated spirits to the footwear/equipment leaving a residual film. Tools may also be washed in a bucket/tray using a 2% solution of Phytoclean. Phytoclean is non-toxic/corrosive at the rates used.

In situ apparatus for footwear hygiene ranges in sophistication from a simple tray and brush system to more sophisticated systems such as:

- the Phyto Fighter 1000 (Figure 6c, WOW Wilderness, 2010); or
- spring-loaded boot cleaning stations such as the 'Anakie Scrubber' (Figure 6b, O'Gara *et. al.* 2005c);
- those developed for use in some National Parks in Western Australia (figures 6d and e).

These systems incorporate attached brushes to remove soil and mechanisms to deliver disinfectants to footwear, minimise evaporation of disinfectant, and prevent the entry of rainfall and fauna to the reservoir (O'Gara *et. al.* 2005c). The boot wash stations also provide an important awareness aspect for users.

The importance of removing soil should not be underestimated. If a disinfectant is not available, remove as much soil as possible using a brush. Place footwear and other muddy items in a bag or bucket and clean thoroughly before using at another site.

Figure 4. (a) A permanent automatic wash- down facility in Western Australia, (b) portable trailer wash-down unit, (c) All Terrain Vehilce (ATV) mounted with spay unit for washdown and (d) semi- permanent wash-down facility in Victoria (O'Gara *et. al*. 2005c)

Figure 5. **(a) Field washdown equipment for simple field activities – spray bottles, footbaths, gloves, brush, disinfectant, measuring device (NRM South 2010).**
(b) Hygiene kit to wash vehicles and equipment during general field and fire-fighting operations in South Australia (O'Gara *et. al*. 2005c).

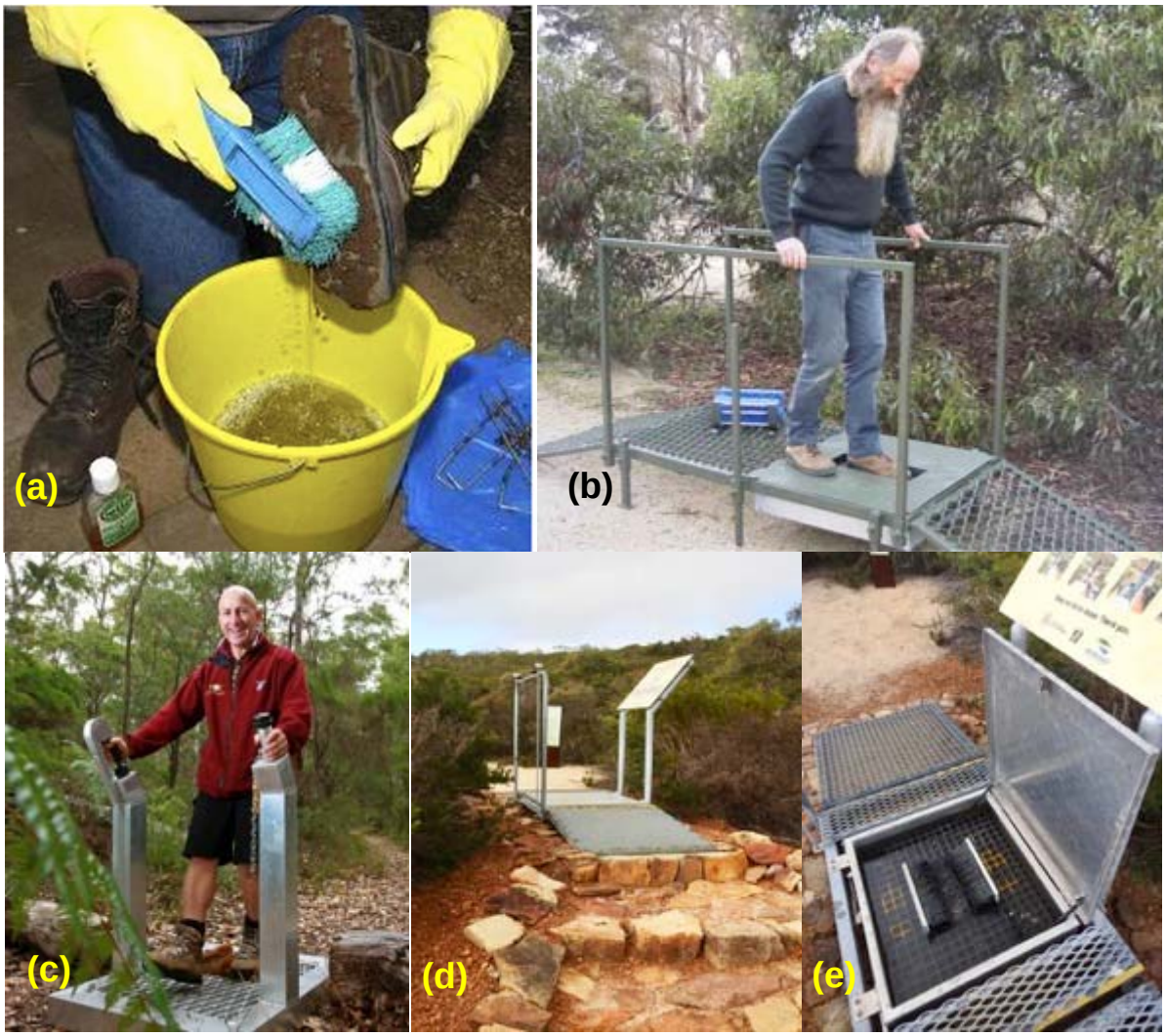


Figure 6. ***In situ*** **apparatus for footwear hygiene ranges in sophistication from (a) a simple bucket and brush system (DNPRSR 2014), to more sophisticated systems such as (b) the 'Anakie Scrubber' (O'Gara *et. al.* 2005c) (c) the Phyto Fighter 1000 (WOW Wilderness, 2010), or boot cleaning station used in Lesueur National Park, Jurien Bay, Western Australia (d) closed, (e) open via spring loaded lid (images Ian Smith)**

5.5. Parks Victoria and Contractors Resources/equipment

A hygiene kit for the cleaning of footwear and small equipment should be carried in all Parks Victoria and contractor vehicles working in areas of high risk along the GPT (Figure 5b). The kits should include:

- Stiff brush or steel scraper for removing soil and seeds from footwear, tyres and small machinery;
- Water for washing hands, boots and small tools (minimum 4 litres);
- Paper towel;
- Sealable plastic bags for disposal of gloves and waste;
- Spray bottle to be filled with 2% solution of Phytoclean disinfectant (20ml per litre). Diluted disinfectant must be fresh, and made up on a weekly basis. Alternatively, 70% methylated spirits (700mL per litre) can be used and kept for longer periods, if the container is well sealed to prevent evaporation of alcohol.
- Plastic bucket or tray.

5.6. Barrier System for Working Across Disease Boundaries

To prevent contamination of an uninfested part of a work site, a physical barrier such as logs, may be used to mark an infestation boundary. These boundary markers should be accompanied by appropriate signage. Any operation can thus be split so that certain tasks are restricted to the uninfested part of the site with clean machinery, vehicles and equipment, and other tasks to the infested area with separate machinery, vehicles and equipment that are not subject to hygiene (O'Gara *et. al*. 2005). Alternatively operations can be scheduled so that clean machinery and equipment can be used in the uninfested area first, and then moved into infested area prior to hygiene procedures being implemented.

Where *in situ* footbaths are installed along the GPT at the entrance to an uninfested area, a barrier/fence either side of the footbath should be considered to encourage hikers to use the hygiene facilities, particularly during events. Again appropriate signage needs to accompany the in situ footbaths.

5.7. Emergency treatment due to hygiene breach

Where hygiene barriers are breached and emergency treatment is recommended, the pesticides listed in Table 9 are recommended.

Table 9. Fungicides used on plants infected with pathogens due to breach of hygiene protocols.

Fungicide/rate	Method/timing
Metalaxyl Systemic Fungicide Granules at 100 g per m^2 (Amgrow 2017)	For established plants showing moderate to severe symptoms of decline. Apply as a soil application in November and again 8 to 12 weeks later until plants have recovered.
Phosphonate (e.g. Agriphos 600, (Agrichem 2017)) used as a stem injection or foliar spray. For current rates see DWG 2017 https://www.dwg.org.au/treatment	• Trunk injection: Repeat injection every 3-5 years. • Foliar: Spray to runoff. Repeat spray on a yearly basis.

Metalaxyl is a soil applied systemic granular pesticide registered for the control of *Phytophthora* root rot of many susceptible agricultural tree and vegetable crops. After application, it is taken up by the plant and is translocated through the plant penetrating the cells of *Phytophthora* where it selectively interferes with DNA synthesis, inhibiting mycelium growth, spore germination and haustorium formation. The pesticide targets organisms in the Oomycota, and thus does not impact on fungi within soil or in the plant (e.g. Mycorrhizae).

Phosphonate is the anionic form of phosphonic acid (HPO32-), and has been shown in Western Australia and Victoria to slow the spread and reduce the impact of PC in susceptible vegetation. Phosphonate exhibits a complex mode of action, both acting directly on the pathogen and indirectly by stimulating host defence responses to inhibit pathogen growth. Injecting a tree with phosphonate provides three to five years' protection (Figure 7 a). In contrast, spraying with phosphonate provides protection for only one to two years (Figure 7 b). In Western Australia tree injection, spraying both from the ground and through aerial application, is routinely used to protect areas of high conservation value and critically endangered species from the threat of PC (Figure 7c) (DWG 2017b, O'Gara *et. al.* 2005). Because it only provides temporary

protection, treatment needs to be ongoing and included in bushland management and future action plans (DWG 2017b).

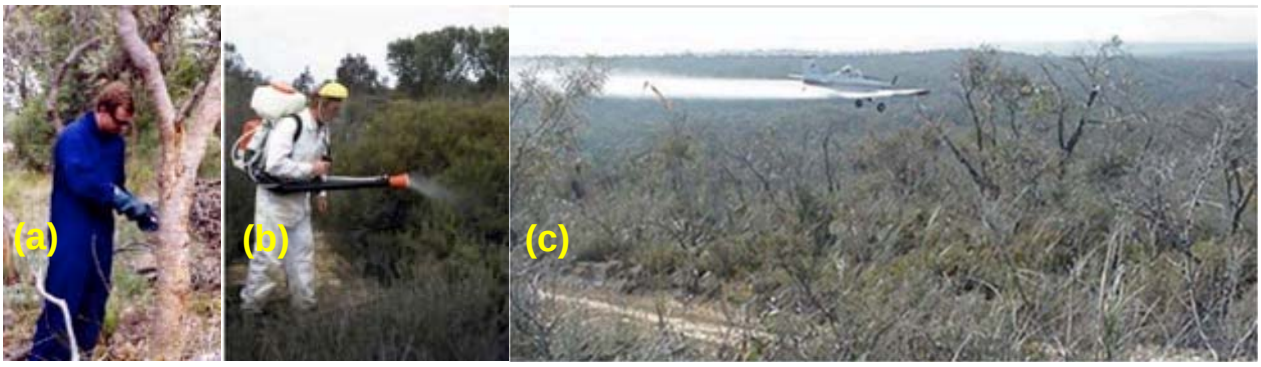


Figure 7. (a) Trunk injection (b) Foliar application of phosphonate for the control of PC in susceptible vegetation in Western Australia (O'Gara et al 2005a) and (c) Aerial spraying of phosphonate in the Anglesea heathland, Victoria (DSE (2008) image David Cahill).

5.8. Communication, Training, Education and Awareness programs

5.8.1. Communication

This GPT TAP requires cooperation and commitment not only from Parks Victoria staff and contractors, but also from the general public. The role of communication in effective deployment of PC management measures cannot be underestimated. The form and intent of management prescriptions needs to be communicated clearly to all stakeholders. The appropriate communication tools for a particular circumstance will depend on the target stakeholder group but may include: organisational standard operating procedures, codes of practice, conditions of contract, management and work plans for specific sites, training for on-ground workers, appropriate signage, extension material and programs and consultation processes. The form and dissemination of the appropriate information must be considered during the planning phase for management of the site or area (O'Gara *et. al.* 2005c).

Figure 8. Mobile phone mapping App (Flytomap 2017)

Phone apps are a great tool to disseminate information. For example an App provided by Flytomap has hiking information for Grampians NP GPS and outdoor charts with guide (Figure 8). Any 'Phone App' created for hiking purposes on the GPT should be encouraged to include PC hygiene requirements expected of hikers during their stay.

5.8.2. Training

To facilitate this GPT TAP, a training program will need to be established by Parks Victoria to promote and encourage hygiene implementation and disease risk mitigation to staff, contractors and other authorised persons and agencies during construction and operation of the GPT. This includes:

- clarifying roles and responsibilities;
- educating staff, contractors and volunteers of the status and location of infested and uninfested sites, and high risk areas;
- providing instruction in the identification, spread and control of PC and reporting requirements, including routine and emergency responses;
- providing instruction in the use of PPE and occupational health and safety issues;
- providing induction training of new staff, volunteers and contractors in safe operating practices;
- providing instruction on the operation of wash down equipment;
- providing instruction in waste disposal;

- developing specific information for the training of other Government agencies, neighbours and other stakeholders including infrastructure owners accessing the GPT (e.g. communication towers, land managers, bushwalkers) to ensure that they understand the risk should PC establish along the GPT;

5.8.3. Education and awareness

Education and awareness programs on the impact and potential spread of PC by hikers/visitors to the GPT, are important to promote and encourage hygiene compliance during operation of the GPT.

This includes:

- including visitor education and awareness programs on the impacts of PC on native fauna and flora. This material could be supplied from Grampian Visitor information centres. Consider developing a short awareness video for presentation in the visitor centres such as that used in Western Australia TV advertisements (e.g. https://www.youtube.com/watch?v=6Z6Pkx50yVw)
- providing information along with camping/hiking permits detailing PC hygiene requirements expected of hikers during their stay
- ensure that any 'Phone App' created for hiking purposes on the GPT, includes PC hygiene requirements expected of hikers during their stay.
- erecting appropriate signage at entrances to the GPT and at all hygiene stations along the route of the GPT. Examples of signage can be found at Project Dieback (2008).

5.9. Monitoring of disease

5.9.1. Annual monitoring

After the initial mapping of disease along the GPT, an annual monitoring program of the GPT for disease by trained Parks Victoria staff or contractors is recommended to provide an early warning for any potential breakdown in hygiene that could result in further spread of the pathogen. Early detection of new disease areas could lead to the installation of further washdown stations (Section 5.4), and/or implementation of control procedures (Section 5.7). This relies on both aerial and ground surveillance methods to produce maps of the location of healthy and diseased vegetation combined with sampling of diseased plants to confirm the presence of the pathogen.

5.9.2. Reporting by Hikers and Contractors

A reporting of potential new disease areas, and or other plant health issues by hikers and contractors could also be included in the educational awareness programs and any GPT phone app that may currently be available or may be produced in the future. For example an app similar to the 'Climate watch' phone app that has been produced to encourage hikers to help monitor the biodiversity of the Grampians along the Venus Baths Trail out of Halls Gap, may be adapted to include plant disease symptoms (Figure 9, Earthwatch 2017).

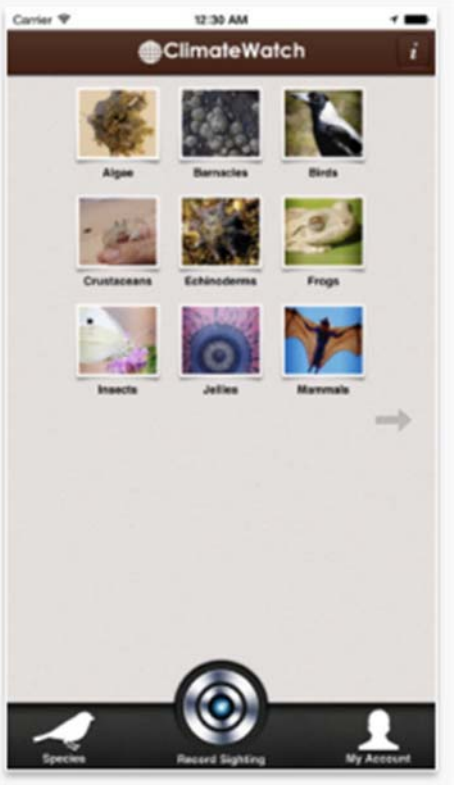


Figure 9. Potential mobile phone App. for recording disease symptoms (Earthwatch 2017)

5.9.3. Remote Sensing

High-resolution digital multi-spectral imagery has been used in Western Australia and Victoria to assess the distribution of disease caused by *Phytophthora cinnamomi* in heathlands and woodlands (Hill *et. a*l. 2009, Wilson *et. a*l. 2012). Remote sensing and aerial images taken over time provides an ability to map changes in the health of the vegetation over time and enables targeting of areas for treatment (Figure 10).

In an urban environment and in agriculture, high-resolution images using drones and aircraft have developed sufficiently to be able to identify individual trees that need treatment (Figure 11). Acquiring high-resolution images of the GPT every 2 years could be considered so as to evaluate the impact of the construction and operation of the trail so as to target any potential remedial action including correct placement of hygiene stations.

Figure 10. Aerial images taken in 1987 and 2008 showing change over time of disease caused by *Phytophthora cinnamomi* in Banksia Woodland in Western Australia (Wilson *et. a*l. 2012)

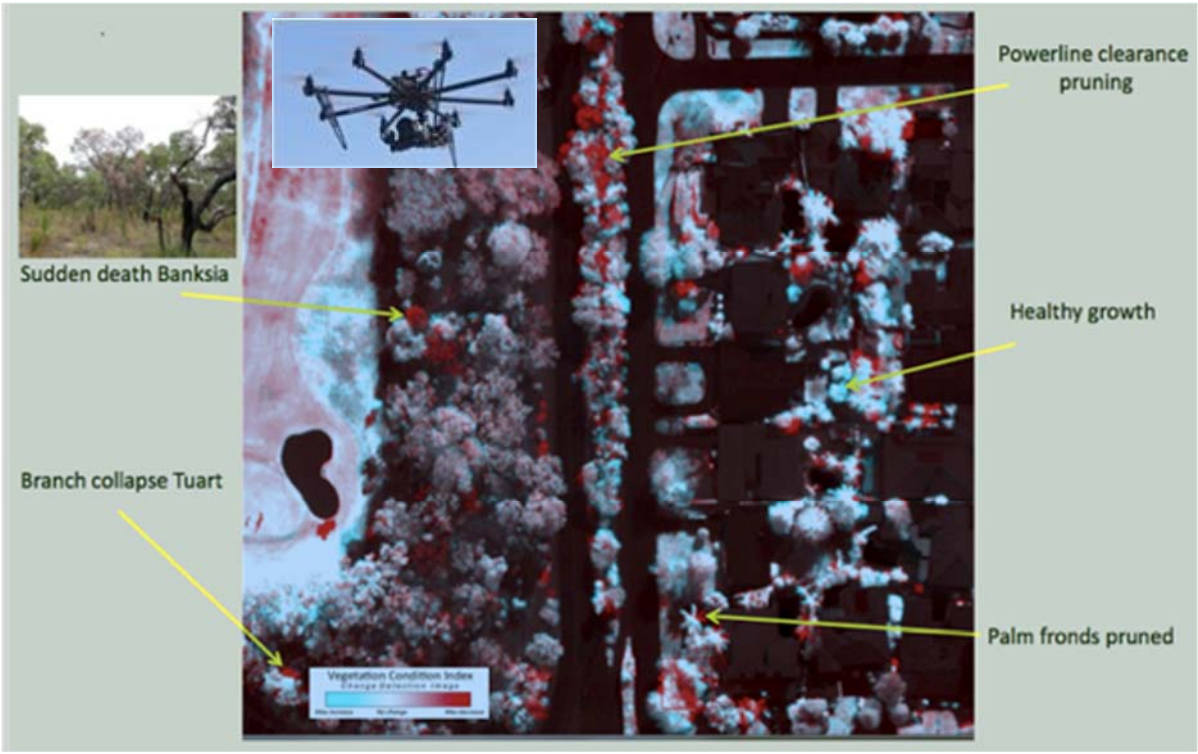


Figure 11. False colour image taken in an urban environment demonstrating the ability to evaluate management actions (Barber 2017)

5.10. Summary for GPT construction

- PV staff and contractors review the section of trail that is to be constructed for the potential for traversing through highly susceptible vegetation
- Following appropriate training on identifying highly susceptible vegetation and symptoms of disease, and under oversight by PV staff, contractors building the trail will be in a position to determine the hygiene regime to be implemented (Section 5.4.).
- As the trail width is a maximum of 800mm the contractors need only consider the health of vegetation immediately in front of those building the track.
- Contractors will map via GPS, the presence of disease symptoms that they come in contact with for evaluation by PV staff for potential future hygiene stations.
- The trail under construction will have appropriate signage and barricades to prevent unauthorised access to the construction site until appropriate hygiene measures have been implemented

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Appendix 1 Background information on *Phytophthora cinnamomi*

Phytophthora cinnamomi (Rands) is an introduced microscopic plant and soil-borne fungal-like plant pathogen known to cause dieback and death of susceptible plants in native forests, plantations, farm and roadside shelterbelts, nurseries and home gardens (RBG 2017a, OEH, 2016, O'Gara *et. al* 2005a) It was probably introduced by early European settlers, presumably within infected plants to Australia at the turn of the 20th Century although the first official record was in Victoria on Cricket Bat Willows in 1935 (McLennan *et. al* 1973). It has infested thousands of hectares of vegetation communities across all States of Australia.

The pathogen is favoured by warm (15-30ºC) poorly drained soils and infects fine feeder roots via motile zoospores when soils are saturated. It then invades and kills both the fine feeder roots and the main roots and collars of many native and introduced plants leading to dieback and death of susceptible hosts (Figure 11. Marks and Smith 1991, O'Gara *et. al.* 2006a, DSE 2008, DoE 2014, DWG 2017c). However an extended period of soil temperatures above 35ºC and below 5ºC kills the pathogen. The pathogen also produces long-lived chlamydospores in the roots of dying plants that are released into soil and potential gravel sources. It has an extremely wide host range and in time may be responsible for a permanent change to some vegetation communities and the wildlife that depend on them.

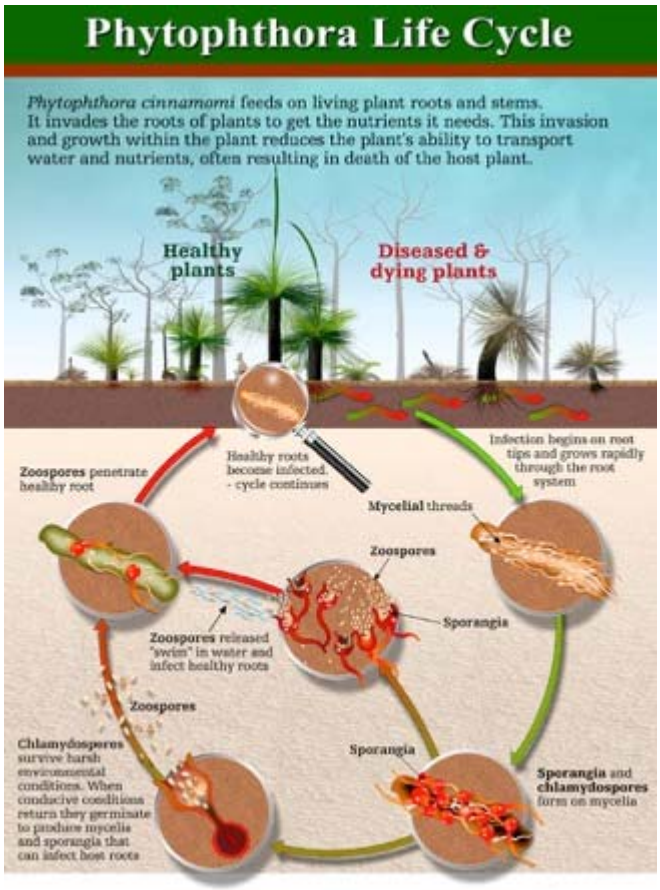

Figure 12. Life Cycle of *Phytophthora cinnamomi* (DWG 2017c).

The climatic envelope in Australia (i.e. rainfall and minimum temperatures), where conditions are considered conducive to the proliferation of *P.cinnamomi* and the establishment of disease has been summarised in Figure 2 (DoE, 2015). Disease has been generally shown to have the greatest and most widespread impact in areas in the temperate south of the continent, generally south of latitude 30º where the average annual rainfall exceeds 600 mm although exceptions to this exist due to localised soil conditions. (O'Gara *et. al* 2005d).

In Victoria, the pathogen has had significant impacts and is of greatest risk in the Brisbane Ranges, Grampians, Great Otway, Lower Glenelg, Point Nepean, Kinglake, Croajingalong and Wilsons Promontory National Parks in addition to Lerderderg State Park, Lake Tyers, Anglesea Heathlands, Warby Ranges and the coastal forests of East and South Gippsland (Figure 13, Marks and Smith 1991, DSE 2008, Parks Victoria 2012). The pathogen is also a serious problem in some plantations, roadside shelterbelts, horticultural crops, nurseries and parks and gardens where susceptible species are grown (DEPI 2013).

Susceptible species display a wide range of symptoms from death to no apparent symptoms. In some circumstances, *P. cinnamomi* may also contribute to plant death where there are other stresses present (e.g. waterlogging, drought, and perhaps wildfire). Within a plant species there may also be a variable response to infection, indicating variability in resistance (McDougall *et. al* 2001, Marks & Smith 1991).

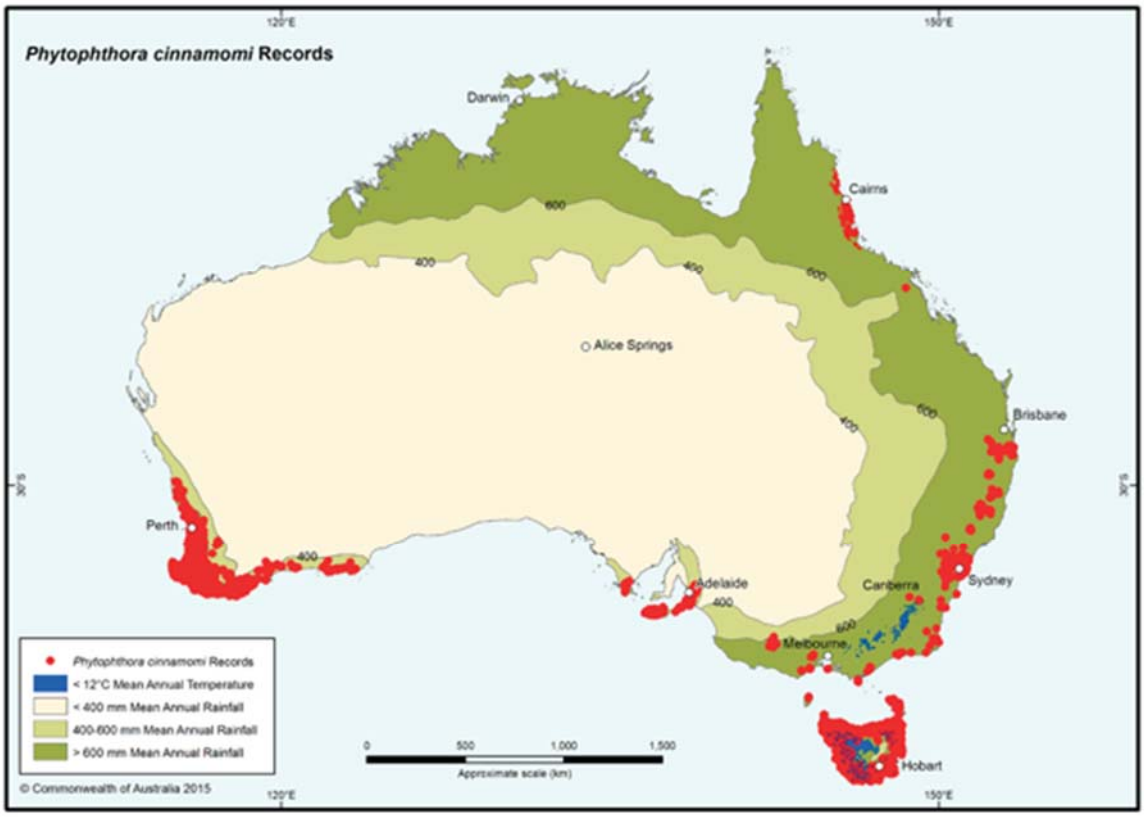

Figure 13. *Phytophthora cinnamomi* isolations, records of impact and broad climatic envelope of plant susceptibility in Australia (DoE 2015).

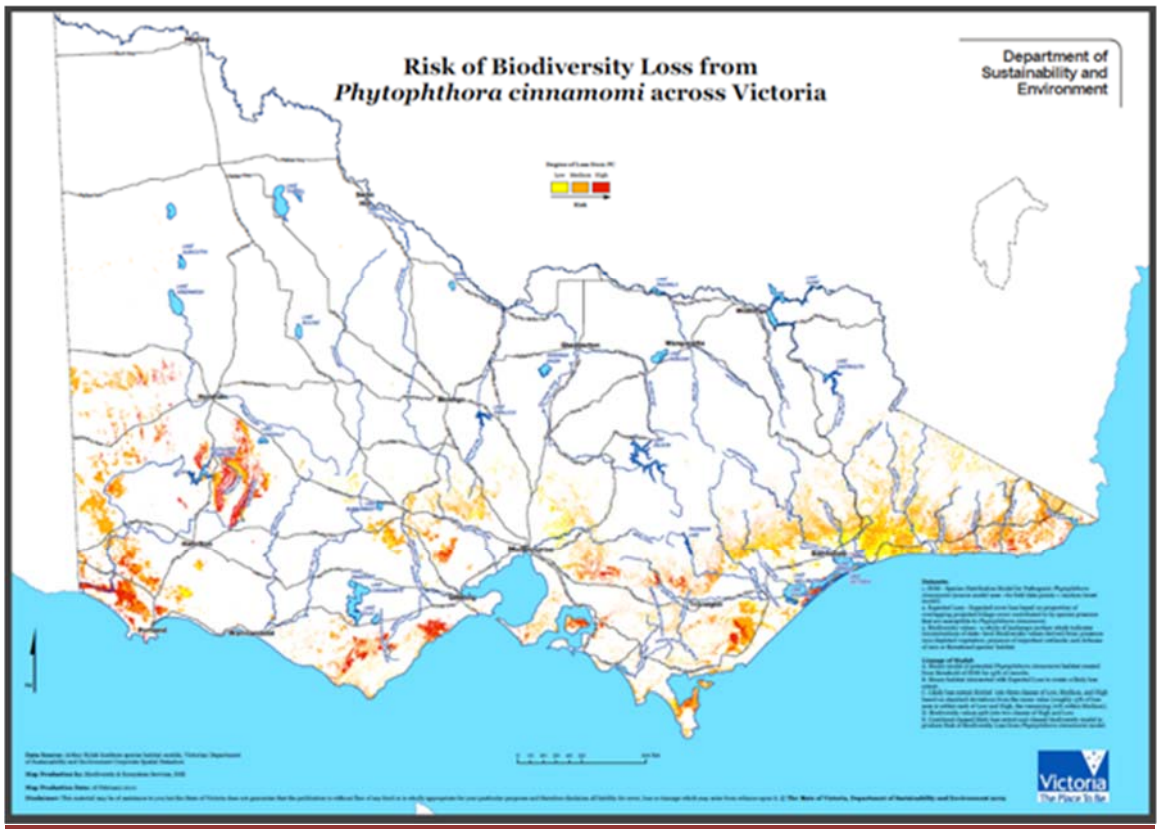

Figure 14. Risk of Biodiversity loss from *Phytophthora cinnamomi* in Victoria (DSE 2008)

Commonwealth listing

'Dieback caused by the root-rot fungus *Phytophthora cinnamomi*' was listed in 2000 as a 'key threatening process' under Section 183 of the Commonwealth Environment Protection and Biodiversity Conservation Act 1999, and is currently subject to a National TAP (DoE 2014, CoA 2017a, b).

Victorian listing

The pathogen has been listed twice as a 'potentially threatening process' under the Flora and Fauna Guarantee Act 1988 (FFG Act):

1. 'Use of Phytophthora-infected gravel in construction of roads, bridges and reservoirs' (22 May 1991)
2. 'The spread of *Phytophthora cinnamomi* from infected sites into parks or reserves, including roadsides, under the control of a state or government authority' (5 Feb 2002)

Public authorities should be administered so as to have regard to the FFG Act's conservation and management objectives, one of which is to manage potentially threatening processes such as those listed in regard to *P. cinnamomi*.

Other legislation

Agencies may also have the power or potential to improve management of the pathogen under provisions in several Acts of Parliament. These include Codes of Practice, plant pathogen controls, extractive industry controls, planning controls and Regional Catchment Strategies.

Management approach

As eradication of the pathogen is currently not feasible in National Parks, the approach to its management aims to:

- identify areas of potential risk of disease development and thus need for management
- slow the spread of the pathogen across Victoria until other potential management options are developed
- maintain ecological processes for potential development of natural resistance in the population of susceptible species.

Management is targeted at protecting vegetation and ecological communities most at risk of disease development, and in particular those species that are potentially threatened (O'Gara *et. al.* 2005b). It is also targeted at minimising impacts in vegetation prone to disease through the use of appropriate revegetation methods that provides opportunity for selection for resistance.

Species at Risk in the Grampians

Mapping of biodiversity values with a management overlay of the Grampians Peak Trail shows that new sections of the GPT generally do not pass through vegetation of a rare or vulnerable status (Figure 14).

Plant species in the Grampians threatened by *Phytophthora cinnamomi* are listed in Table 10 with sections of the GPT already infested with the pathogen (Figures 2 & 14). Within the Grampians National Park (GNP), a high level of death of Austral grass trees has been recorded in the Victoria Valley with Jimmy Creek, Mt Christabel and the Mt Abrupt Hiker Camp site also likely to have PC. However the Wonderland area appears clean and therefore should be targeted for protection. Central and southern sections of GNP are probably greater concern than the north (David Roberts, pers. comm. Parks Victoria).

Further information on the pathogen can be found in Victoria's Public Land *Phytophthora cinnamomi* Management Strategy (DSE 2008) and background documents to the NTAP (DoE 2014, O'Gara *et. al*. 2006) and on the Parks Victoria website (Parks Victoria 2012).

Table 10. Species recorded as susceptible to *Phytophthora cinnamomi* in the Grampians (Weste *et. al.* 2002) (Scott-Walker & Francis, 2012)

Family / Species	Susceptibility	Species	Susceptibility
Casuarinaceae			
Allocasuarina pusilla	Susceptible	*Allocasuarina grampiana*	Susceptible
Allocasuarina misera	Susceptible	*Allocasuarina muelleri*	Susceptible
Allocasuarina verticillata	Susceptible		
Dilleniaceae			
Hibbertia fascicularis	Susceptible	*Hibbertia riparia*	Susceptible
Elaeocarpaceae			
Tetratheca ciliata	Susceptible		
Ericaceae (syn. Epacridaceae)			
Acrotriche serrulata	Susceptible	*Astroloma humifusum*	Susceptible
Brachyloma daphnoides	Susceptible	*Brachyloma depressum*	Susceptible
Epacris impressa	Susceptible	*Leucopogon glacialis*	Susceptible
Leucopogon virgatus	Susceptible	*Monotoca scoparia*	Susceptible
Stenanthera conostephioides	Susceptible	*Styphelia adescens*	Susceptible
Euphorbiaceae			
Amperera xiphoclada var. *xiphoclada*	Highly Susceptible	*Phylanthus hirtella*	Susceptible
Fabaceae			
Aotus ericoides	Highly Susceptible	*Daviesia brevifolia*	Highly Susceptible
Dillwynia glaberrima	Susceptible	*Dillwynia* spp	Susceptible
Gompholobium ecostatum	Susceptible	*Hovea linearis*	Susceptible
Platylobium obtusangulum	Highly Susceptible	*Pultenaea daphnoides*	Highly Susceptible (Rare in Grampians)
Pultenaea mollis	Highly Susceptible	*Pultenaea scabra*	Highly Susceptible
Lamiaceae			
Prostanthera hirtella	Susceptible		
Myrtaceae			
Calytrix alpestris	Possibly Highly Susceptible	*Calytrix tetragona*	Possibly Highly Susceptible
Eucalpytus baxteri	Susceptible	*Eucalyptus obliqua*	Susceptible
Eucalyptus radiata	Susceptible	*Leptospermum continentale*	Susceptible
Leptospermum myrinoides	Susceptible	*Melaleuca decussata*	Susceptible
Thryptomene calycina	Highly Susceptible		
Proteaceae			
Banksia marginata	Highly Susceptible	*Conospermum mitchellii*	Highly Susceptible
Grevillea aquifolium	Highly Susceptible	*Grevillea dimorpha*	Highly Susceptible
Isopogon ceratophyllus	Highly Susceptible	*Persoonia juniperina*	
Rutaceae		**Hemerocallidaceae**	
Phebalium bilobum	Susceptible	*Stypandra glauca*	Highly Susceptible
Xanthorrhoeaceae		**Cupressaceae**	
Xanthorrhoea australis	Highly Susceptible	*Callitris rhomboidea*	Susceptible

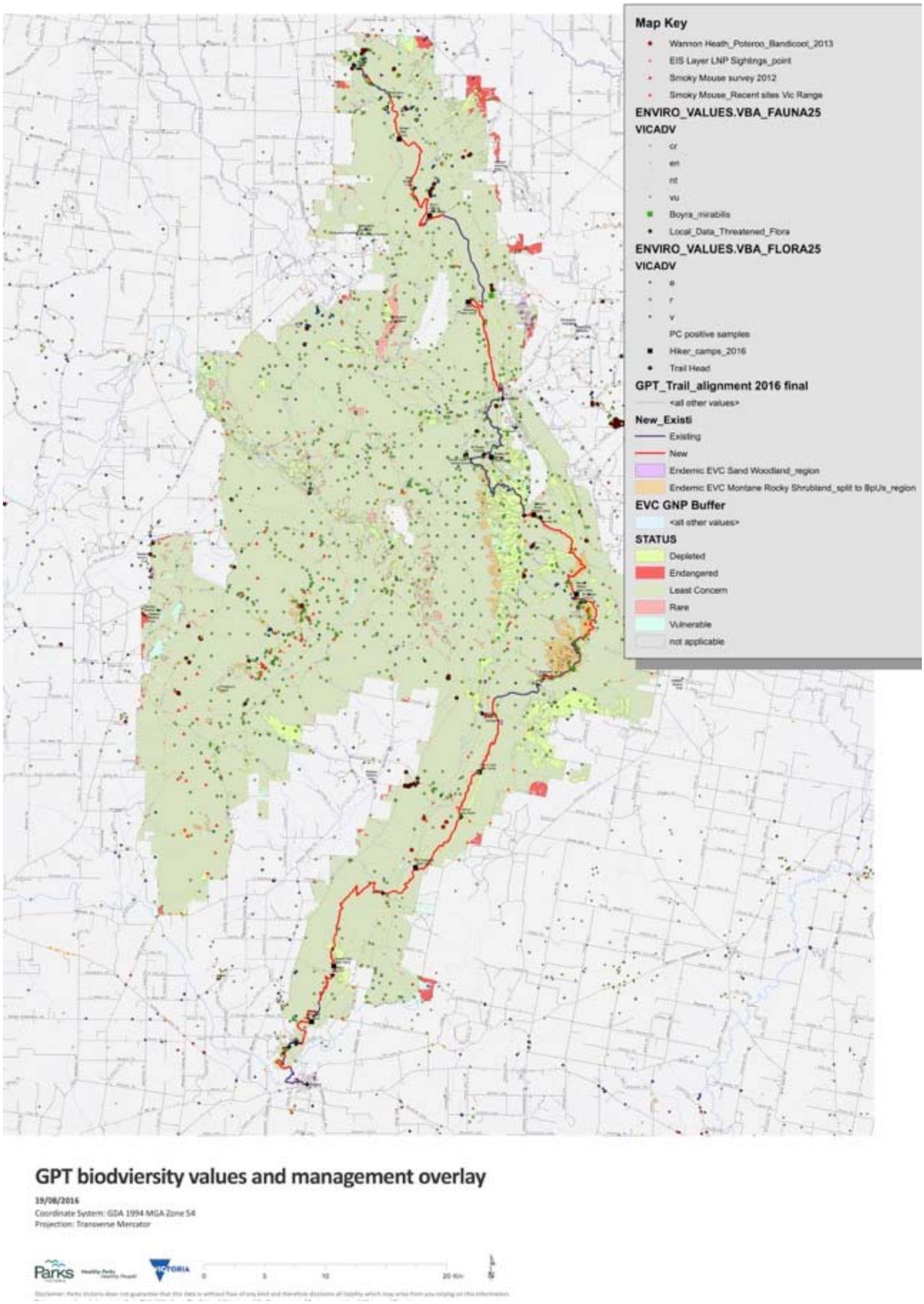

Figure 15. Biodiversity values and management overlay of the Grampians Peak Trail.

Other Phytophthora species

The number of described *Phytophthora* species worldwide is rapidly increasing, with at least 124 species now described (Scott et al. 2013, Martin et al. 2014, Dunstan et al 2016). This rapid increase in species reflects the improvement in identification of many species using molecular methods.

At least 32 species of *Phytophthora* occur in various parts of Australia and other species of *Phytophthora*, including *P. cryptogea*, *P. megasperma*, *P. multivora* and *P. arenaria* are known to cause damage in the wild, particularly in Western Australia (DoE 2014). In Victoria, several *Phytophthora* species have also been isolated from native forest soil and streams, some of which are shown in Table 11. The first record in Australia of *P. fallax, P. niederhauserii* and *P. siskiyouensis* were also recorded from Victoria in the last 10 years (Cunnington *et. al.* 2010, Abad *et. al.* 2014, Hansen *et. al.* 2011, Smith *et. al.* 2006). *P. fallax* is known to cause foliage disease in eucalypt plantations in New Zealand. The threat of these species of *Phytophthora* to Victoria's flora is still to be determined. However to date, more extensive damage in native flora has been attributed to the presence of *P. cinnamomi* than other *Phytophthora* species.

Table 11. *Phytophthora* species isolated from soil and streams in Victoria.

Phytophthora species	Location	Reference
Clade 6 (unidentied)	Soil, Streams	Dunstan *et. al.* (2016)
Clade 6 hybrids	Soil, Streams	Dunstan *et. al.* (2016)
P. "hennops",	Streams	Dunstan *et. al.* (2016)
P. "paludosa"	Streams	Dunstan *et. al.* (2016)
P. "personii"	Streams	Dunstan *et. al.* (2016)
P. amnicola	Streams	Dunstan *et. al.* (2016)
P. chlamydospora	Streams	Dunstan *et. al.* (2016)
P. cryptogea	Soil and streams	Smith *et. al.* (2009), Dunstan *et. al.* (2016)
P. elongate	Soil	Dunstan *et. al.* (2016)
P. fallax	Soil and Streams	Cunnington *et. al.*(2010) , Dunstan *et. al.* (2016)
P. gonapodyides	Soil	Dunstan *et. al.* (2016)
P. gregata	Soil	Dunstan *et. al.* (2016)
P. multivora	Soil	Dunstan *et. al.* (2016)
P. niederhauserii	Soil and plant	Abad *et. al.* (2014)
P. siskiyouensis	Soil and plant	Smith *et. al.* (2006), Hansen,
P. thermophile	Streams	Dunstan *et. al.* (2016)
P.cinnamomi	Soil and streams	Weste (1972), Marks & Smith (1991), Smith *et. al.* (2009), Dunstan *et. al.* (2016)
Phytophthora citricola	Streams	Smith *et. al.* (2009)
Phytophthora gonapodyides	Streams	Smith *et. al.* (2009), Dunstan *et. al.* (2016)
Phytophthora taxon Clade	Streams	Smith *et. al.* (2009)
Phytophthora taxon Clade 8	Streams	Smith *et. al.* (2009)
Phytophthora taxon Pgchlamydo	Streams	Smith *et. al.* (2009)
Phytophthora taxon Pgchlamydo	Streams	Smith *et. al.* (2009)
Phytophthora taxon Unknown clade	Streams	Smith *et. al.* (2009)
Taxon related to P. citrophthora	Streams	Smith *et. al.* (2009)
Taxon related to P. cryptogea	Streams	Smith *et. al.* (2009)

Appendix 2 Susceptibility of vegetation to *Phytophthora cinnamomi* along the Grampians Peak Trail

Table 12. Ecological Vegetation Classes based on species susceptibility to *Phytophthora cinnamomi* and used for mapping along the Grampians Peak Trail (DELWP 2017).

EVC Number	Description	EVC Number	Description
Low Susceptibility (contains 4 – 6 species susceptible to PC)			
8	Wet Heathland	192	Montane Rocky Shrubland
18	Riparian Forest	195	Seasonally Inundated Shrubby Woodland
23	Herb-rich Foothill Forest	198	Sedgy Riparian Woodland
29	Damp Forest	280	Floodplain Thicket
30	Wet Forest	283	Plains Sedgy Woodland
37	Montane Grassy Woodland	285	Dry Creekline Woodland
53	Swamp Scrub	641	Riparian Woodland
134	Sand Forest	642	Basalt Shrubby Woodland
175	Grassy Woodland	709	Scree-slope Woodland
184	Montane Wet Heathland	803	Plains Woodland
191	Riparian Scrub		
Medium Susceptibility (contains 7 – 9 species susceptible to PC)			
28	Rocky Outcrop Shrubland	278	Herb-rich Heathy Forest
45	Shrubby Foothill Forest	279	Heathland Thicket
67	Alluvial Terraces Herb-rich Woodland	282	Shrubby Woodland
71	Hills Herb-rich Woodland	704	Lateritic Woodland
165	Damp Heath Scrub	710	Damp Heathland
193	Rocky Outcrop Herbland		
High Susceptibility (contains 10 or more species susceptible to PC)			
16	Lowland Forest	47	Valley Grassy Forest
20	Heathy Dry Forest	48	Heathy Woodland
22	Grassy Dry Forest		

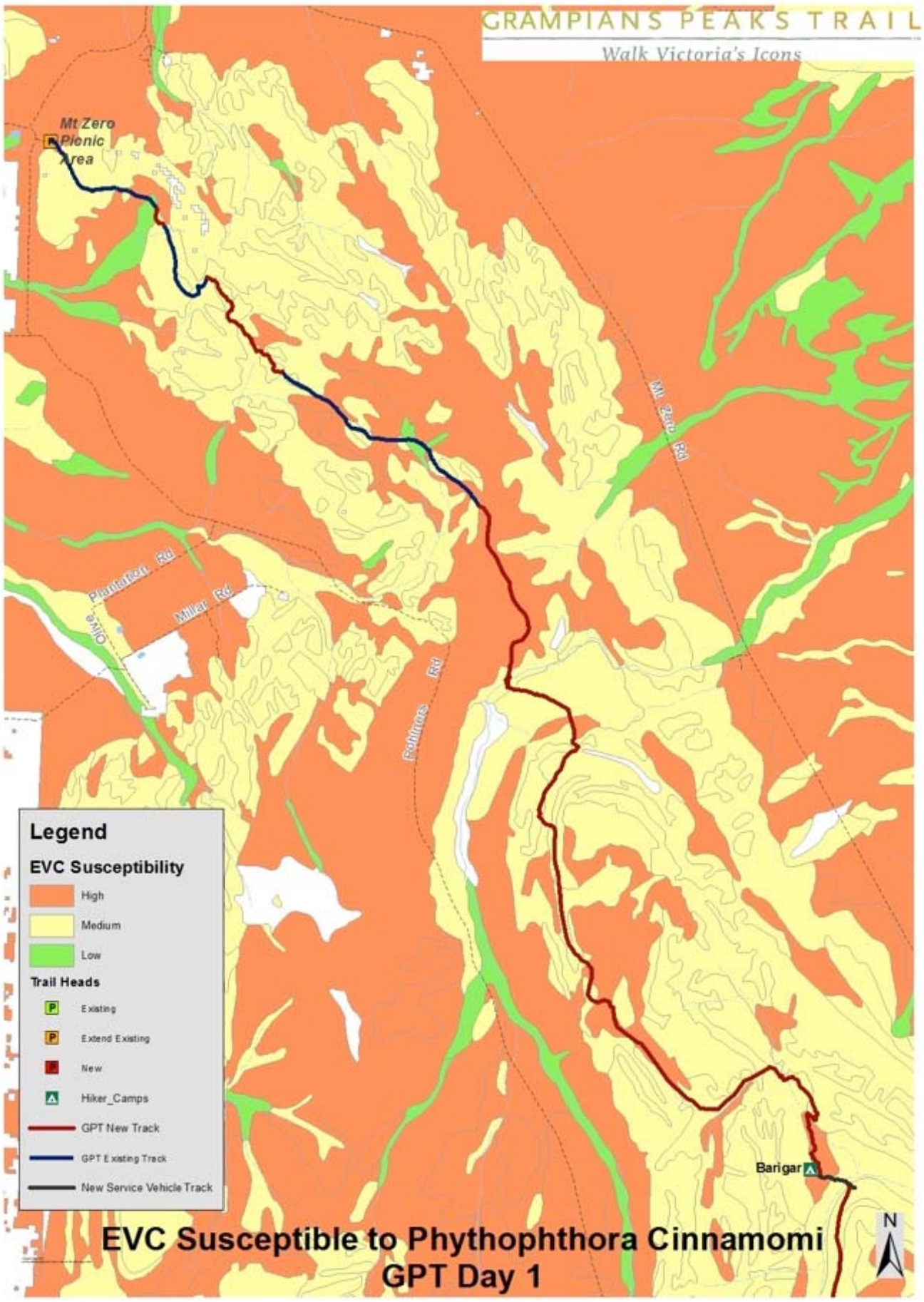

Figure 16. Susceptibility of vegetation to *Phytophthora cinnamomi* along Day 1 of the Grampians Peak Trail.

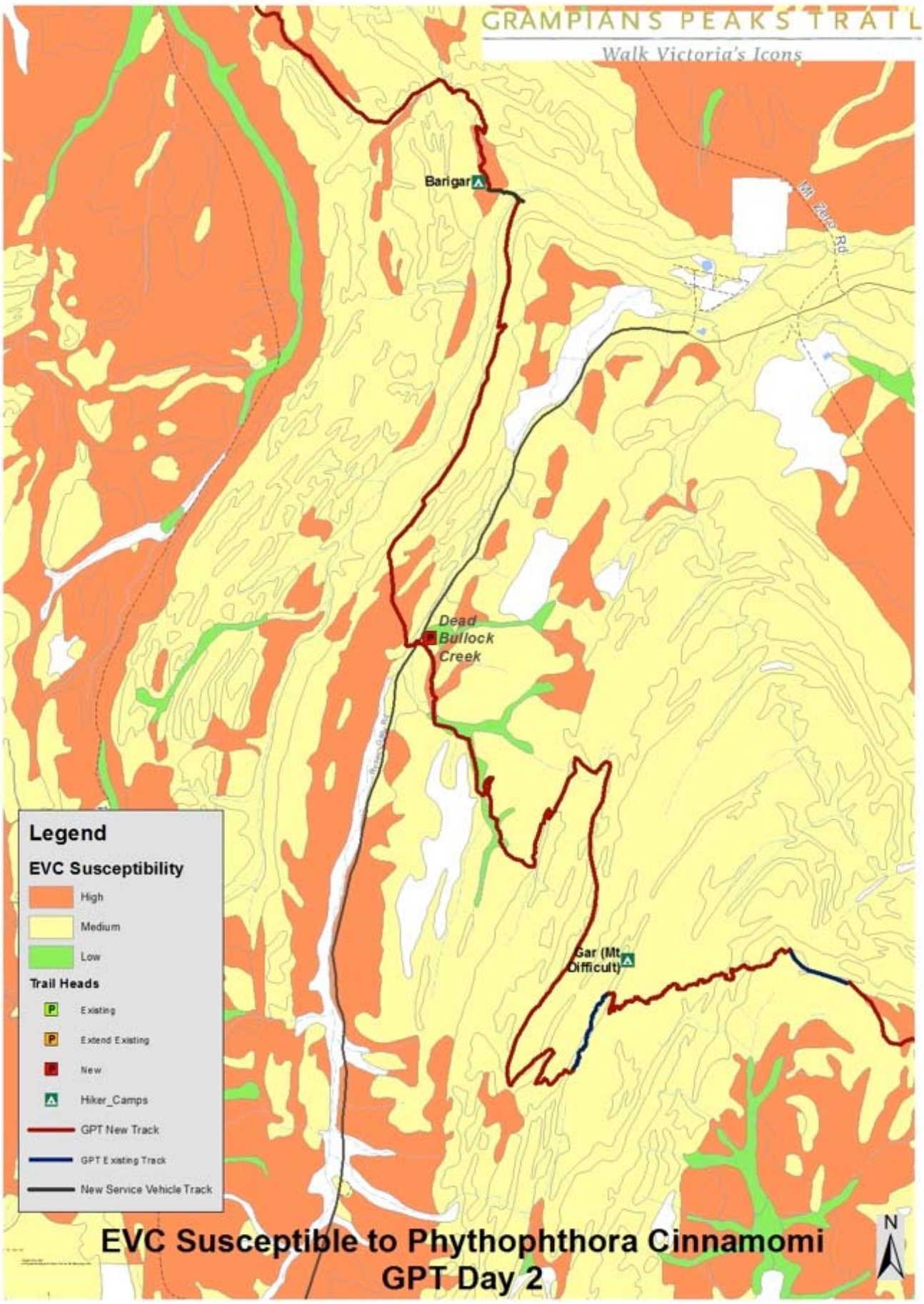

Figure 17. Susceptibility of vegetation to *Phytophthora cinnamomi* along Day 2 of the Grampians Peak Trail.

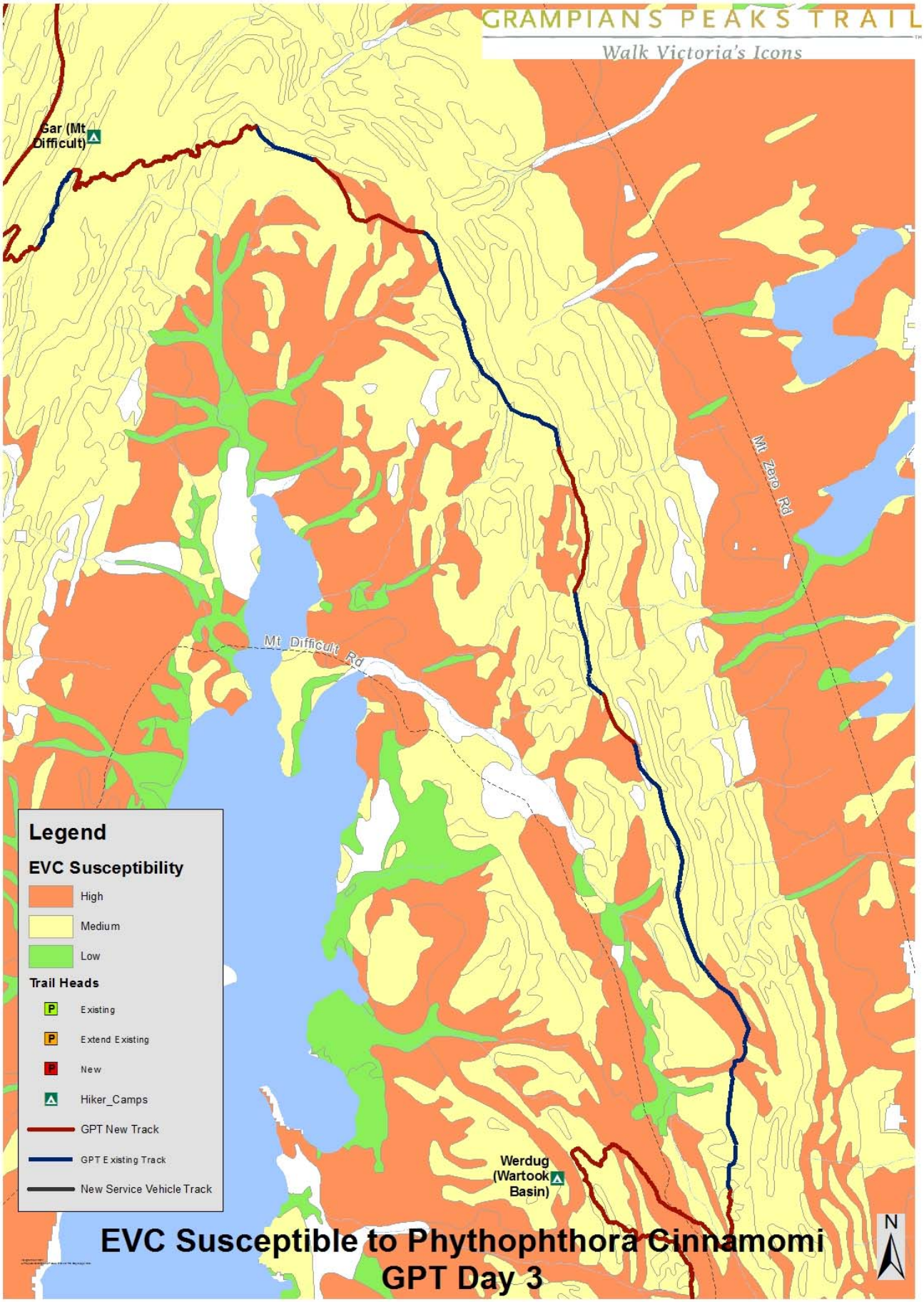

Figure 18. Susceptibility of vegetation to *Phytophthora cinnamomi* along Day 3 of the Grampians Peak Trail.

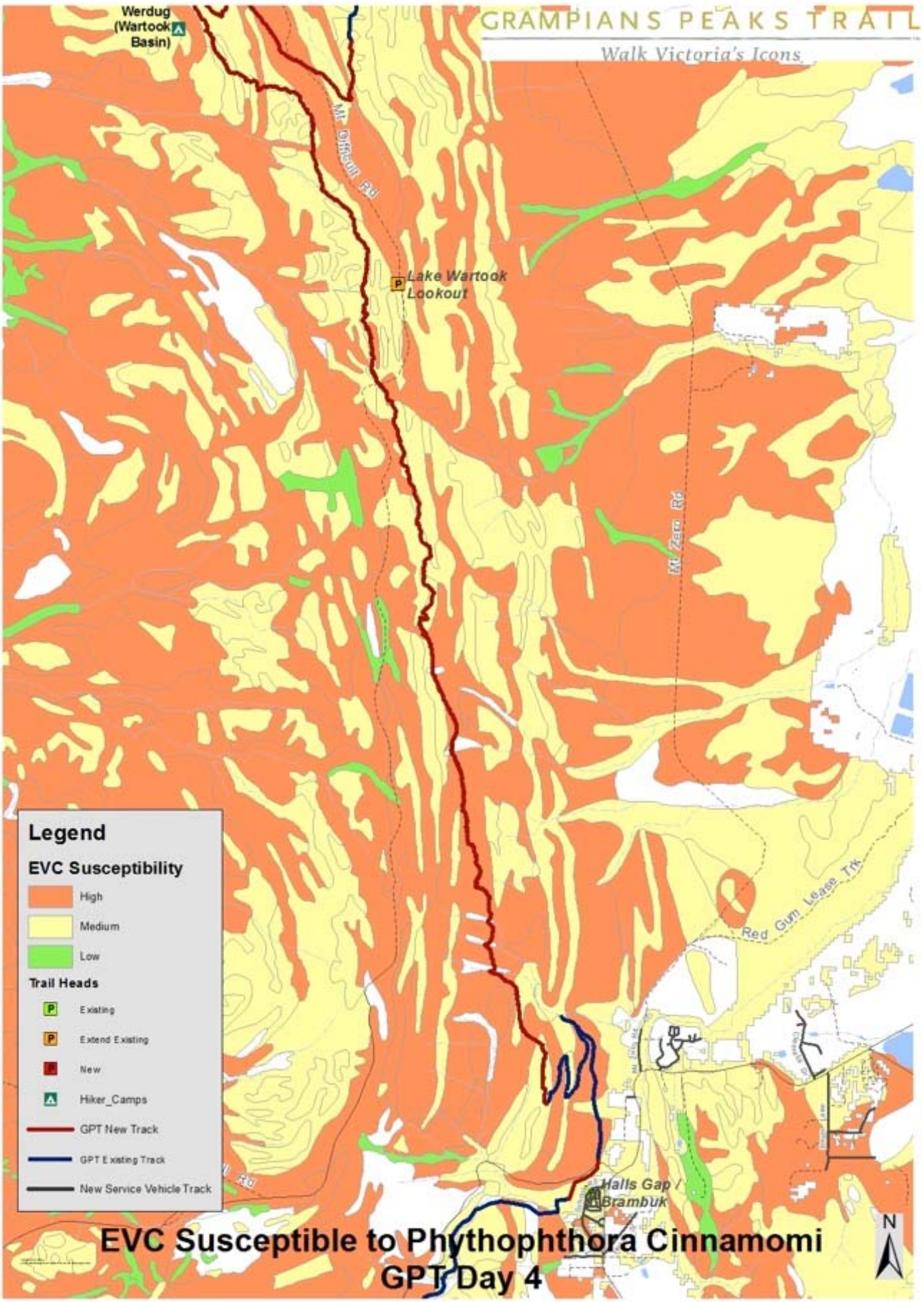

Figure 19. Susceptibility of vegetation to *Phytophthora cinnamomi* along Day 4 of the Grampians Peak Trail.

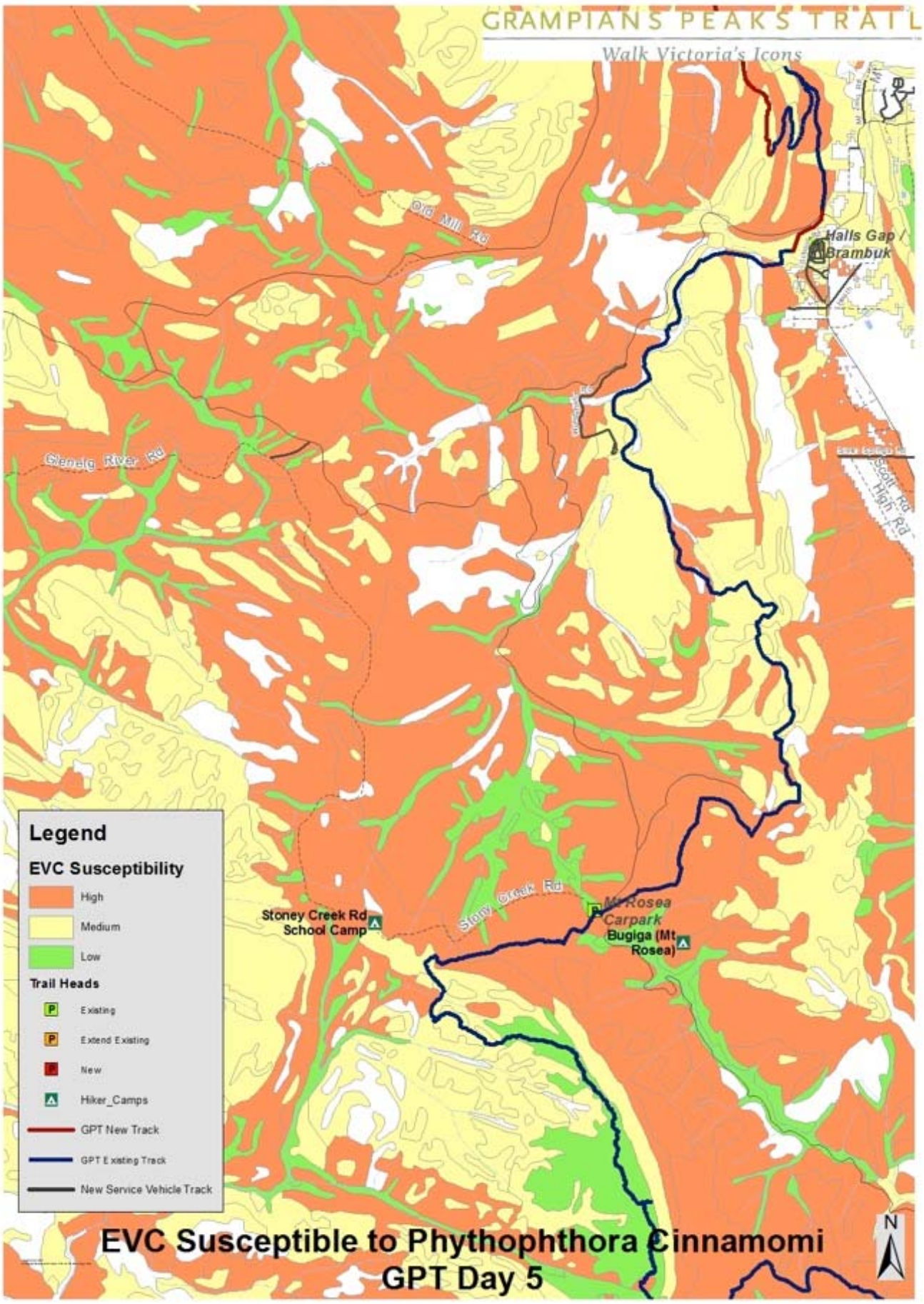

Figure 20. Susceptibility of vegetation to *Phytophthora cinnamomi* along Day 5 of the Grampians Peak Trail.

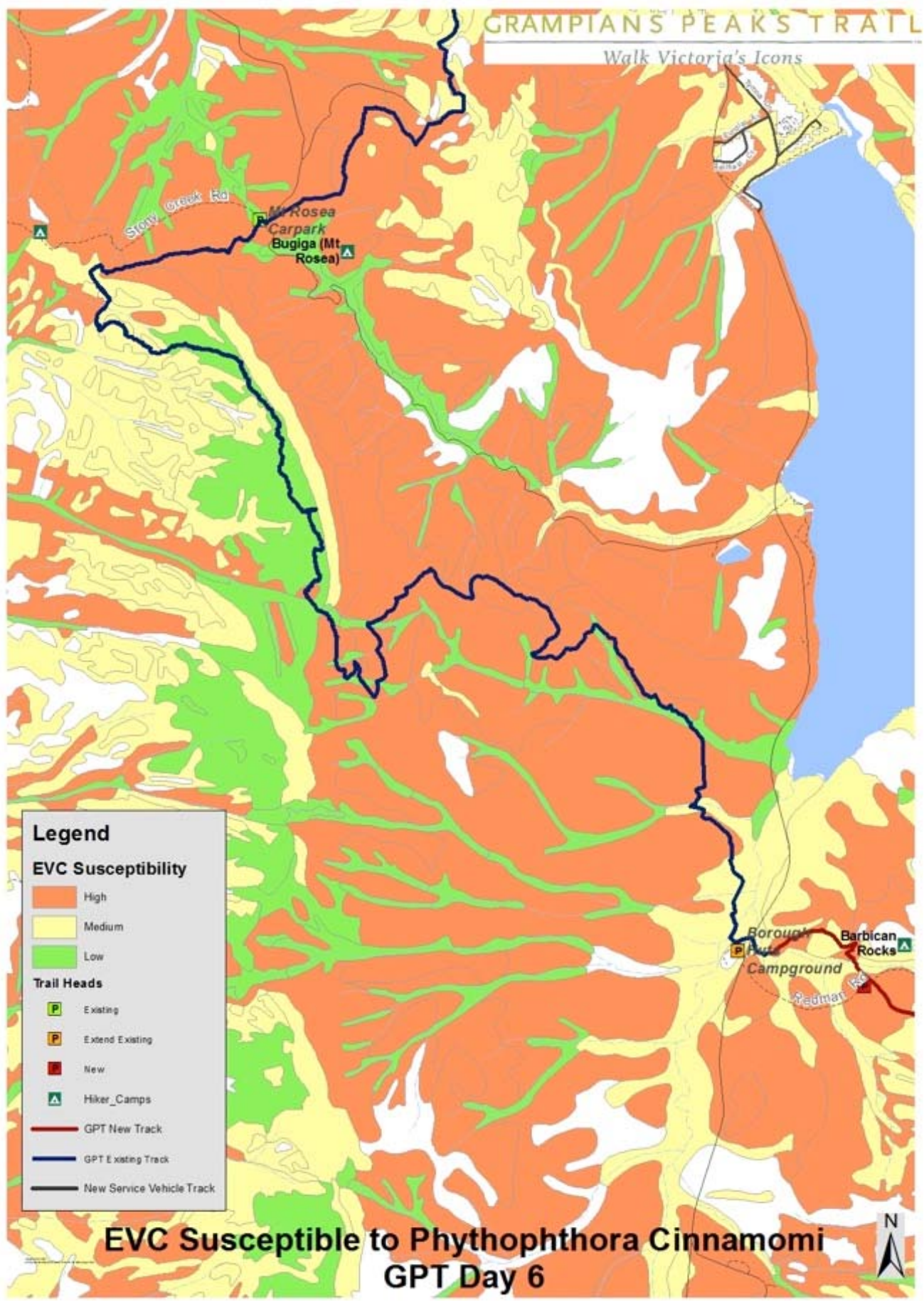

Figure 21. Susceptibility of vegetation to *Phytophthora cinnamomi* along Day 6 of the Grampians Peak Trail.

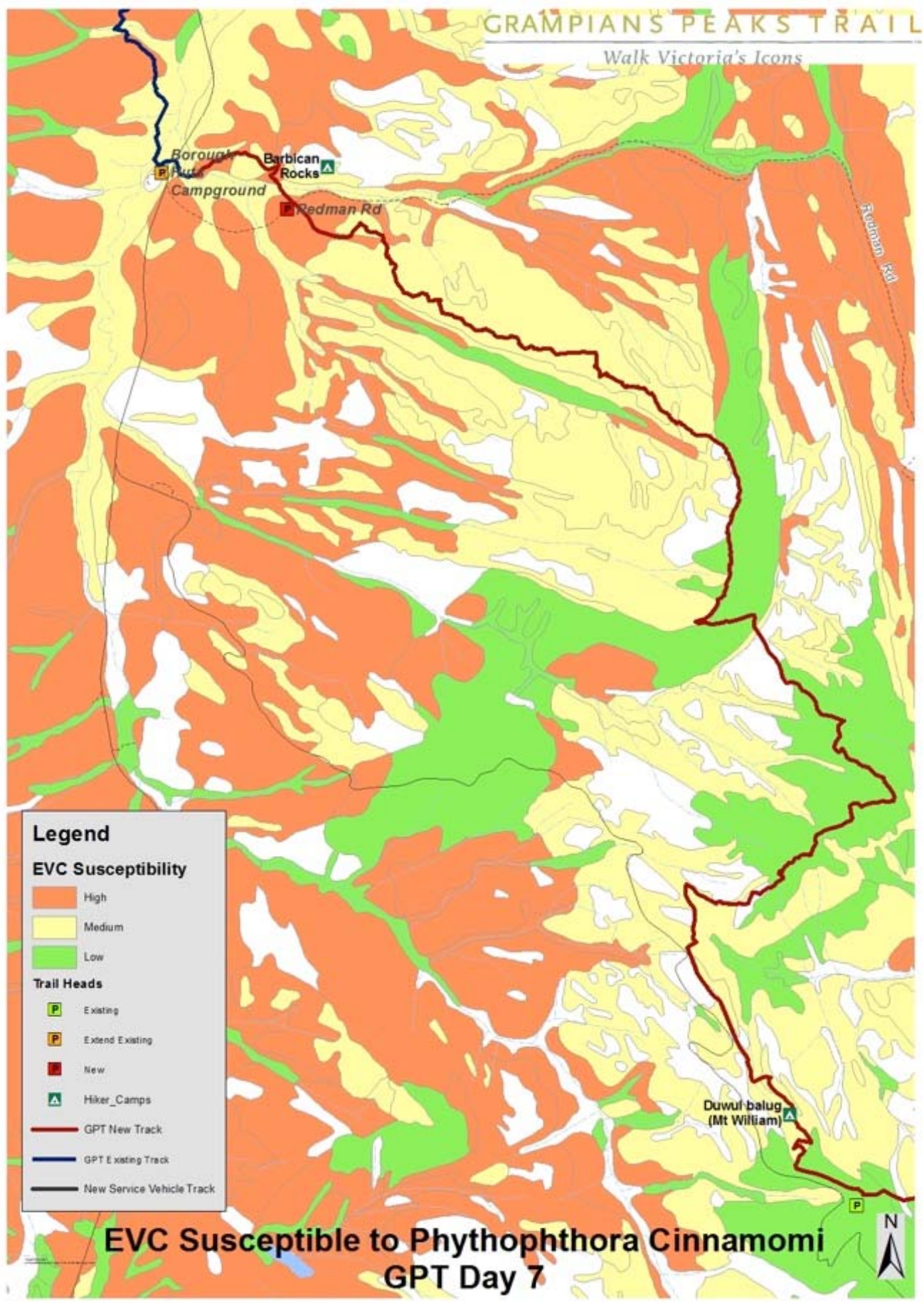

Figure 22. Susceptibility of vegetation to *Phytophthora cinnamomi* along Day 7 of the Grampians Peak Trail.

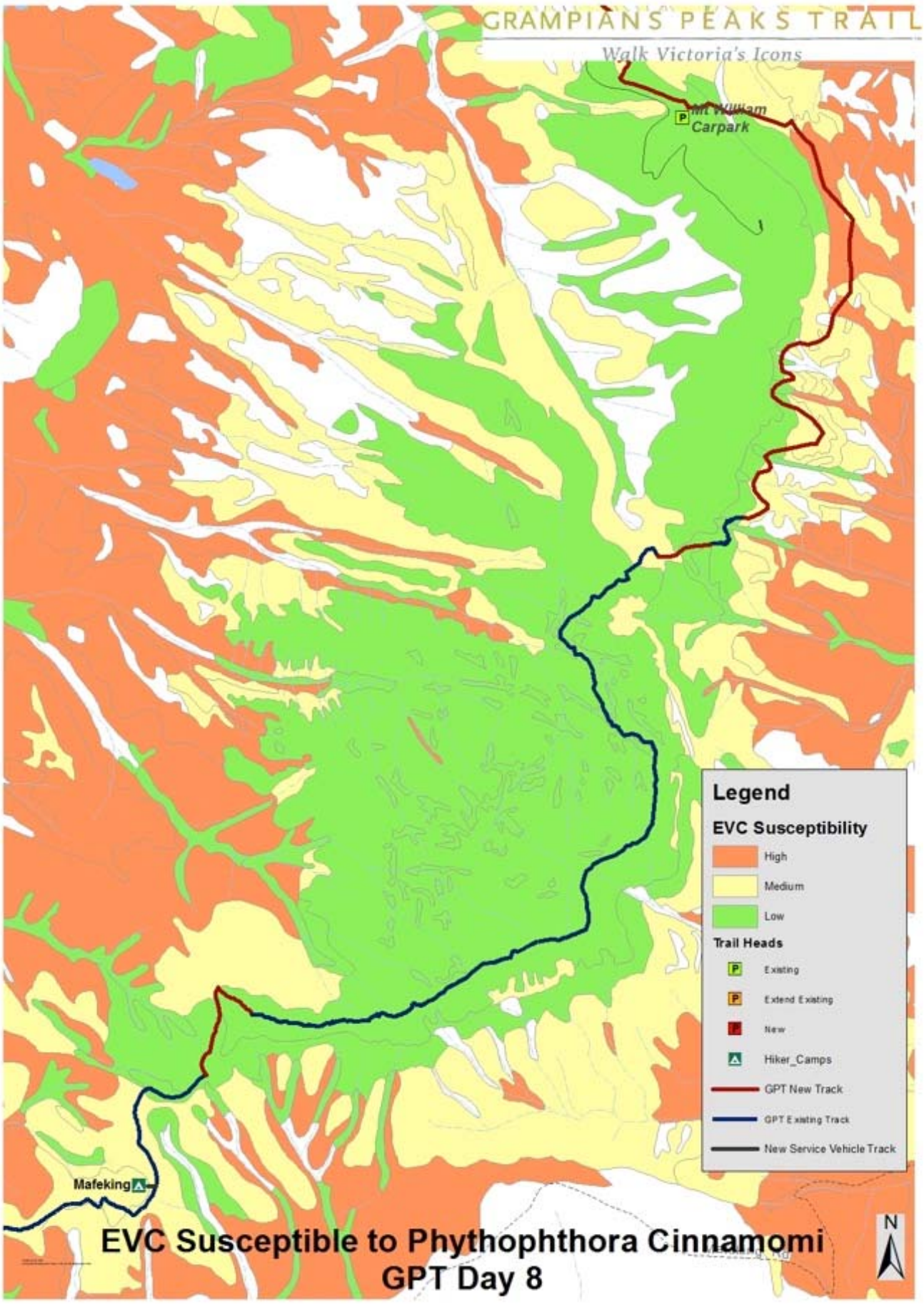

Figure 23. Susceptibility of vegetation to *Phytophthora cinnamomi* along Day 8 of the Grampians Peak Trail.

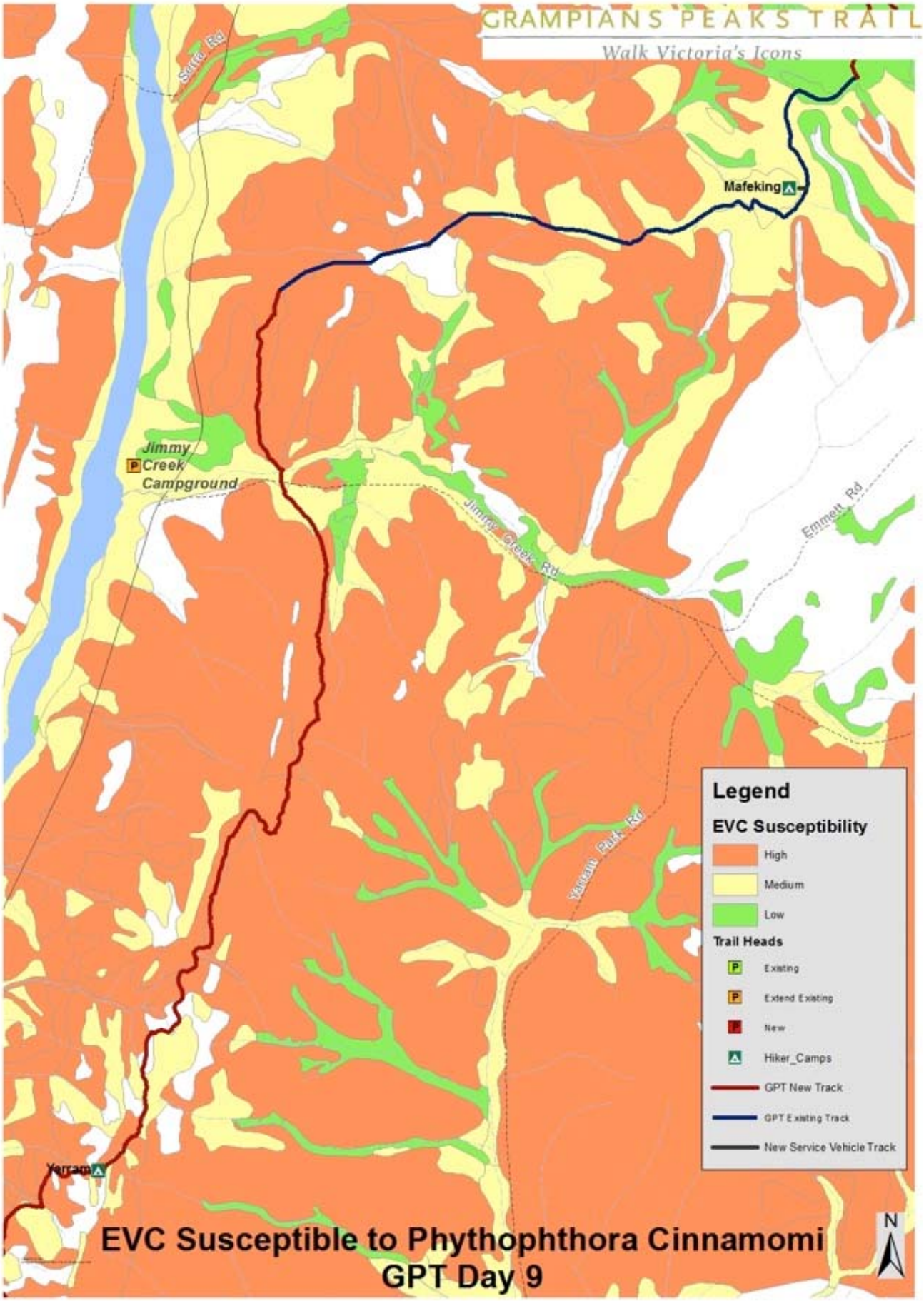

Figure 24. Susceptibility of vegetation to *Phytophthora cinnamomi* along Day 9 of the Grampians Peak Trail.

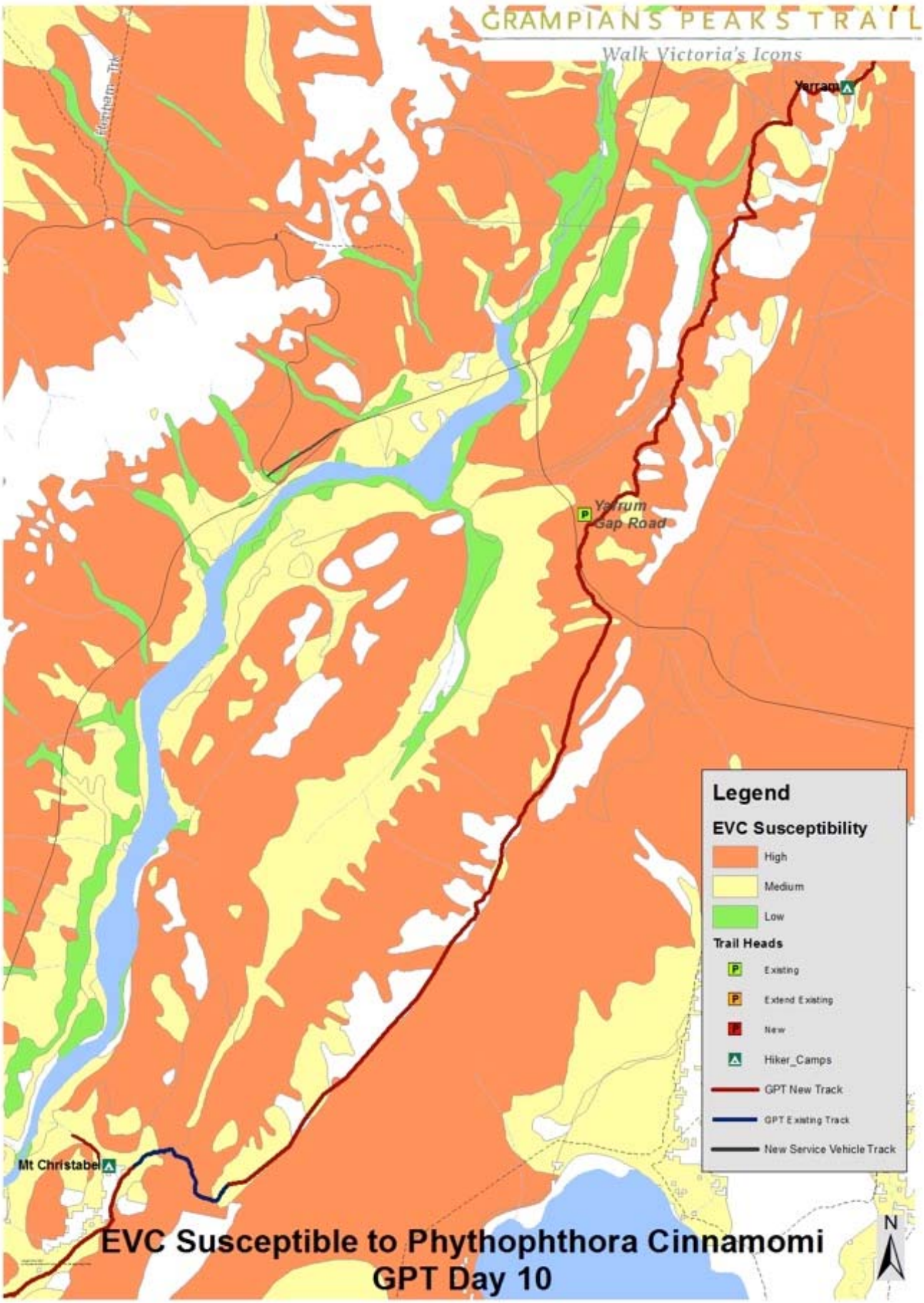

Figure 25. Susceptibility of vegetation to *Phytophthora cinnamomi* along Day 10 of the Grampians Peak Trail.

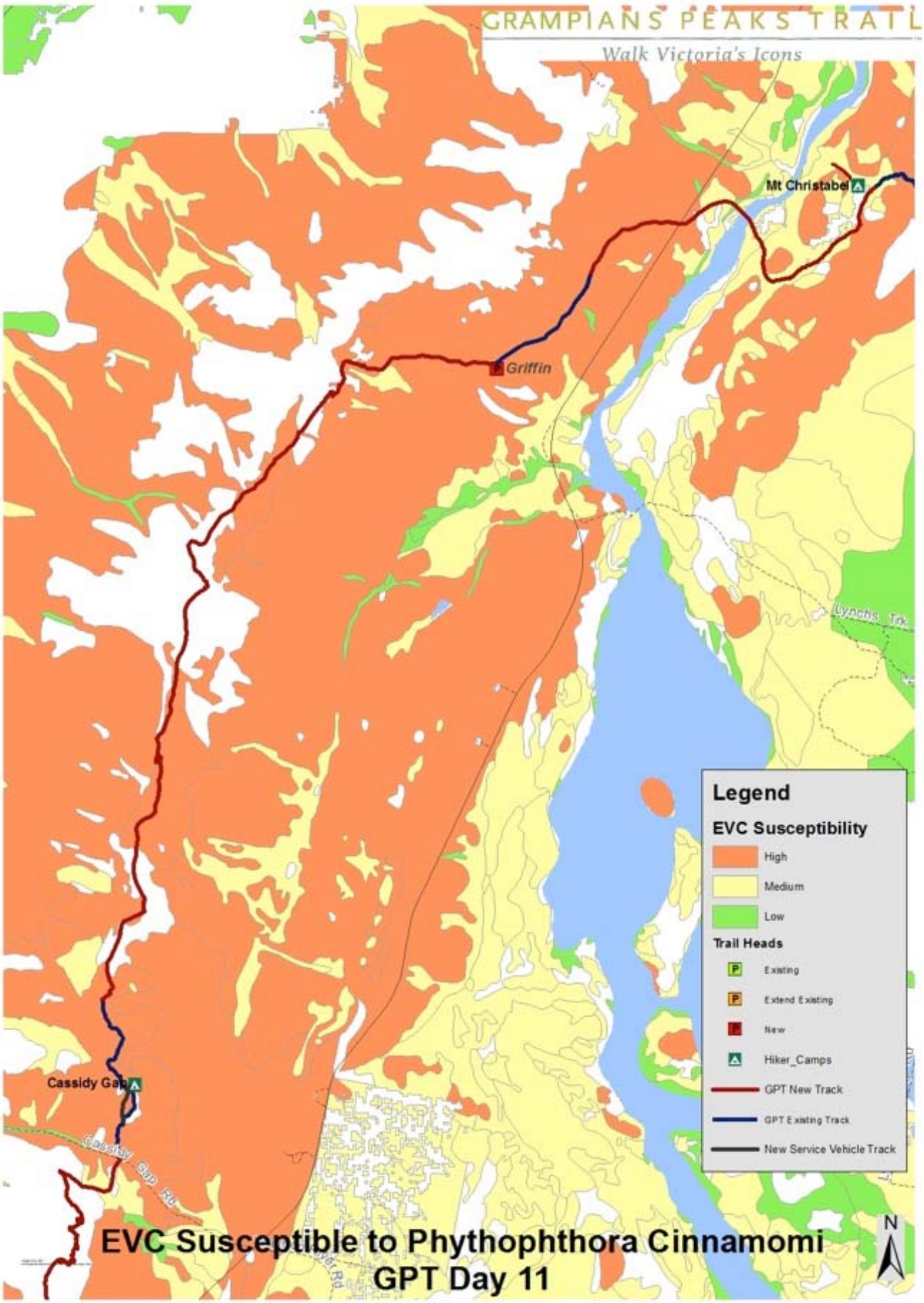

Figure 26. Susceptibility of vegetation to *Phytophthora cinnamomi* along Day 11 of the Grampians Peak Trail.

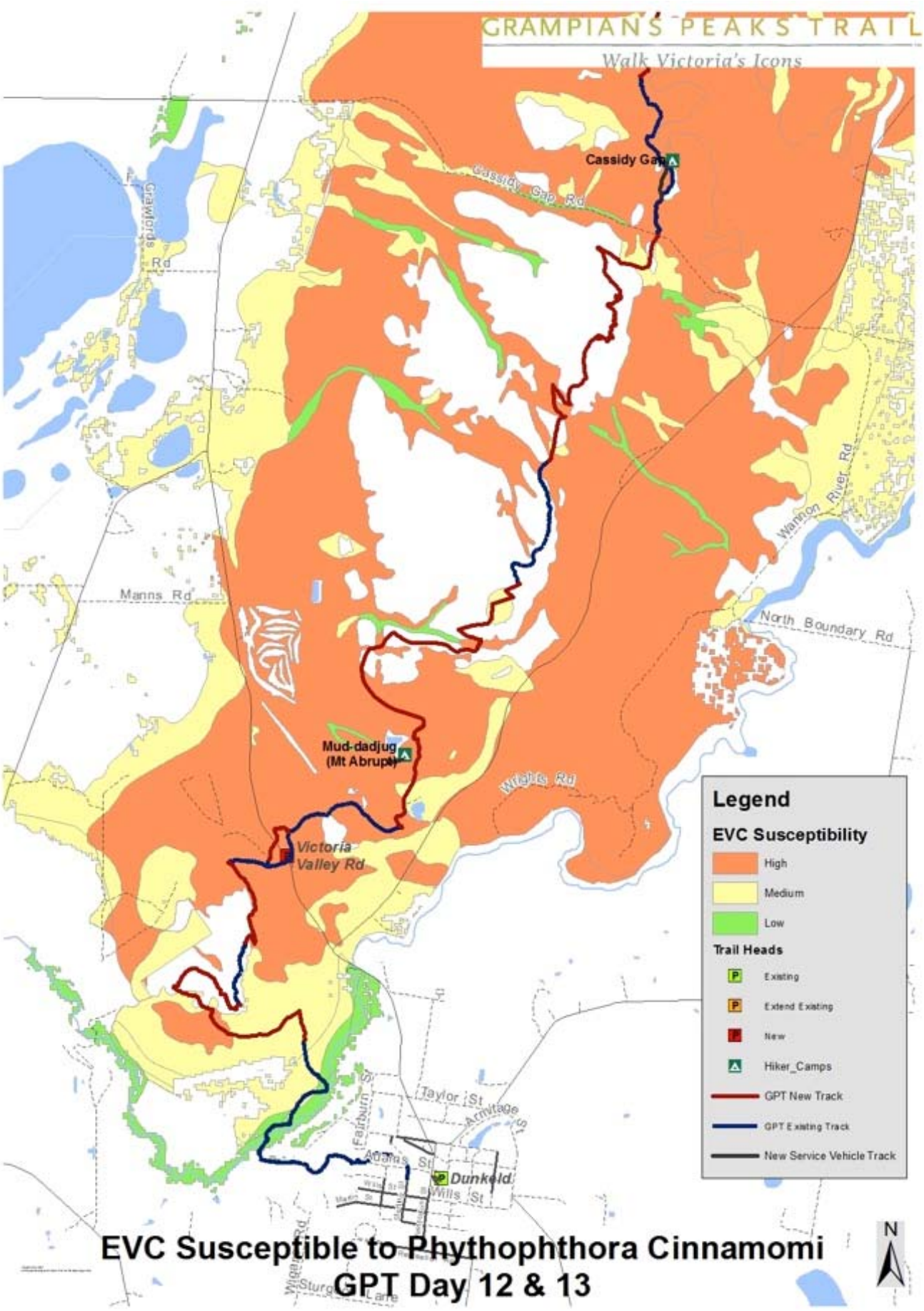

Figure 27. Susceptibility of vegetation to *Phytophthora cinnamomi* along Day 12 & 13 of the Grampians Peak Trail.