Appendix C

Relevant environmental protection guidelines for matters of NES

Environment Protection Guideline
Road Works

Project Section:	All

Issue		Management Measures	Check	Compliance Notes
Vegetation Clearing				
1	Construction zones	For road widening there will be no construction disturbance outside the designated construction zone.		
		Prior to works commencing in any given area, all construction exclusions zones noted will be marked out on the ground by a suitably qualified person.		
2	Construction zone delineation	The construction zone will be delineated with tape. Construction exclusion zones will be delineated with tape and signs erected on the perimeter.		
3	Previously undetected discoveries	If flora and fauna that may be of conservation significance is detected during clearing work, the site will be temporarily marked off as a construction exclusion zone until management advice has been taken from a relevant specialist.		
4	Clearance minimisation	Vegetation clearance will be minimised as far as practicable, particularly at watercourses (e.g. chainsaws will be used to trim branches and the width of clearing minimised).		
5	Habitat fragmentation	Wildlife habitat fragmentation effects will be minimised by maintaining tree canopy connectivity where practicable, particularly at watercourses and roadside remnants.		
6	Eagle nests	If a previously unknown wedge-tailed eagle or white bellied sea-eagle nest is discovered during the breeding season (August - January inclusive) all activity within 500 metres of the nest or within 1 km if in line of sight of the nest will immediately be ceased. The nest site will be inspected by the Forest Practices Authority zoologist and/or DPIPWE specialist, who will provide advice on appropriate further action.		
		If a previously unknown wedge-tailed eagle or white bellied sea-eagle nest is discovered outside the breeding season (February - July inclusive) all activities within 500 metres of the nest will immediately be ceased. The nest site will be inspected by the Forest Practices Authority Zoologist and/or DPIPWE specialist, who will provide advice on appropriate further action.		
7	Masked owl	Operations will cease within 100 m of any tree suspected of containing a previously unknown masked owl nest, (trees with large nesting hollows in combination with evidence of pellets (regurgitated skin/bones, and/or white droppings at the base of the tree) and a Forest Practices Authority Zoologist and/or DPIPWE specialist will be advised as soon as practical to determine a management prescription for the nest.		
8	Tasmanian devils	Mature logs or downers greater than 70 cm diameter at the large end or which have a hollow section will be treated as potential habitat for the Tasmanian devil. Any such logs will be removed to a designated site for safe keeping outside the works area until required for rehabilitation. Mature/dry logs will not be heaped and burnt but retained for habitat.		
9	Wombat	Any identified wombat burrows will be avoided where practicable. If avoidance is not practicable, advice will be taken from a Forest Practices Authority zoologist and/or DPIPWE specialist to determine a		

Project Section:	All

Issue		Management Measures	Check	Compliance Notes
		management prescription.		
11	Retained vegetation	Vegetation to be retained within the construction zone will be marked with yellow flagging or marker tape to indicate that it should be avoided. Marker paint will not be used.		
		Disturbance of roots or compacting of soil in the drip zone of vegetation to be retained will be avoided.		
		Clearing will aim to retain the maximum amount of root stock within the construction area. Slashing may be undertaken as a means of vegetation clearing, particularly in sown pastures or at watercourses.		
12	Vegetation stockpiling	Cleared vegetation will be stockpiled separately in a manner which: facilitates respreading or salvaging does not impede vehicles, stock or wildlife avoids damage to adjacent live vegetation (e.g. trees shall be felled onto the easement away from standing timber).		
13	Rock stockpiling	Surface rock removed from the easement will be stockpiled in an adjacent area, either for respreading, use at another location as riprap or disposal as appropriate.		

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	Road Grading & Sealing	

Project Section:	All

Issue		Management Measures	Check	Compliance Notes
Grading				
1	Soil stockpiling	Graded soil will be stockpiled separately from other materials (e.g. vegetation), where it can be readily recovered for respreading and where it will not be lost through wind or water erosion or other means.		
		Graded soil will not be stockpiled where it has the potential to result in sedimentation or acidification of land or surface water (e.g. on slopes which drain immediately to a watercourse). Topsoil containment measures (e.g. berms and sediment fencing) will be used as necessary. Any acid sulphate soils will be identified and stockpiled within bunding to prevent mixing with other soils.		
		Grading and stockpiling of soil will not, as far as practicable, impede surface drainage or waterflows.		
2	Soil stability	Soil and surface stability will be maintained at all times (e.g. cut and fill excavation will be shaped to maintain slope stability and temporary erosion control berms; drains and sediment barriers will be installed as necessary and maintained until final construction reinstatement is completed).		
3	Watercourses	Grading of watercourse beds and banks will be minimised, leaving an undisturbed organic mat within the riparian zone, or delayed until construction of the crossing is imminent, thus preventing sediment input into watercourses.		

1	Spill response	Appropriate spill response equipment, including containment and recovery equipment, will be available on site.		
		Spill response procedures will be formulated and workforce training conducted in land and water spill responses.		
Site reinstatement and rehabilitation				
2	Site restoration	The requirement to restore camps, worksites and laydown areas will be determined in consultation with relevant regulatory authorities and landholders. In some instances, landholders and/or regulatory authorities may choose to maintain the site for future purposes; in which case, partial site rehabilitation may be required.		
3	Infrastructure removal	Temporary infrastructure and wastes will be removed from site. Any contaminated soils may require analysis and appropriate disposal options determined with approval from relevant regulatory authorities (e.g. EPA and local government).		
4	Site re-profiling	The site will be re-profiled in a manner that ensures soil stability and which is as near as practicable to pre-existing contours.		
5	Compaction relief	Soil compaction relief will be conducted in trafficked areas as necessary (i.e. ripping along the contours).		
6	Topsoil spreading	Stockpiled topsoil will be respread over the rehabilitation area.		
7	Revegetation	Appropriate regeneration/revegetation measures will be implemented, taking into consideration site-specific characteristics which may affect regrowth and stabilisation success. Seeding and the use of geotextile materials may be appropriate.		
8	Erosion control	Erosion and sediment control measures will be applied as required (e.g. diversion berms, geotextiles and silt fences).		
9	Hydrocarbon wastes	Hydrocarbon wastes, including lube oils and oily sludges, will be collected for safe transport off-site for reuse, recycling, treatment or disposal at approved locations.		
10	Bunding	Hazardous waste storage areas will be suitably designed to adequately contain any spills and leaks (e.g. bunded in accordance with statutory requirements).		
11	Contaminated soils	Contaminated soils (e.g. loading bay drain/pig trap contents, oil/fuel spills) will be managed according to their location, their concentration of contaminants, their tendency to leach and the extent of area affected. Appropriate disposal options will be determined in consultation with the relevant environment protection authorities.		
Putrescible Wastes				
12	Waste types	Putrescible wastes are those wastes able to be decomposed by bacterial action and may include discarded food, domestic garbage, commercial wastes and garden clippings.		

13	Approved disposal	Putrescible wastes will be disposed of by collection and transportation to a landfill approved by the relevant regulatory authority (this may include local government approval).		
Housekeeping				
14	General hygiene	The construction area and associated camp, work and storage sites will be maintained to an orderly and hygienic standard.		
15	Litter avoidance	Appropriate measures will be taken to ensure that litter accumulation is avoided, such as the provision of litter bins on-site and regular site maintenance duties.		

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Environment Protection Guideline
Watercourse Works & Crossings

Project Section:	All

Issue		Management Measures	Check	Compliance Notes
Access				
1	Equipment quality	All equipment required for the crossing will be on-site and in good working order prior to work commencing on the crossing.		
		All hydraulic, fuel and lubricating systems of machinery used in the watercourse crossing will be in good repair in order to avoid water pollution.		
2	Weed free certification	Construction machinery will be inspected to confirm that they are weed free prior to allowing access to the watercourse.		
3	Access crossings	Access tracks/roads will, where practicable, avoid crossing waterways. Watercourse crossings will either be: Via existing crossings Through the stream bed at dry waterway crossings (e.g. ephemeral streams). However, access will be limited, where practicable, to vehicles and equipment essential to construction at the site. Via culvert causeways, bridges or other such crossing structures.		
4	Additional measures	Crossings will be designed and constructed in a manner that minimises sediment release into waterways, does not prevent water flows and is capable of accommodating locally significant rainfall events.		
		A culvert will be installed to allow the running water free access through the crossing.		
Construction Weather				
5	Dry conditions	Construction will be restricted to dry weather and soil conditions whenever practicable.		
6	Wet conditions	If wet weather work is unavoidable, silt fencing will be used to minimise the likelihood of sediments entering the waterway. Work will be stopped during and after heavy rain.		
Machinery Crossing Points				
7	Minimise disturbance	Existing crossings will be used to move equipment across the waterway wherever possible. If there is no existing crossing and the stream must be crossed, any disturbance will be minimised. If crossing once, the machinery will be carefully 'walked' across the stream. If crossing many times, a temporary crossing will be made by laying a pad of clean rock at a shallow point of the waterway. The rock will be removed when works have finished.		
Watercourse Diversions				
8	Temporary diversion	If excavation in a stream channel in unavoidable, the flow will be diverted and the works site isolated, unless the environmental risk is small and the flow is low, in which case it may be possible to do the works without a diversion structure.		

Project Section:		All		
Issue		**Management Measures**	**Check**	**Compliance Notes**
		Stream diversion will be by constructing a cofferdam, berm or temporary channel.		
Grading at Watercourses				
9	Grading of topsoil	Where practicable, grading topsoil from the construction area on watercourse approaches will be avoided, thus allowing the undisturbed organic mat to remain *in situ*. Vegetation removal on unstable and erodible banks will be by hand.		
		If grading of banks and slopes leading to watercourses is necessary, it will be delayed until construction of the crossing is imminent, thus minimising erosion and sedimentation risk.		
		Soil will be graded away from the watercourse.		
10	Soil stockpiles	Soil will be stockpiled at an appropriate distance from the watercourse or behind adequate stockpile berms.		
11	Drainage patterns	Other than what is unavoidably part of the project works, there will be no change to drainage patterns or surface flows around aquatic habitat sites.		
Reinstatement in Watercourses				
12	Bank stabilisation	Appropriate stabilisation measures will be implemented on both the banks and bed of watercourses. Such measures will be determined on a site-specific basis following consideration of local influencing factors such as stream hydrology, soil type, rainfall, vegetation regeneration potential, land use, etc. Long-term measures to control erosion at the works site may include slope stabilisation, revegetation, soil coverings, riprap and armouring, check dams, sediment traps, brush barriers and vegetation filters.		
13	Topsoil respreading	Topsoil will be respread over the area from which it was removed and seeding areas of disturbance.		
14	Cobble protective layer	A surface layer of cobbles, coarse gravel or rock may be replaced or introduced over disturbed areas as riprap. Particular care will be taken to ensure that the material is replaced on the river bed to a depth equivalent to the original conditions and so that it is not likely to act as a barrier to the passage of aquatic fauna.		
15	Scour protection	Sandbag, gabion or other means of scour protection may be applied and will be placed to conform with existing natural contours, as appropriate, with topsoil respread over the sandbags or gabions.		
16	Access restriction	Access to rehabilitating crossing sites will be restricted, e.g. fencing or barriers, to assist site recovery.		
17	Silt fences	Silt and sediment fences will be used as necessary on slopes to filter surface run-off water.		
18	Reseeding	Reseeding or replanting of disturbed banks will be undertaken as appropriate.		
19	Fertilisation	There will be no fertiliser application within 5 m of aquatic habitat or remnant native vegetation areas.		
20	Biocides	Only biocides endorsed by the Australian Pesticides and Veterinary Medicines Authority will be used.		

Project Section:		All		
Issue		**Management Measures**	**Check**	**Compliance Notes**
		There will be no spraying within 5 m of aquatic habitat or remnant native vegetation areas.		
21	Stabilisation	Stabilising materials such as, hydromulch, jute matting or other suitable geotextile material will be applied as appropriate.		
22	Track direction	Up-slope vehicle tracks will be avoided on rehabilitation areas.		

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Project Section:	All		
Issue	**Management Measures**	**Check**	**Compliance Notes**
Exclusion Zones			
1 Exclusion zones	Heritage features which may not be impacted upon will be protected by construction exclusion zones which will be taped off in the field prior to construction works commencing. There will be no disturbance inside a construction exclusion zone.		
Permitted Impacts on Listed Items			
2 Approval or exemption conditions	Where impacts on heritage items have been approved under a statutory approval, such as a permit or a works exemption, potential impacts will be mitigated in accordance with any applicable permit or exemption conditions.		
Minimising Impacts on Non-listed Items			
3 Impact minimisation	Where there are potential impacts on heritage items which are not protected under legislation, impacts will be minimised by best practice management, including (but not limited to) the following.		
	A 20 m avoidance buffer will be applied wherever practicable.		
	Where heritage features extend across the construction zone, wherever practicable disturbance will be aligned between individual features in an attempt to minimise impacts.		
Unanticipated Discovery during Construction			
4 Cease work in vicinity	Activities which may lead to damage of a newly discovered heritage item/feature (natural or built) will be temporarily discontinued and the find reported to DIER. Work may continue at an appropriate, predetermined distance (nominally no less than 30 m) from the discovery.		
5 Establish buffer zone	A buffer protection zone of 10 m X 10 m will be established around the suspected heritage item (but see *Suspected skeletal material*, below). No unauthorised entry or earth disturbance will be allowed within this protection zone until such time as the suspected heritage item has been assessed, and appropriate management measures determined.		
6 Notify specialists	The construction crew will notify project management of the potential find and appropriate archaeological, anthropological and/or environmental specialists will be brought to the site to identify and assess its significance. This may require a works notice to commence and a sign off form/clearance certificate to allow works to recommence. If it is believed that human skeletal remains or burial sites have been discovered, the project management will also notify local police.		
7 Notify authorities	In the event that the discovery is determined to be of heritage significance (natural or built), project management for the pipeline proponent will, as soon as reasonably practicable, notify all relevant regulatory authorities (e.g. Aboriginal Heritage Tasmania, Heritage Council).		

Project Section:		All		
Issue		**Management Measures**	**Check**	**Compliance Notes**
8	Suspected skeletal material	Under no circumstances will the suspected skeletal remains be touched or disturbed. (If these are human remains, then this area potentially is a crime scene. Tampering with a crime scene is a criminal offence.) Any person discovering suspected skeletal remains will notify machinery operators that are working in the general vicinity of the area that earth disturbing works must stop immediately. A buffer protection zone of 50 m X 50 m will be established around the suspected skeletal remains. No unauthorised entry or earth disturbance will be allowed in this buffer zone until such time as the suspected skeletal remains have been assessed. The relevant authorities (police in the first instance) will be contacted and informed of the discovery.		
9	Implement agreed management measures	Following verification and documentation of the site, an appropriate management option will be pursued by the proponent in consultation with relevant heritage specialists and community representatives and relevant regulatory authorities.		

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	Noise	

Project Section:		**All**		
Issue		**Management Measures**	**Check**	**Compliance Notes**
Construction				
1	Noise limits	Construction activities will comply with all relevant regulatory requirements and guidelines pertaining to noise control.		
2	Noisy equipment	Construction equipment will be equipped with appropriate noise abatement devices (e.g. mufflers), and equipment and noise abatement devices will be maintained in good working order.		
3	Locate and/or enclose	Noise generating equipment (e.g. generators) will be located at appropriate distances from residences and/or within noise enclosures if necessary.		
4	Noise barriers	Noise attenuation barriers will be provided where appropriate.		

pitt&sherry sustainable*thinking*®	Environment Protection Guideline Dust & Other Air Emissions	

Project Section:	All		
Issue	**Management Measures**	**Check**	**Compliance Notes**
Construction			
1 Source isolation	Known sources of air emissions leading to impact or inconvenience will be isolated and treated by an appropriate measure (e.g. liquid and solid waste producing air emissions will be located away from sensitive receptors or prevailing wind conditions).		
2 Vehicle speeds	Vehicle speeds on tracks, work and camp sites, and the construction area will be restricted to minimise dust. Multiple plant or equipment close to sensitive receptors may need to be monitored for exhaust emissions.		
3 Plant maintenance	Plant and equipment will be regularly maintained and monitored (mobile and fixed).		
5 Minimise disturbance	Ground disturbance will be minimised through retaining existing groundcover vegetation.		
6 Watering and stabilisers	Water will be applied to exposed soils as required to prevent dust generation. Water supplies will be of an appropriate water quality so as not to lead to soil contamination (e.g. saline groundwater or contaminated waste water will not be used). In heavily trafficked areas, or where water resources are scarce, dust stabilisers may be used. In problem areas it may be appropriate to remove additional soil layers down to the harder subsoils.		
7 Stockpiles	Dust generated from soil stockpiles will be minimised by ensuring exposure time is minimised, applying water, covering stockpiles with protective materials (e.g. hessian, tarpaulins), applying polymers or applying sterile grass as a longer term stabiliser on stockpiles or exposed slope batters.		
8 Adverse conditions	If all available methods of dust stabilisation fail to suppress dust and it continues to result in unacceptable impacts, construction activities may need to be temporarily halted until dust generating conditions subside or are rectified.		
9 Temporary halts	If all available methods of dust stabilisation fail to suppress dust and it continues to result in unacceptable impacts, construction activities may need to be temporarily halted until dust generating conditions subside or are rectified.		
10 No burning	No burning of rubbish, vegetation or other matter in incinerators or in open spaces will be undertaken without the written approval of the project superintendent.		

pitt&sherry sustainable*thinking*®	**Environment Protection Guideline**	
	Introduced Plants	

Project Section:		**All**		
Issue		**Management Measures**	**Check**	**Compliance Notes**
Weeds				
1	Preconstruction control	Where any declared weeds have been identified or are present they will be controlled prior to works commencing on the pipeline.		
2	Licensed subcontractors	Licensed and suitably qualified or experienced weed control subcontractors will be engaged as appropriate.		
3	Weed eradication	Weed eradication by spraying with non-residual herbicide or by mechanical removal will be used in areas of significant noxious weed infestation.		
4	Equipment wash down	Wash-down/blow-down of vehicles, equipment and portable infrastructure will be undertaken to remove all soil and organic matter prior to arriving at the construction site and prior to leaving a known infestation site.		
		Weed wash-down wastewater or sediment may require treatment by physical or chemical means to ensure that weeds do not occur at discharge locations.		
		Wash-down protocols will be in accordance with the DPIPWE Washdown Guidelines for Weed and Disease Control - Machinery, Vehicles and Equipment - Edition 1, April 2004.		
5	Wash down points	Wash-down points will be located close to infected/infested areas along the route to reduce the risk of spreading infected material.		
6	Access restrictions	Access of vehicles and personnel will be restricted from areas of known noxious weed infestation to the extent practicable. Vehicles entering and leaving such areas may need to be rewashed.		
7	Imported soil and vegetation	Imported topsoil and organic revegetation matting will be certified to be weed free by the supplier prior to being brought to site.		
8	Emergence monitoring	Regular monitoring for potential germination will be undertaken within the construction zone and controlled prior to seed set in accordance with DPIPWE control guidelines.		
9	Chemical usage	Weed control activities involving the use of chemicals will be undertaken in consultation with the relevant landholders and regulatory authorities giving due consideration to sensitive land uses (e.g. reservoir water sheds and flora and fauna sensitivities).		

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Environment Protection Guideline
Pests & Diseases

Project Section:	All

Issue		Management Measures	Check	Compliance Notes
Pests & Diseases				
1	Areas of special protection	Areas of high conservation value requiring special protection will be identified.		
2	Subcontractors	Suitably qualified or experienced pest and disease professional (integrated pest management) subcontractors will be engaged if and as required.		
3	Imported crushed rock	Any crushed rock and gravel imported for road construction or maintenance will be sourced from a quarry that is currently certified as being *Phytophthora* free.		
4	Equipment wash down	Wash-down/blow-down of vehicles, equipment and portable infrastructure will be undertaken to remove all soil and organic matter prior to arriving at the construction site and prior to leaving a known infestation site.		
		Wash-down wastewater or sediment may require treatment by physical or chemical means to ensure that weeds do not occur at discharge locations.		
		Wash-down protocols will be in accordance with the DPIPWE Washdown Guidelines for Weed and Disease Control - Machinery, Vehicles and Equipment - Edition 1, April 2004.		
5	Wash down points	Wash-down points will be located close to infected/infested areas along the route to reduce the risk of spreading infected material.		
6	Demountable buildings	Where demountable buildings are used in infected/infested areas along the route proper, thorough removal of soil and vegetative matter will be carried out prior to removal of buildings from infected/infested area.		
7	Training	Construction personnel will be trained in pest and disease management and hygiene procedures, appropriate to pests and diseases known to occur on site.		
8	Boot washing	Facilities will be provided for employees to wash down boots prior to moving out of infected/infested areas.		
9	Wash down register	Vehicles and machinery that are washed will be included in a Vehicle Wash-Down Register.		

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Project Section:	All		
Issue	**Management Measures**	**Check**	**Compliance Notes**
Preparedness			
1 Fire authorities	Regular and timely consultation will be undertaken with all relevant regulatory authorities and compliance with all relevant fire restrictions, notification requirements, permitting procedures and requirements.		
2 Work scheduling	Construction will be scheduled to avoid high fire danger days to the extent practicable.		
3 Extreme fire risk days	Construction activities that pose a fire risk in fire prone areas will be discontinued during extreme high fire danger periods.		
4 Cleared areas	Flammable materials will be cleared from the immediate vicinity of field equipment which may pose a potential fire hazard e.g. petrol driven pumps, generators and other potential ignition sources.		
5 Machinery maintenance	Machinery will be maintained and operated so as to comply with relevant fire safety standards thus minimising fire risk.		
6 Machinery parking	Machinery and vehicles not in use will be parked in areas free of flammable material and vegetation (e.g. not parked over shrubs, tall grass or cleared vegetation residue).		
Response			
7 Fire fighting equipment at work sites	Appropriate fire fighting equipment will be stored at all work and camp sites in accordance with the requirements of the relevant State fire protection requirements. Equipment will be of the required standard and will be inspected and well maintained throughout the construction phase		
8 Fire fighting equipment in vehicles	Construction machinery and vehicles will be equipped with fire fighting equipment (e.g. water knapsacks, rakehoes and fire extinguishers) as appropriate.		
9 Training	Construction workforce bushfire education and training will be undertaken, as appropriate, addressing fire prevention and safety, personnel responsibilities and basic fire suppression.		

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Environment Protection Guideline
Drainage, Erosion & Sediment Control

Project Segment(s):	All

Issue		Management Measures	Check	Compliance Notes
Erosion Control				
Sediment Control				
1	Silt fences	Sediment or silt barriers will be used where necessary and generally constructed from geotextile silt fence or filter fabric secured in place with star pickets or sand bags, concrete saddle weights or culverts. If straw bales are used for sediment control they will be weed and seed free.		
2	Sediment basins	Sediment basins or ponds will be constructed downslope as necessary and designed to catch and retain run-off water allowing sediment to settle out.		
3	Regular inspections	Sediment control structures will be regularly inspected and maintained to ensure that they remain effective (i.e. removal of silt build up, replacement/re-installation of failed components such as straw bales and fencing), particularly after high intensity rainfall or run-off events.		
Discharge Water Control				
4	Discharge monitoring	Where necessary, discharge water quality will be monitored against relevant water quality standards and appropriate disposal options determined in consultation with relevant regulatory authorities.		
5	Avoid direct discharges	Direct discharge of construction site water to waterways will be avoided where discharge water sediment loads significantly exceed that of the receiving waters and are likely to result in detrimental impacts.		
6	Avoid flooding	Water will be discharged in a manner that does not result in flooding of land both on and off the construction area or run-off beyond the intended receiving area or to waterways.		
7	Diverted watercourses	Diverted watercourse water will be discharged directly back into the watercourse over riprap protection downstream of the crossing		
8	Sediment filters	Water will be discharged through sediment filters (e.g. hose outlet filters, geotextiles or straw bales) to remove solids.		
9	Sediment basins	Water will be discharged as necessary to holding or settling ponds to avoid erosion and permit sediment to settle out of the water column.		
10	Flow diffusers	Water will be discharged to stable land through flow diffusers (e.g. spray bars) and energy dissipaters (e.g. rock riprap or geotextile filters/fabrics).		

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Environment Protection Guideline

Coffer Dam Construction

Project Segment(s):	Rapid River bridge replacement

Issue		Management Measures	Check	Compliance Notes
General				
1	Approach	Coffer dams will be constructed in accordance with relevant best practice guidelines, including those of the International Erosion Control Association (Australasia).		
Dam Materials				
2	Earth	Earth materials will be non-dispersive, Emersons's aggregate class 6, 7 or 8, and free of any organic debris		
3	Dam slope	If the coffer dam is to be constructed of free-standing compacted fill, the sides of the dam will be no steeper than 2:1 (H:V).		
4	Geotextile	Geotextiles will be heavy duty, needle-punched, non-woven filter cloth (minimum BIDIM A34 or equivalent)		
Dam Installation				
5	Sediment control	Subject to the flow in the watercourse, where practicable downstream sediment control devices and/or flows diversion systems will be installed prior to the installation of the coffer dam provided that they will provide a net environmental benefit.		
6	Stream flows	To the extent practicable, construction works will not occur within open flowing waters		
7	Clearing	Clearing and excavation of access tracks, the stream bank and the stream bed will be minimised to the extent practicable.		
8	Erosion risk	If dispersive or highly erosive soils are exposed by the works they will be promptly stabilised		
9	Disturbed area stabilisation	All disturbed areas subject to flowing water and vulnerable to erosion, including bypass and overflow areas, will be stabilised with rock and other suitable materials. The minimum rock size for stabilisation in the main channel will be 200 mm.		
10	Debris removal	Any cleared organic debris from the coffer dam location will be removed from the stream channel and relocated to an appropriate location for temporary storage and then, if appropriate, used to assist rehabilitation of disturbed areas at the completion of works.		
11	Underlayer of geotextile	Prior to the installation of the coffer dam, the bed of the dam site will be covered with a protective layer of geotextile filter cloth (if multiple sheets are required they will have a minimum overlap of 600 mm) to assist with the removal of dam materials at the completion of works.		
Dam Maintenance				
12	Dam inspections	While the coffer dam is in place it will be inspected daily during and after extended periods of rainfall or		

Project Segment(s):		Rapid River bridge replacement		
Issue		Management Measures	Check	Compliance Notes
		otherwise weekly to ensure that the dam is stable and undamaged.		
13	Dam repairs	Any damage or weaknesses in the coffer dam, such as might occur from flowing or overtopping water, will be repaired as soon as practicable.		
14	Debris removal	Any accumulated sediment or debris will be removed and relocated to an appropriate location for temporary storage and then, if appropriate, used to assist rehabilitation of disturbed areas at the completion of works.		
15	Floodway inspections	If a bypass floodway is used, it will similarly be inspected regularly and repaired if and as necessary.		
Dam Removal				
16	Timing	The coffer dam will be removed as soon as practicable after it is no longer required.		
17	Debris removal	Prior to dam removal, any accumulated sediment or debris will be removed and relocated to an appropriate location for temporary storage and then, if appropriate, used to assist rehabilitation of disturbed areas at the completion of works.		
18	Sediment control	Subject to the flow in the watercourse, where practicable downstream sediment control devices and/or flows diversion systems will be installed prior to the removal of the coffer dam provided that they will provide a net environmental benefit.		
19	Remove all materials	All dam materials, including earth and geotextiles will be removed for off-site disposal and/or reuse.		
Rehabilitation				
20	Reinstate channel	Following the removal of the coffer dam, the stream channel will be reinstated to its original cross-section, smoothed and stabilised.		
21	Rehabilitate disturbed areas	Following the removal of the coffer dam, disturbed work areas will be rehabilitated and covered with vegetative material, such as mulch, slash and stored organic material to reduce erosion risk while the areas are naturally regenerating.		
22	Regeneration	If appropriate, the natural regeneration will supplemented with seeding of native species commensurate with the surrounding vegetation.		

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	Waste & Hydrocarbon Management	

Project Section:	All

Issue		Management Measures	Check	Compliance Notes
Solid Inert Wastes				
1	Approved disposal	General refuse will be collected and transported to local council approved disposal sites.		
Putrescible Wastes				
2	Approved disposal	Putrescible wastes will be disposed of by collection and transportation to a landfill approved by the relevant regulatory authority (this may include local government approval).		
Hydrocarbon Wastes				
3	Hydrocarbon wastes	Hydrocarbon wastes, including lube oils and oily sludges, will be collected for safe transport off-site for reuse, recycling, treatment or disposal at approved locations.		
4	Bunding	Any fuel storage or refuelling areas will be suitably designed to adequately contain any spills and leaks (e.g. bunded in accordance with statutory requirements).		
5	Contaminated soils	Any contaminated soils (e.g. oil/fuel spills) will be managed according to their location, their concentration of contaminants, their tendency to leach and the extent of area affected. Appropriate disposal options will be determined in consultation with the relevant environment protection authorities.		
Litter				
6	Litter avoidance	Appropriate measures will be taken to ensure that litter accumulation is avoided, such as the provision of litter bins on-site and regular site maintenance duties.		

Appendix D

Benefit cost analysis

Tarkine Forest Drive Upgrade Benefit Cost Analysis

September 2012

Incorporating Construction, Tourism, Development and Wider Economic Benefits

creating Preferred Futures

reflect focus perform

Contents

EXECUTIVE SUMMARY

The investment of public funds in upgrading the Tarkine Forest Drive to "Tourist Road" standard results in a very high return on investment to government and the community. This result is achieved from the combination of the direct and flow-on impacts of the project and most dramatically from increased tourism demand, expenditure and investment.

In conjunction with associated marketing of the Tarkine and complementary private investment in experiential tourism offers and infrastructure, visitation is estimated to increase from 30,000 interstate and overseas tourists in 2011 to 74,000 by 2025.

The following table indicate the benefit-cost relationships of the combination of public investment, tourism activity and induced private investment.

Tarkine Forest Drive Benefit Cost Table			With Reduced Tourism Impact (50%)
Discount Rate	4%	7%	4%
Cost ($M) P90	$36.469M	$30.973M	$36.47
Benefit ($M)	$256.449M	$162.270M	$146.07
NPV	$219.98M	$131.297M	$109.60M
Ratio	7.03	5.24	4.01

Employment Contribution	Total job years	Average Jobs per Annum
Road Design & Construction period	127	43
Road Maintenance Period	66	2
Tourism Activity	3,508	117

The above job contribution is based on the direct and indirect jobs created by the Tarkine Drive Project and consequent increases in tourism expenditure. It is important to note that the Tarkine Drive Upgrade is an investment to improve and increase access to what is a major Tasmanian natural asset. It is an investment to remove an access barrier, as a result (and with complementary private investment) the Tarkine will receive increased visitation.

It is important to note that because the investment is an upgrade, rather than a new road, the benefit/cost ratio is very high. This reduces the social return on investment risk to a level that if only half of the visitation estimate was achieved, the project would still deliver a strong Benefit Cost ratio of 4.01 at a 4% discount rate.

1 INTRODUCTION

Benefit/cost analysis (BCA) is a way to develop an understanding of and articulate the ratio of the benefits and costs of an initiative. BCA has evolved from relatively narrow form, similar to business return on investment (ROI)

analysis, to wider forms such as social return on investment and then into "triple bottom line" assessments. In projects such as this, a twenty-five (25) year time horizon is a standard period of analysis.

ROI and BCA have always been plagued with result challenges arising from the uncertainty of forecasting, particularly when the time horizon for the investment lifecycle is relatively long. ROI is a picture of the relative ratio of definable costs to revenue, resulting in a ratio as the end result (and in many instances the sole focus). The BCA final ratio becomes increasingly problematic as a single indicator of merit with the inclusion of elements such as "amenity" where valuation is challenging and "value laden". As the scope of the "benefit/cost" widens the value of using the ratio as the single indicator on which to make a decision diminishes. The question arising is one of "why bother"; because this form of analysis can frame a sensible narrative of benefit to cost that uses and combines relatively well defined "monetised" information with other non-monetised but scalable information.

Infrastructure Australia recommends the use of wider BCA and the inclusion of non-monetised benefits and costs where appropriate. This reinforces the importance of the $ ratio being a part of the BCA narrative. The "wider" perspective is important in considering public infrastructure in that it enables inclusion of:

- Direct jobs and income to the region from the investment;
- Multiplier effects from the investment;
- Flow-on economic and social benefits from the investment;
- Reduction in unemployment benefit expenditures consequent to the increased jobs contribution;
- Induced effects – what further investment and business activity is likely to arise from the investment;
- The multiplier effects of induced development and activity; and
- Other economic, social and environmental factors can be included as non-monetised items within the narrative.

2 TARKINE FOREST DRIVE BCA CONSIDERATIONS

The following factors have been considered in determining the benefit/cost of the investment in the Tarkine Forest Drive.

2.1 Construction and Maintenance

Construction and maintenance activity has direct, indirect and consumption effects through the region, these are known as Type 2 multipliers and the employment and income effects are calculated using input/output analysis. The direct jobs created are assumed to reduce the local rate of unemployment (actual or potential) and as a consequence there is a saving to government benefit disbursements. This is considered important within the region, in particular at the current time.

With "normal" road replacement or improvements there is often a reduction in transport costs (time/distance) and dependent upon the form of improvement a reduction in accident frequency. For the Tarkine Forest Drive this is unlikely to be the case, the critical consideration is the mitigation of accident risk given the change in vehicle volumes and potential conflict between vehicle types. In this instance High Productivity Vehicles (HPV) will in future be excluded from the road link reducing the accident risk. While mitigating crash costs, the exclusion results in increased transport cost to the forestry industry, consequently factored into the BCA.

2.2 Visitation Effects

The investment in the Tarkine Forest Drive is viewed as a key foundation investment in the development of "The Tarkine" as an important destination consistent with Tasmania's visitation wilderness (and heritage) motivation. The road's role is to provide access to key locations and is designed to enable people to experience the attributes that define The Tarkine. Further, as opportunities are identified and arise the road makes a strong contribution to the viability of private and public tourism investment. Without the road upgrade, the potential to attract significant numbers of the target market was considered (refer previous strategies) limited. The facilitation of tourism access will then support the transition of the current "Tarkine" brand and positioning to one of relevance to specific segments of the national and international visitor markets.

2.3 Induced Effects

Increased access to specific visitor sites along the road, in conjunction with increased visitation is likely to be the pre-cursor to the introduction of new layers of tourism experience, most likely service based in the first instance, followed by more capital intensive investment. It is understood that there are a number of real investment proposals currently planned or in planning, but dependent upon the upgrade proceeding. Projects such as these are introduced into the BCA time horizon at their forecast cost. These investments are introduced as both a direct investment benefit (with construction multipliers) and from a tourism expenditure effect (with multipliers), as a consequence the forecast visitor numbers are important.

Previous reports identified conversion benchmarks for the range of "Nature Enjoyer" segments, these estimates related to the loop road and its partial components. It is considered that the locations used to compare the partial options (and this current proposal) were inconsistent with the locational and experiential attributes accessible with the current proposal and underestimated the likely visitation. The conversion assumption has a significant effect on the determination of benefits.

2.4 Environmental Factors

Identification of environmental benefits and costs range from reduced likelihood of fires becoming uncontrolled, improved stormwater run-off controls through to increased animal losses and loss of amenity. Factors such as these are notoriously difficult to monetise, however are able to be included in the discussion using, for example, qualitative scales.

Within this report, while such factors are identified, they are cross referenced to the source report to ensure critical aspects are considered in their entirety.

2.5 Economic Impact of the Tarkine Forest Drive Upgrade

The proposed Tarkine Forest Drive upgrade will generate a series of economic impacts in terms of employment and a stimulus to Gross State Product (GSP) and further impacts through increased tourism activity and induced development.

These economic impacts result from pre-construction, construction and maintenance phases.

GSP is the total value of final goods and services produced in the region over the period of one year. This includes exports but subtracts imports.

GSP can be measured by adding up all forms of final expenditure (Expenditure Method)
- consumption by households
- consumption by governments
- additions or increases to assets (minus disposals)
- exports (minus imports)

This calculation does not include intermediate expenditure as this would lead to double counting (i.e. the wheat and flour in a loaf of bread).

Alternatively GSP can be measured by adding up all incomes (Income Method)
- earned by individuals (wages and salaries)
- earned by firms (gross operating surplus or profits)
- collected by governments (taxes on products or services)

In addition, an assessment is made of the likely indirect or flow-on effects of this economic stimulus, again using the most widely recognised economic indicators of employment, GSP and wages / salaries.

The methodology for the economic analysis is based on the Input-Output (I/O) model. This model is widely used in regional economic analysis by local government, private consulting firms and some government agencies. The I/O model is constructed from the Australian input-output model produced by the Australian Bureau of Statistics (ABS).

For the purposes of this present analysis, the North West region is used as the basis for the economic modelling. The model allows estimates to be made of the economic impact considered as viable within the proposed Tarkine Forest Drive upgrade.

To model the impact of the **scoping, development and delivery aspects of the construction work**, the **Professional, Scientific and Technical Services** sector of the I/O model is used. This sector is defined, according to ABS ANZSIC coding, to include:

6910	Scientific Research Services
6921	Architectural Services
6922	Surveying and Mapping Services
6923	Engineering Design and Engineering Consulting Services
6924	Other Specialised Design Services
6925	Scientific Testing and Analysis Services
6931	Legal Services
6932	Accounting Services
6940	Advertising Services
6950	Market Research and Statistical Services
6961	Corporate Head Office Management Services
6962	Management Advice and Related Consulting Services
6970	Veterinary Services
6991	Professional Photographic Services
6999	Other Professional, Scientific and Technical Services
7000	Computer System Design and Related Services

To model the actual **construction phase and the on-going maintenance phase of the project**, the **Heavy and Civil Engineering Construction** sector of the I/O model is used. This sector is defined by the ABS as part of the broader Construction sector to include:

3101 Road and Bridge Construction
3109 Other Heavy and Civil Engineering Construction

2.5.1 Use of Multipliers in the analysis

The indirect or flow on effects of a particular economic change (such as a major construction project, the provision of goods and services or major/minor construction work) are defined as comprising Industrial Effects and Consumption Effects.

The Industrial Effects are defined as the increased output (employment) generated by servicing industry sectors in response to the direct change in output and demand. The Consumption Effects are defined as the increased output (employment) generated by the increased employment and wages and salaries paid to local employees. Part of this additional income to households is used for consumption in the local economy; this consumption leads to further increases in demand and output.

Therefore, economic multipliers in the I/O Model are defined as either Type I or Type II. Type I multipliers include the Direct Effect + Industrial Effects. For example, a Type I output multiplier of 1.57 indicates that, for every direct one dollar increase in output, there will be an extra $0.57 of activity generated within the region due to the industrial effects.

Type II multipliers include the Direct Effect + Industrial Effects + Consumption Effects. For example a Type II output multiplier of 2.31 indicates that, for every direct one dollar increase in output, there will be an extra $1.31 of activity generated within the region due to the industrial effects plus the consumption effects.

This current analysis uses the larger Type II multipliers to capture the effects of the flow-on consumer spending effects.

Input-output analysis requires a number of assumptions about the production of goods and services.

However, it is useful to recognize some of the more limiting assumptions[1]:

(1) Industry production is a linear process. Changing output creates no economies or diseconomies of scale.

(2) Each industry creates only one product. This assumes the total output of multi-product firms is allocated to the primary product produced by that firm or that the production of products can be separated.

(3) Each product is produced by a fixed and known process. Different firms producing the same product are assumed to use the same process.

(4) There is no substitution of factor inputs, e.g. a firm using a different technology is not recognized.

(5) Changes in price will not affect the proportion of inputs used. Changing final demand is the only way to change the level of inputs into production.

[1] Hastings and Brucker 1993; Shaffer 1989, Pp. 274-284. Taylor et al., 1992

(6) There are no input constraints. The supply of inputs is infinite and perfectly elastic.

(7) There are no unused or underused local resources. Excess capacity in firms and labour are not recognized.

These assumptions obviously may not apply to a specific locale. In spite of these simplifying assumptions the model makes a significant contribution to describing the economy and predicting impacts.

The modelling within this report differentiates between the State and Regional Impacts. For the pre construction phase the impact of expenditure is modelled on a statewide basis (GSP), while the construction phase, induced investment and visitation impact is modelled on a regional basis (GRP).

Within the framework of wider benefit analysis, the direct and indirect jobs contribution of the project and following visitation services and investment is assumed to reduce unemployment. The average cost of this in terms of benefits paid by the Australian Government is included as a project benefit for the purposes of the BCA.

3 ECONOMIC IMPACT OF THE TARKINE ROAD UPGRADE

3.1 Base Costs Used in the Analysis

For the purposes of this analysis, the cost base figures supplied by Pitt&Sherry are used for estimating the economic impacts of the upgrade.

The costs provided have been assessed so as to include only items that are relevant to the calculations.

Heavy and civil construction activities of a larger nature are usually assumed to have some proportion of contractor expenditure that is mainland based. For the purposes of this analysis, however, and given the relatively small scale nature of this project, it is assumed that 100 per cent of the project is provided by Tasmanian contractors, including N/W coast employees, the Gross Regional Product (GRP) nature of the modelling excludes imports to the State, rendering the modelling reflective of the flow of goods and services to the project.

The costs associated with all components of the project adjusted by the contingency inflator relevant to each component, and the escalation factor applied across the whole project cost, are set out in the following table.

The estimate reflects P90 costings, an estimating methodology reflecting probability based approaches. P50 represents the project cost with sufficient risk provisions to provide a 50% level of confidence in the outcome i.e. that there is a 50% likelihood that the project cost will not be exceeded. Over a large sample of projects it would be expected that the P50 value would be exceeded 50% of the time. P90 represents the project cost with sufficient risk provisions to provide a 90% level of confidence in the outcome i.e. that there is a 90% likelihood that the project cost will not be exceeded. In other words, it represents a conservative position, one that has only a 10% chance of being exceeded. Over a large sample of projects it would be expected that the P90 value would be exceeded 10% of the time.

Table 1. Costing for Tarkine Forest Drive Upgrade and Maintenance

	Cost
CURRENT CONSTRUCTION & MAINTENANCE (Pre 2011 to 2013-2014)	
Planning, Scoping, Development & Delivery	$ 2,945,000
Construction at P90	$20,697,393
Routine Maintenance of Gravel Road	$424,168
Routine Maintenance of Sealed Road	$72,436
TOTAL CURRENT CONSTRUCTION & MAINTENANCE	$24,138,997
FUTURE CONSTRUCTION & MAINTENANCE (2014-2015 to 2041-2042)	
Reseal Deteriorated seal on Blackwater Road	$398,135
Reseal balance of Blackwater Road (except light coloured aggregate section) and sealed sections of Sumac Road and Tayatea Road	$1,857,215
Apply Reseal over primerseal	$3,669,815
Apply Reseal over Primerseal with light coloured Aggregate	$1,345,652
Reapply rumble strip groups at 5 year intervals	$673,985
Reapply pavement marking at reseal	$218,237
Routine Maintenance of Gravel Road	$0
Routine Maintenance of Sealed Road	$4,019,382
TOTAL FUTURE CONSTRUCTION & MAINTENANCE	$12,182,420
Cost Escalation	4.7%

3.2 One-Off Planning, Scoping, Development and Delivery Expenditures

Information provided in relation to the project indicates that the total base cost of planning, scoping, developing and delivering the road upgrade options are expected to be $4.96 million.

Using the I/O model[2], it is estimated that the scoping, development and delivery of the upgrade would directly generate 14 man-years of work – primarily in pre2011[3].

Table 2. Cost Employment generated by planning, scoping, development and delivery phase

	Direct Job Effect	Indirect Job Effect	Total
Pre 2011	14	10	24
Total	14	10	24

To ensure that there is no double counting of the employment and GRP effects, the indirect stimulus provided by the construction activity (in Section 4 below) to the Professional, Scientific and Technical Services sector has been removed from the indirect employment generated by the construction expenditure.

In Gross Regional Product terms, the benefits to the North West are estimated to be $1.312M.

Table 3. GRP generated by scoping, development and delivery phase

GRP	Direct $m	Indirect $m
Pre 2011	1.312	1.175
Total	1.312	1.175

[2] After adjusting the cost estimates to remove non- economic impacting expenditures or to adjust from outright costs to 'margins', as discussed earlier.
[3] These calculations use the "Professional, Scientific and Technical Services" component of the I/O model.

3.3 One-Off 22-Month Construction Phase

It is estimated that the total Base construction cost of the Tarkine Forest Drive upgrade will be $17.735 million. The construction phase is programmed to be completed by 2014.

Using the I/O model, it is estimated that there will be 21 man-years of work on the project, which can be isolated in the following timeframe[4]:

Table 4. Employment generated by construction phase

YR END	**Direct Job Effect**	Indirect **Job effect**	Total
2012	2	8	10
2013	11	45	56
2014	8	29	37
Total	21	82	103

The model also estimates that the construction phase will provide a stimulus to the Gross Regional Product of $4.882 million in the 24- month construction period.

Table 5. GRP generated by construction phase

YR END	**Direct $m**	**Indirect $m**
2012	0.455	0.878
2013	2.653	5.120
2014	1.774	3.423
Total	4.882	9.421

3.4 Specific Year and On-Going Maintenance

Maintenance, re-sealing and upgrades of the Tarkine Forest Drive will be required, to varying extents, from the completion of the upgrade in 2014-15, with specific actions to flow through this period.

The I/O model estimates that varying levels of employment will be generated during those maintenance periods, together with the associated stimulus to GSP[5]. This stimulus is the same, irrespective of the project component. The I/O model indicates that the employment impacts are relatively small, with the average being 0.286 direct jobs per annum for the period from 2014-15 to 2041-42. Similarly, the direct GRP impacts are relatively small, averaging $0.100 million per annum for that same period.

[4] These calculations use the "Heavy and Civil Engineering Construction" component of the I/O model.
[5] In these calculations, the maintenance work is assumed to be 100 per cent Tasmanian based.

Table 6. Employment and GRP generated by maintenance phase

	Maintenance Cost	Employment		GRP ($M)	
	($M)	**Direct**	**Indirect**	**Direct $m**	**Indirect $m**
2015	0.144		1	0.033	0.064
2016	0.144		1	0.033	0.064
2017	0.278		1	0.064	0.124
2018	0.144		1	0.033	0.064
2019	0.144		1	0.033	0.064
2020	0.343		2	0.079	0.153
2021	0.144		1	0.033	0.064
2022	0.144		1	0.033	0.064
2023	1.207	1	5	0.278	0.537
2024	0.144		1	0.033	0.064
2025	0.144		1	0.033	0.064
2026	0.144		1	0.033	0.064
2027	0.144		1	0.033	0.064
2028	1.574	2	6	0.363	0.702
2029	2.785	3	11	0.641	1.238
2030	1.440	1	6	0.332	0.641
2031	0.144		1	0.033	0.064
2032	0.144		1	0.033	0.064
2033	0.278		1	0.064	0.124
2034	0.144		1	0.033	0.064
2035	0.343		2	0.079	0.153
2036	0.144		1	0.033	0.064
2037	0.144		1	0.033	0.064
2038	1.207	1	5	0.278	0.537
2039	0.144		1	0.033	0.064
2040	0.144		1	0.033	0.064
2041	0.144		1	0.033	0.064
2042	0.144		1	0.033	0.064
Average 2014-15 to 2041-42		0.286	2.071	0.100	0.194

3.5 Summary of Employment and GRP Stimulus

In summary, the various stages of the proposed upgrade are estimated to contribute the stimulus to the North West Gross Regional Product[6] as set out in the Charts at the end of this Report.

3.5.1 Costing

The one-off stimulus from the roadwork construction and the associated scoping, development and delivery of the project is estimated to peak in 2014-15 with Gross Regional Product estimated to increase by $7.773 million (0.15 %) to $5,357.913 million. Contributing to this is a direct increase in output of $11.517 million, 11 additional jobs, $1.889 million more in wages and salaries and a boost in value-added of $2.653 million.

On an on-going basis, the stimulus to North West GRP will be in the order of $0.435M (average) as a result of the on-going maintenance of the highway after 2014-15.

On an on-going basis, the stimulus to employment will be in the order of 2.36 jobs (average) as a result of the minor on-going maintenance of the highway and the re-sealing and upgrades.

[6] The contribution of the maintenance of the road is calculated as the average GRP and employment for the period 2014-15 to 2041-42.

3.6 Indirect Effects

In addition to the direct impact of the Tarkine Forest Drive provided by the development, construction and maintenance activities associated with the road works, there will also be further indirect or flow-on effects into other areas of Tasmania as a result of the initial or direct increased economic activity.

In the construction phase (including the scoping, development and delivery) the additional economic activity will also generate the following flow-on effects in output, Gross State Product, wages and salaries and employment[7]:

3.6.1 Costing

Table 7. Direct and Flow-on Effects of One Off Design and Planning Phase

One Off Design/Planning Phase				
North West	Output $M	GRP $	Wages & Salaries $M	Employment
Direct	2.945	1.312	0.963	14
Flow On	2.385	1.175	0.617	10
Total	5.33	2.487	1.58	24

Table 8. Direct and Flow-on Effects of One Off Construction Phase

One Off Construction Phase				
North West	Output $M	GRP $M	Wages & Salaries $M	Employment
Direct	21.193	4.882	3.476	21
Flow On	21.455	9.421	5.03	82
Total	42.648	14.303	8.506	103

[7] After removing the double counting between the construction impact and the ancillary jobs generated as a result of the scoping and design.

3.6.2 On-going maintenance

Additional economic activity will also be generated by the on-going maintenace of the road. On an on-going basis, it is calculated that an average of 2.36 jobs per year will be generated by the maintenance during the period 2012-13 to 2041-42.

Table 9. Direct and Flow-on Effects of On-going Maintenance

On Going Maintenance				
North West	Output $M	GRP $	Wages & Salaries $M	Employment
Direct	12.191	2.805	2.008	8
Flow On	12.344	5.425	2.89	58
Total	24.535	8.23	4.898	66

3.7 Summary - Employment

The direct and indirect employment generated from Road construction & maintenance is as follows:

Table 10. Direct and indirect employment Road construction & maintenance

Employment		
Yr END	Direct	Indirect
2011	14	10
2012	2	8
2013	11	45
2014	8	29
2015	0	1
2016	0	1
2017	0	1
2018	0	1
2019	0	1
2020	0	2
2021	0	1
2022	0	1
2023	1	5
2024	0	1
2025	0	1
2026	0	1
2027	0	1
2028	2	6
2029	3	11
2030	1	6
2031	0	1
2032	0	1
2033	0	1
2034	0	1
2035	0	2
2036	0	1
2037	0	1
2038	1	5
2039	0	1
2040	0	1
2041	0	1
2042	0	1

3.8 Summary – Gross Regional Product

The direct and indirect GRP generated is as follows:

Table 11. Direct and indirect GRP generated

GRP	$M	$M
Yr END	Direct	Indirect
2011	1.312	1.175
2012	0.455	0.878
2013	2.653	5.120
2014	1.774	3.423
2015	0.033	0.064
2016	0.033	0.064
2017	0.064	0.124
2018	0.033	0.064
2019	0.033	0.064
2020	0.079	0.153
2021	0.033	0.064
2022	0.033	0.064
2023	0.278	0.537
2024	0.033	0.064
2025	0.033	0.064
2026	0.033	0.064
2027	0.033	0.064
2028	0.363	0.702
2029	0.641	1.238
2030	0.332	0.641
2031	0.033	0.064
2032	0.033	0.064
2033	0.064	0.124
2034	0.033	0.064
2035	0.079	0.153
2036	0.033	0.064
2037	0.033	0.064
2038	0.278	0.537
2039	0.033	0.064
2040	0.033	0.064
2041	0.033	0.064
2042	0.033	0.064

4 TARKINE FOREST DRIVE ECONOMIC AND SOCIAL EFFECTS

The Tarkine Forest Drive project will impact on two industry sectors:

- Tourism/hospitality; and
- Forestry.

The Tarkine also supports mining activity. There are some active sites and others in development stages. The development of Tarkine Forest Drive will not adversely effect mining operations because of both the vehicles used to transport the material and the conditions placed on the operations. The heavy vehicle numbers are relatively low and are not expected to negatively impact on visitor perceptions and use of the road and the Tarkine.

4.1 Tourism Effects

The construction of the Tarkine Forest Drive to standards conforming with a tourist road is designed to act as a catalyst for visitation. This objective is well documented within various strategies and associated reports prepared on behalf of the Cradle Coast Authority and Forestry Tasmania. These strategic objectives are included within the "project initiation & scoping document" prepared by DIER; specifically

- Significant increase in nature based tourism sector in Tasmania;
- Increase in visitor numbers and new spending per annum;
- Most visitors will stay extra night(s) to enjoy the forest wilderness and coastal attractions due to new opportunities to stop and enjoy/observe the environment;
- The ability to travel in a circuit, avoiding the need to cover the same route twice, in a non-threatening travelling environment, particularly on unfamiliar roads (i.e. a sealed, speed controlled road);
- Other regions will also benefit from the new tourist icon – "The Tarkine"; and
- When completed, significant new jobs in tourist operations are expected.

An increase in visitation will have an economic effect by increasing expenditure on tourism experiences and also by increasing expenditure on hospitality and transport services within the local area and region overall. With the appropriate marketing and promotion, visitation will achieve levels that will attract additional investment in tourism and hospitality infrastructure. The potential benefits from the mix of Tarkine Forest Drive infrastructure investment and "Tarkine marketing" by government, regional organisations and enterprises is captured in both increased visitation expenditure and also from direct capital investment. The tangible social impacts are those derived from employment and business profits contributing to the regional community wellbeing and liveability.

The Tarkine already experiences/delivers small scale tourism. The Tasmanian Visitor Survey (TVS) indicates the following interstate/overseas visitation profile:

Table 12. Number of Visitors to the Tarkine Area

	Jan 2008 - Dec 2008	Jan 2009 - Dec 2009	Jan 2010 - Dec 2010	Jan 2011 - Dec 2011
Smithton (Passed through)	22,500	19,900	16,400	16,500
Arthur River (from July 2006) (Passed through)	13,000	10,000	8,100	10,000
Smithton (Visited)	25,900	30,400	23,600	21,200
Arthur River (from July 2006) (Visited)	16,400	15,600	12,400	13,300
Smithton (Overnight)	10,700	10,700	8,500	11,900
Arthur River (from July 2006) (Overnight)	6,500	7,600	5,900	6,900
TOTALS				
Arthur River	35,900	33,200	26,400	30,200
Smithton	59,100	61,000	48,500	49,600
% Arthur	0.607445008	0.544262295	0.544329897	0.608870968

Source: Tourism Tasmania, Tasmanian Visitor Survey

Corinna, accessed through Waratah and/or Zeehan receives approximately 41,000 visitors, of whom 14,600 stay, contributing 34,600 bed nights to the industry. The Corinna profile indicates a higher proportion of visitors who stay overnight, with an average stay of 2.37 bed/nights.

Interestingly, both Smithton and Arthur River have slightly increased the number of visitors who overnight rather than only visit or pass through. This is encouraging for operators because of the revenue and yield associated with overnight stays. The longer than average stay experienced by Corinna operators is similarly encouraging; it demonstrates that visitors will stay longer (than the statewide average stay) if the location and experiences suit. Arguably those who visit the Tarkine via the Tarkine Forest Drive will replicate these behaviours. However for the purposes of modelling the lower Statewide average stay (weighted average of 1.37 nights for the segment) has been used, consistent with the need for conservative estimates.

Visitation forecasts have been included in prior studies, in particular the "TARKINE ROAD OPTIONS – Tourism Assessment, December 2008 (Moore Consulting, SCA marketing & EMDA) prepared a comparative analysis of

demand forecasts for what were the three elements of the previous Tarkine Loop Road proposal of which the current project forms the "Western Loop".

The above report indicated very low levels of visitation for the "Tarkine Forest Drive". The basis of the conclusion was that the route did not conform to the concept of a "loop" as it required visitors to enter and exit through Smithton, rather than being able to utilise Smithton and Burnie as entry/exits. In adopting this assumption, the Tarkine was then compared with visitor locations such as Cockle Creek. This BCA report challenges that assumption on two grounds:

1. Cockle Creek is indeed an "out and return" journey providing no real alternative route options from Huonville, south to Cockle Creek a distance of 80km much of which is low standard and gravel surfaced.
2. Cockle Creek, while an entry point to the "South Coast Walk" is essentially undeveloped in terms of supported experiences or modern camp sites; it has neither a recognised market position or well developed tourism infrastructure.

Discussions with the "Cradle Coast Authority", while not revealing specific proposals given either commercial confidentiality or lack of a specific, detailed proposal, indicated the style of development envisaged. These include:

- Multi-day walks of 4-5 day duration using either high end campsites (such as existing in Cradle and on the East Coast) or in stages where visitors return to "base" each night;
- Multi-day kayaking with high end camp sites;
- Mountain biking (base, free camping, day trips)
- Themed learning based experience (e.g. photography, art, ecosystems)
- Guided full and half day visits.

In addition to the organised activities, improved access in conjunction with appropriate camp sites will motivate those with similar interests but a preference for "free travel" to visit.

The co-existence of these experiences with the Tarkine's natural environment and access transforms the Tarkine into a destination that potentially motivates a wide range of visitor segments. However, it is important to note that there is no detail available on these experiences as no firm proposals currently exist.

On this basis the visitor numbers have been re-estimated using modified benchmark visitation assumptions. This methodology re-applies the 2008 comparative analysis model using different locations as the benchmark. As the previous approach also applied average daily spends and visitor nights, the base data was revisited. TVS data indicates no significant change in visitor daily spend since 2008 and as such the values utilised in the 2008 report were applied in the current estimation.

The forecast visitor number to the Tarkine experiencing the natural attributes and attractions are estimated using a combined benchmark of the proportion of Nature Enjoyer Segments based on the mid point between "Tahune" and "Nelson Falls". This approach is taken because no identified single location matches the access, locational and natural attributes of the Tarkine. The "bookends" are selected on the following basis:

- Tahune presented as a well developed and promoted experience that is primarily an "out and back" route, however is in relative close proximity to Hobart; while
- Nelson Falls is a spectacular natural, undeveloped location but relatively remote, albeit on the well travelled hire and drive circuit.

On balance they have been selected as the higher and lower limits of achievable visitation, with the mid-point selected as a likely outcome. In addition to utilising this as a forecast, this report continues the 2008 methodology by including an allowance of an additional 15% to account for visitors not represented in the nature enjoyer category.

The methodology results in the following visitation estimate. It should be noted that the estimate reflects interstate and overseas visitation, Tasmanian visitors are not included for the purpose of the analysis as the local benefit from their visit is considered as offset by a cost to another region of the State.

The 2008 report was prepared pre the "Global Financial Crisis" (GFC) and the consequent downturn, however it did reflect the impact of the relatively high value of the Australian dollar on increased overseas travel by Australians in preference to interstate travel. Progress towards the report's 2017 target will be strongly related to the marketing effort applied to attracting visitors to Tasmania and to the Tarkine.

A recent review by BDA Marketing and Planning (BDA) for the Tourism Industry Council Tasmania reports a decline in interstate and overseas visitation and expenditure over last 6 months. While numbers had declined, the visitor spend rate had slightly increased. Importantly the visitor appeal was still highly focused on experiential tourism, natural and built heritage. BDA highlighted that the decision to travel to Tasmania was highly sensitive to the level of the Tasmanian marketing effort, particularly in the SE Australian States.

Dependent on marketing effort BDA forecasts growth in aggregate visitor expenditure of between 21% and 42% by 2020, on a long term trend growth rate BDA estimates 35% growth rate from 2011 to 2020.

Given the characteristics of the Tarkine and expected marketing effort, it is concluded that tourism growth will be higher than that for the State as a whole. To achieve the previous 2017 target by 2025, visitation would need to increase by approximately 8% per annum between the end of construction and 2025. This growth is considered achievable when moving from a small base. Consequently for the purpose of the BCA the 2008 report forecasts have been extended from 2017 to 2025.

The achievement of this level of increased tourism expenditure will contribute an average of 117 jobs per annum within the region in providing visitor services.

Table 13. Tarkine Tourism Forecasts for Tasmanian Nature Based Tourism Segment

TAS NATURE BASED VISITOR SEGMENT	FORECASTS 2025	PENETRATION	NUMBERS - 2025	NIGHTS	EXPENDITURE	EXP/NIGHT	REVENUE
Nature Enthusiasts	103000	0.15	14935	1.75	175	100	2613625
Lower Older	85000	0.21	17425	1.25	214.78	171.824	3742541.5
Affluent Older	80000	0.15	12000	1.25	267.58	214.064	3210960
Family	51000	0.20	10200	1.25	358.67	286.936	3658434
Younger	67000	0.15	9715	1.25	175	140	1700125
			64275				14,925,685
Other segments (15%)			9641				2,238,852
			73916				17,164,538
Less existing visitation			30,000				
Net increase			43,916				10,198,057

Source "TARKINE ROAD OPTIONS – Tourism Assessment December (2008), adapted by creating Preferred Futures

The Tarkine Forest Drive project is estimated to increase interstate and overseas visitation to the region by 44,000 people by 2025 and to achieve an additional $10.2m in direct tourism expenditure within the region. This is based on the Tarkine developing both the "experience" based services and infrastructure identified above and the associated marketing necessary to position and promote the offer to the segments motivated to respond.

These visitors will not all stay overnight within the Circular Head area. Based on the weighted average of the above profile, the average stay will be 1.37 nights, this equates to 60,000 bed nights. Over an 8 months peak demand season with an average occupancy rate of 80%, this equates to approximately 300 beds required within the area. Local occupancy rates, for all accommodation categories in aggregate, are approximately 51% on a year round basis. This rate varies significantly by type and operator marketing strategy, theoretically there is adequate excess capacity to absorb the almost 90% increase in visitation.

Based on discussions with "Cradle Coast Authority" and a number of key tourism operators, it is likely that those businesses experiencing higher occupancy rates will invest in additional rooms and that a new operator investment will occur as demand increases are signalled. For the purposes of this analysis it is assumed that 50% of the increased demand will be absorbed by the current supply and the remaining 50% by new investment. The following costs are based on multiple industry sources.

Of this new investment of 40 rooms, the profile proposed is:

25 Stand alone self catering units	10 additional motel rooms	5 Apartments
Estimated Cost $3.5m	Estimated Cost $0.9m	Estimated Cost $1.2m

Servicing this demand would require further public and private investment in camping facilities and beds in more traditional tourism accommodation.

Based on other locations and from the 2008 report, the following direct investment profile is estimated:

Table 14. Development Opportunities and Estimated Investment

Development	Investor	Estimated Investment
Public Camping Grounds (4) associated infrastructure plus staff accommodation	State	$1.4m
Private Camping Facilities (5) & associated infrastructure	Private	$2.5m
Traditional Beds (40 rooms)	Private	$5.6m

The potential for the projected increased visitation to significantly diminish the value of the Tarkine is considered low. On a daily basis the numbers are relatively low, with vehicle movements relatively dispersed. Access to key locations is limited largely to identified and developed locations and a significant proportion of extended stay will be via organised experiences. Access will occur over a relatively long "drive", unlike other locations where access is a point of concentration e.g. Tahune Airwalk, Cradle Mountain, National Park" and results in much more intense development. As identified above, the nature of the access will result in much of the associated accommodation and other visitor services being provided from broader afield across Circular Head and the North West Coast. Development adjacent to the Tarkine Forest Drive will be subject to development approval processes reflective of the sensitivity of the area and it's zoning within the scheme.

The camping infrastructure likely to be constructed reflects that developed in other highly sensitive Tasmanian environment such as Cradle Mountain National Park and Bay of Fires. These facilities have been constructed, used and maintained with design and approaches that have not diminished the natural values and amenity of the locations. Indeed they have provided access to such areas for many who would have otherwise not experienced the values. Tasmanian operator and the specialist developers and builders are sensitive to and protective of the values on which the operations are based. In conjunction with the development approval processes, the culture underpinning such development will combine to not diminish the values.

4.2 Forestry

The construction of the Tarkine Forest Drive to facilitate a tourist road will limit the size of vehicles able to travel the road, precluding the use of High Productivity Vehicles (HPV). DIER has recently taken over administration of the roads required to facilitate the Tarkine Forest Drive, converting the roads from Forestry Tasmania to public roads. On Tasmanian public roads High Productivity Vehicles can only use the gazetted High Productivity Network, unless a special permit is granted. At this point in time there is no intention to make the Tarkine Forest Drive a High Productivity Vehicle Route. This limitation will result in increased costs to the forest sector by increasing the cost per tonne of logs transported for further processing. The increased cost of using smaller, less efficient freight vehicles, compared to the HPVs that could otherwise travel the road, is included as a cost within the BCA over the affected period.

Table 15. Projected $ Value Impact to the Forest Industry of Not Having B-double Access on the Tarkine Forest Drive Route

	$M
2011 - 2012	0.09
2012 - 2013	0.363
2013 - 2014	1.09
2014 - 2015	0.216
2015 - 2016	0.371
2016 - 2017	0.255
2017 - 2018	0.277
2018 - 2019	0.371
2019 - 2020	0.513
2020 - 2021	0.907
2021 - 2022	1.233
2022 - 2023	0.63
2023 - 2024	0.287
2024 - 2025	0.705

2025 - 2026	0.795
2026 - 2027	0.422
2027 - 2028	0.682

Source: Forestry Tasmania

The above figures are based on the internal costing data provided by Forestry Tasmania, due to the commercial nature of this information, the parameters are not included in the report.

4.3 Mining

The area is the location of some mining activity, proposed development and exploration.

Tasmania Advanced Minerals Pty Ltd (TAM) has been operating a silica flour extraction pit at Blackwater Road, near Kanunnah Bridge since early 2008 as a "level 2" activity, regulated under Schedule 2 of the *Environmental Management and Pollution Control Act 1994* by the EPA Division of the Department of Primary Industries, Parks, Water and Environment. Producing approximately 50,000 m^3/year of silica flour, (equivalent to 100,000 tonnes/year), the product is transported in 30 – 35 tonne trucks to an off-site processing facility located in Wynyard. An average of 12 vehicle movements per day utilises an approximate 3.5km segment of the proposed route - from Kanunnah Bridge to the mine Blackwater Road.

The company's "Hawkes Creek" site does not use any segments of the Tarkine Forest Drive.

Shree minerals propose a magnetite/hematite mine near Nelson Bay River subject to approval. Transport of product would utilise Rebecca Road, Blackwater Road and Sumac Road, all part of the proposed Tarkine Forest Drive.

From a BCA perspective the reclassification of the Tarkine Forest Drive will not negatively impact on the operations of the mines. Vehicle movements associated with the production volumes will not significantly impact on the amenity and natural values, while mitigation policies will minimise roadkill. It is important to note that such policies will be under continuous review, learning and modification to achieve the outcomes sought.

5 ENVIRONMENTAL IMPACT

The key potential environmental impact considered within this BCA is that of increased propensity for roadkill. The challenge has been addressed within the main PER document prepared by Pitt & Sherry. Review of the report indicates a number of key approaches and principles:

- The precautionary principle informed by Principle 15 of the Rio Declaration Strategy (1992);
- Frequent, systematic monitoring;
- A mix of localised and overall mitigation responses and adaptive management.

Based on this report and its mitigation strategies, in conjunction with a primarily tourism use and unlikely achievement of high levels of road use between dusk and dawn, any significant increased level of risk of roadkill is considered low.

Similarly the potential for loss of amenity is considered low. Traffic volumes will be relatively small and strict environmental and planning conditions within the planning regime will ensure development as described above will reflect the characteristics of the Tarkine. This minimal impact outcome has been demonstrated in other locations.

6 GOVERNANCE

The Tarkine Forest Drive Upgrade represents a relatively small value but highly complex system of interests and interrelationships. The Roadkill mitigation project and its reflexive, learning based implementation model provides the governance lead to the project, its implementation and ongoing evaluation. The BCA is premised on evidence based projections, direct information, existing regulatory tools and mechanisms and what is reasonably foreseeable.

Importantly the project is one that spans, local, regional, state and federal interest and has governance overlays that reflect this. While the scope of the BCA is broad, the direct changes to outputs as projected within the BCA tend to be local or regional in their effect. Consequently and with the visitation focus, much of the complementary marketing, approval and evaluation work necessary to realise the projections will be the domain of the Circular Head Council, Cradle Coast Authority and the local and regional tourism groups.

The project has significant potential state and federal benefit. Protection of threatened species and ecological systems through mitigation is an area where the benefit flows to the national and indeed global levels. From a social benefit perspective, the Tarkine Forest Drive is premised on the concept of wider benefits - the balance of ecological, economic and social benefits and costs; a multiple perspective arena with which the community and policy makers are learning to operate within. The Tarkine Forest Drive project potentially provides an example of a "this – and" as opposed to "this – or" as a means of progressing development initiatives through a mix of complementary policies and development pathways that facilitate incremental change, learning and adaptation. Such case studies are considered important in terms of learning how to optimise public investment in an increasingly pluralist and connected development and investment environment.

7 BENEFIT COST ANALYSIS TABLES

The following benefit cost analysis outlines the estimates of cost and the estimates of direct and indirect benefits accruing from the investment.

Costs reflect pre-construction, construction and maintenance phases and impact on Forestry due to the removal of HPV Transportation; benefits include direct benefits, forecast tourism increases, campsite and accommodation investment benefits. The economic benefits are based on the input/output analysis identifying both direct and flow-on benefits from construction. Additionally the impact of the investment on unemployment is factored into the benefits analysis.

Table 16. Summary Benefit Cost Table

Tarkine Forest Drive Benefit Cost Table			With Reduced Tourism Impact (50%)
Discount Rate	4%	7%	4%
Cost ($M)	$36.469M	$30.973M	$36.469
Benefit ($M)	$256.449M	$162.270M	$146.067
Ratio	7.03	5.24	4.01

It is noteworthy to identify the project BC ratio is not highly sensitive to the achievement of the forecast rate of visitation and associated investment. To demonstrate this the BCA was remodelled based on visitation achieving only 50% of the estimated increase; using the 4% discount rate, the project investment still achieved a BC ratio of 4.01. The conclusion remains that even in the face of challenging tourism futures, the project remains a strong investment from a benefit/cost perspective.

7.1 Benefit Cost Tables

Table 17. Benefit Cost Table P90 4% Discount Rate

P90	OPTION A																																	
	Discount Rate =	**4.00%**																																
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
		pre 2011	2011 - 2012	2012 - 2013	2013 - 2014	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018	2018 - 2019	2019 - 2020	2020 - 2021	2021 - 2022	2022 - 2023	2023 - 2024	2024 - 2025	2025 - 2026	2026 - 2027	2027 - 2028	2028 - 2029	2029 - 2030	2030 - 2031	2031 - 2032	2032 - 2033	2033 - 2034	2034 - 2035	2035 - 2036	2036 - 2037	2037 - 2038	2038 - 2039	2039 - 2040	2040 - 2041	2041 - 2042	Present Value	
1.0	**Costs**																																	
1.1	**ProjectEstimate Cost**	2.945	1.976	11.269	7.452	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	23.992
1.2	**Road Maintenance**	0.000	0.000	0.248	0.248	0.144	0.144	0.278	0.144	0.144	0.343	0.144	0.144	1.237	0.144	0.144	0.144	0.144	1.574	2.785	1.440	0.144	0.144	0.278	0.144	0.343	0.144	0.144	1.207	0.144	0.144	0.144	0.144	6.393
1.3	**Forestry**																																	
	Does not consider area affceted by IGA.	0.000	0.090	0.363	1.090	0.216	0.371	0.255	0.277	0.371	0.513	0.907	1.233	0.630	0.287	0.705	0.795	0.422	0.682	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.084
	Net Cost	2.945	2.066	11.880	8.790	0.360	0.515	0.533	0.421	0.515	0.856	1.051	1.377	1.837	0.431	0.849	0.939	0.566	2.256	2.785	1.440	0.144	0.144	0.278	0.144	0.343	0.144	0.144	1.207	0.144	0.144	0.144	0.144	
																																		36.469
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
	Year ENDING 30 June	pre 2011	2011 - 2012	2012 - 2013	2013 - 2014	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018	2018 - 2019	2019 - 2020	2020 - 2021	2021 - 2022	2022 - 2023	2023 - 2024	2024 - 2025	2025 - 2026	2026 - 2027	2027 - 2028	2028 - 2029	2029 - 2030	2030 - 2031	2031 - 2032	2032 - 2033	2033 - 2034	2034 - 2035	2035 - 2036	2036 - 2037	2037 - 2038	2038 - 2039	2039 - 2040	2040 - 2041	2041 - 2042	Present Value	
2	**Benefits**																																	
2.1	**Economic Impact**																																	
	Indirect/direct employment	0.570	0.237	1.329	0.878	0.024	0.024	0.024	0.024	0.024	0.047	0.024	0.024	0.112	0.024	0.024	0.024	0.024	0.190	0.332	0.166	0.024	0.024	0.024	0.024	0.047	0.024	0.024	0.142	0.024	0.024	0.024	0.024	4.036
	DIRECT GSP $m	1.312	0.455	2.653	1.774	0.033	0.033	0.064	0.033	0.033	0.079	0.033	0.033	0.278	0.033	0.033	0.033	0.033	0.363	0.641	0.332	0.033	0.033	0.064	0.033	0.079	0.033	0.033	0.278	0.033	0.033	0.033	0.033	8.240
	INDIRECT GSP $m	1.175	0.878	5.120	3.423	0.064	0.064	0.124	0.064	0.064	0.153	0.064	0.064	0.537	0.064	0.064	0.064	0.064	0.702	1.238	0.641	0.064	0.064	0.124	0.064	0.153	0.064	0.064	0.537	0.064	0.064	0.064	0.064	13.247
2.2	**Tourism Impact**																																	
	Direct Tourism Effect	0.000	0.000	0.000	0.000	0.927	1.854	2.781	3.708	4.635	5.562	6.489	7.416	8.343	9.270	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	107.841
	Indirect Toruism Effect	0.000	0.000	0.000	0.000	0.697	1.394	2.091	2.788	3.486	4.183	4.880	5.577	6.274	6.971	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	81.094
	Indirect/direct Tourism employment	0.000	0.000	0.000	0.000	0.237	0.498	0.736	0.973	1.234	1.471	1.732	1.970	2.237	2.468	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	28.600
2.3	**Campsite Investment Impact**																																	
	Campsite Direct Effect	0.000	0.000	0.000	0.000	0.350	0.000	0.000	0.000	0.350	0.000	0.000	0.000	0.330	0.000	0.000	0.350	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.931
	Indirect	0.000	0.000	0.000	0.000	0.336	0.000	0.000	0.000	0.336	0.000	0.000	0.000	0.336	0.000	0.000	0.336	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.893
	Indirect/direct employment	0.000	0.000	0.000	0.000	0.047	0.000	0.000	0.000	0.047	0.000	0.000	0.000	0.017	0.000	0.000	0.047	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.125
2.4	**Private Campsite Invesment Impact**																																	
	Private Campsite Direct Effect	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	1.500	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.677
	Indirect	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.961	0.000	1.442	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.612
	Indirect/direct employment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.119	0.000	0.190	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.207
2.5	**Accommodation Investment Impact**																																	
	Increased Accommodation Direct Effect	0.000	0.000	0.000	0.000	0.000	1.120	0.000	1.120	0.000	1.120	0.000	1.120	0.030	1.120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.806
	Indirect	0.000	0.000	0.000	0.000	0.000	1.076	0.000	1.076	0.000	1.076	0.000	1.076	0.030	1.076	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.657
	Indirect/direct employment	0.000	0.000	0.000	0.000	0.000	0.142	0.000	0.142	0.000	0.142	0.000	0.142	0.030	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.483
	Net Benefit	3.057	1.570	9.102	6.075	2.715	6.205	5.820	9.928	12.289	13.833	16.354	17.422	18.514	21.168	20.696	21.429	20.696	21.830	22.786	21.714	20.696	20.696	20.787	20.596	20.854	20.696	20.696	21.532	20.696	20.696	20.696	20.696	
																																		256.449

Table 18. Benefit Cost Table P90 7% Discount Rate

P90	OPTION A																																	
	Discount Rate =	**7.00%**																																
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
		pre 2011	2011 - 2012	2012 - 2013	2013 - 2014	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018	2018 - 2019	2019 - 2020	2020 - 2021	2021 - 2022	2022 - 2023	2023 - 2024	2024 - 2025	2025 - 2026	2026 - 2027	2027 - 2028	2028 - 2029	2029 - 2030	2030 - 2031	2031 - 2032	2032 - 2033	2033 - 2034	2034 - 2035	2035 - 2036	2036 - 2037	2037 - 2038	2038 - 2039	2039 - 2040	2040 - 2041	2041 - 2042	Present Value	
1.0	**Costs**																																	
1.1	**ProjectEstimate Cost**	2.945	1.976	11.269	7.452	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	22.307	
1.2	**Road Maintenance**	0.000	0.000	0.248	0.248	0.144	0.144	0.278	0.144	0.144	0.343	0.144	0.144	1.237	0.144	0.144	0.144	0.144	1.574	2.785	1.440	0.144	0.144	0.278	0.144	0.343	0.144	0.144	1.207	0.144	0.144	0.144	0.144	4.064
1.3	**Forestry**																																	
	Does not consider area affceted by IGA	0.000	0.090	0.363	1.090	0.216	0.371	0.255	0.277	0.371	0.513	0.907	1.233	0.630	0.287	0.705	0.795	0.422	0.682	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.602
	Net Cost	2.945	2.066	11.880	8.790	0.360	0.515	0.533	0.421	0.515	0.856	1.051	1.377	1.837	0.431	0.849	0.939	0.566	2.256	2.785	1.440	0.144	0.144	0.278	0.144	0.343	0.144	0.144	1.207	0.144	0.144	0.144	0.144	
																																		30.973
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
	Year ENDING 30 June	pre 2011	2011 - 2012	2012 - 2013	2013 - 2014	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018	2018 - 2019	2019 - 2020	2020 - 2021	2021 - 2022	2022 - 2023	2023 - 2024	2024 - 2025	2025 - 2026	2026 - 2027	2027 - 2028	2028 - 2029	2029 - 2030	2030 - 2031	2031 - 2032	2032 - 2033	2033 - 2034	2034 - 2035	2035 - 2036	2036 - 2037	2037 - 2038	2038 - 2039	2039 - 2040	2040 - 2041	2041 - 2042	Present Value	
2	**Benefits**																																	
2.1	**Economic Impact**																																	
	Indirect/direct employment	0.570	0.237	1.329	0.878	0.024	0.024	0.024	0.024	0.024	0.047	0.024	0.024	0.142	0.024	0.024	0.024	0.024	0.190	0.332	0.166	0.024	0.024	0.024	0.024	0.047	0.024	0.024	0.142	0.024	0.024	0.024	0.024	3.538
	DIRECT GSP $m	1.312	0.455	2.653	1.774	0.033	0.033	0.064	0.033	0.033	0.079	0.033	0.033	0.278	0.033	0.033	0.033	0.033	0.363	0.641	0.332	0.033	0.033	0.064	0.033	0.079	0.033	0.033	0.278	0.033	0.033	0.033	0.033	7.299
	INDIRECT GSP $m	1.175	0.878	5.120	3.423	0.064	0.064	0.124	0.064	0.064	0.153	0.064	0.064	0.537	0.064	0.064	0.064	0.064	0.702	1.238	0.641	0.064	0.064	0.124	0.064	0.153	0.064	0.064	0.537	0.064	0.064	0.064	0.064	11.465
2.2	**Tourism Impact**																																	
	Direct Tourism Effect	0.000	0.000	0.000	0.000	0.927	1.854	2.781	3.708	4.635	5.562	6.489	7.416	8.343	9.270	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	10.200	64.359
	Indirect Toruism Effect	0.000	0.000	0.000	0.000	0.697	1.394	2.091	2.788	3.486	4.183	4.880	5.577	6.274	6.971	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	7.670	48.396
	Indirect/direct Tourism employment	0.000	0.000	0.000	0.000	0.237	0.498	0.736	0.973	1.234	1.471	1.732	1.970	2.237	2.468	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	2.705	17.067
2.3	**Campsite Investment Impact**																																	
	Campsite Direct Effect	0.000	0.000	0.000	0.000	0.350	0.000	0.000	0.000	0.350	0.000	0.000	0.000	0.350	0.000	0.000	0.350	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.704
	Indirect	0.000	0.000	0.000	0.000	0.336	0.000	0.000	0.000	0.336	0.000	0.000	0.000	0.336	0.000	0.000	0.336	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.676
	Indirect/direct employment	0.000	0.000	0.000	0.000	0.047	0.000	0.000	0.000	0.047	0.000	0.000	0.000	0.047	0.000	0.000	0.047	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.094
2.4	**Private Campsite Invesment Impact**																																	
	Private Campsite Direct Effect	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	1.500	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.257
	Indirect	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.961	0.000	1.442	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.208
	Indirect/direct employment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.119	0.000	0.190	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.155
2.5	**Accommodation Investment Impact**																																	
	Increased Accommodation Direct Effect	0.000	0.000	0.000	0.000	0.000	1.120	0.000	1.120	0.000	1.120	0.000	1.120	0.030	1.120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.899
	Indirect	0.000	0.000	0.000	0.000	0.000	1.076	0.000	1.076	0.000	1.076	0.000	1.076	0.030	1.076	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.785
	Indirect/direct employment	0.000	0.000	0.000	0.000	0.000	0.142	0.000	0.142	0.000	0.142	0.000	0.142	0.030	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.368
	Net Benefit	3.057	1.570	3.102	6.075	2.715	6.205	5.820	3.928	12.289	13.833	16.354	17.422	18.514	21.168	20.696	21.429	20.696	21.830	22.786	21.714	20.696	20.696	20.787	20.596	20.854	20.696	20.696	21.532	20.696	20.696	20.696	20.696	
																																		162.270

Table 19. Benefit Cost Table P90 4% Discount Rate with 50% Reduced Tourism Impact

P50	OPTION A																																
	Discount Rate =	**4.00%**																															
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
		pre 2011	2011 - 2012	2012 - 2013	2013 - 2014	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018	2018 - 2019	2019 - 2020	2020 - 2021	2021 - 2022	2022 - 2023	2023 - 2024	2024 - 2025	2025 - 2026	2026 - 2027	2027 - 2028	2028 - 2029	2029 - 2030	2030 - 2031	2031 - 2032	2032 - 2033	2033 - 2034	2034 - 2035	2035 - 2036	2036 - 2037	2037 - 2038	2038 - 2039	2039 - 2040	2040 - 2041	2041 - 2042	Present Value
1.0	**Costs**																																
1.1	**ProjectEstimate Cost**	2.945	1.976	11.269	7.452	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	23.992
1.2	**Road Maintenance**	0.000	0.000	0.248	0.248	0.144	0.144	0.278	0.144	0.144	0.343	0.144	0.144	1.207	0.144	0.144	0.144	0.144	1.574	2.785	1.440	0.144	0.144	0.278	0.144	0.343	0.144	0.144	1.207	0.144	0.144	0.144	6.393
1.3	**Forestry**																																
	Does not consider area affceted by IGA	0.000	0.090	0.363	1.090	0.216	0.371	0.255	0.277	0.371	0.513	0.907	1233	0.630	0.287	0.705	0.795	0.422	0.682	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.084
																																	36.469
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
	Year ENDING 30 June	pre 2011	2011 - 2012	2012 - 2013	2013 - 2014	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018	2018 - 2019	2019 - 2020	2020 - 2021	2021 - 2022	2022 - 2023	2023 - 2024	2024 - 2025	2025 - 2026	2026 - 2027	2027 - 2028	2028 - 2029	2029 - 2030	2030 - 2031	2031 - 2032	2032 - 2033	2033 - 2034	2034 - 2035	2035 - 2036	2036 - 2037	2037 - 2038	2038 - 2039	2039 - 2040	2040 - 2041	2041 - 2042	Present Value
2	**Benefits**																																
2.1	**Economic Impact**																																
	Indirect/direct employment	0.332	0.214	1.234	0.807	0.024	0.047	0.190	0.190	0.332	0.071	0.024	0.024	0.142	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.190	0.309	0.047	0.024	0.024	0.142	0.024	0.024	0.024	0.024	3.789
	DIRECT GSP $m	1.330	0.880	2.456	1.629	0.033	0.111	0.357	0.357	0.663	0.152	0.033	0.033	0.274	0.033	0.033	0.033	0.033	0.063	0.033	0.033	0.033	0.033	0.357	0.633	0.078	0.033	0.033	0.274	0.033	0.033	0.033	0.033	9.158
	INDIRECT GSP $m	1.191	0.788	4.740	3.144	0.063	0.214	0.690	0.690	1.280	0.294	0.063	0.063	0.529	0.063	0.063	0.063	0.063	0.122	0.063	0.063	0.063	0.063	0.690	1.221	0.150	0.063	0.063	0.529	0.063	0.063	0.063	0.063	14.132
2.2	**Tourism Impact**																																
	Direct Tourism Effect	0.000	0.000	0.000	0.000	0.464	0.927	1.391	1.854	2.318	2.781	3.245	3.708	4.172	4.635	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	5.100	53.922
	Indirect Toruism Effect	0.000	0.000	0.000	0.000	0.349	0.697	1.046	1.394	1.743	2.091	2.440	2.788	3.137	3.486	3.835	3.835	3.835	3.835	3.835	3.835	3.835	3.835	3.835	3.835	3.835	3.835	3.835	3.835	3.835	3.835	3.835	3.835	40.547
	Indirect/direct Tourism employment	0.000	0.000	0.000	0.000	0.119	0.237	0.380	0.498	0.617	0.736	0.854	0.973	1.115	1.234	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	1.353	14.304
2.3	**Campsite Investment Impact**																																
	Campsite Direct Effect	0.000	0.000	0.000	0.000	0.175	0.000	0.000	0.000	0.175	0.000	0.000	0.000	0.175	0.000	0.000	0.175	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.465
	Indirect	0.000	0.000	0.000	0.000	0.168	0.000	0.000	0.000	0.168	0.000	0.000	0.000	0.168	0.000	0.000	0.168	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.447
	Indirect/direct employment	0.000	0.000	0.000	0.000	0.024	0.000	0.000	0.000	0.024	0.000	0.000	0.000	0.024	0.000	0.000	0.024	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.064
2.4	**Private Campsite Invesment Impact**																																
	Private Campsite Direct Effect	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.703
	Indirect	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.961	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.675
	Indirect/direct employment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.119	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.084
2.5	**Accommodation Investment Impact**																																
	Increased Accommodation Direct Effect	0.000	0.000	0.000	0.000	0.000	1.120	0.000	0.000	0.000	1.120	0.000	0.000	0.000	1.120	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.289
	Indirect	0.000	0.000	0.000	0.000	0.000	1.076	0.000	0.000	0.000	1.076	0.000	0.000	0.000	1.076	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.199
	Indirect/direct employment	0.000	0.000	0.000	0.000	0.000	0.142	0.000	0.000	0.000	0.142	0.000	0.000	0.000	0.142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.290
																																	143.057

Table 20. Cost Estimate Cash Flow (Pitt&Sherry)

Estimate Date: May 2012																		
	TOTAL	Year																
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
		2011 - 2012	2012 - 2013	2013 - 2014	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018	2018 - 2019	2019 - 2020	2020 - 2021	2021 - 2022	2022 - 2023	2023 - 2024	2024 - 2025	2025 - 2026	2026 - 2027	
Construction at P90	$20,697,393	$1,976,256	$11,269,233	$7,451,904														
Replace Nelson Bay River Bridge on Rebecca Road with Concrete Structure	$0					$0												
Replace Log Culverts on Rapid River Road	$0																	
Reseal Deteriorated seal on Blackwater Road	$199,068									$199,068								
Reseal balance of Blackwater Road (except light coloured aggregate section) and sealed sections of Sumac Road and Tayatea Road	$928,607												$928,607					
Apply Reseal over primerseal	$0																	
Apply Reseal over Primerseal with light coloured Aggregate	$0																	
Reapply rumble strip groups at 5 year intervals	$269,594						$134,797						$134,797					
Reapply pavement marking at reseal	$218,237																	
Routine Maintenance of Gravel	$424,168		$212,084	$212,084														
Routine Maintenance of Sealed	$1,651,478		$36,218	$36,218	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	
Project Estimate	$24,170,308	########	**$11,517,535**	**$7,700,205**	**$143,549**	**$143,549**	**$278,346**	**$143,549**	**$143,549**	**$342,617**	**$143,549**	**$143,549**	**$1,206,954**	**$143,549**	**$143,549**	**$143,549**	**$143,549**	
Cost Escalation	4.7%	**$0**	**$541,324**	**$740,829**	**$21,207**	**$28,950**	**$71,856**	**$45,546**	**$54,434**	**$152,129**	**$73,481**	**$83,682**	**$793,388**	**$105,544**	**$117,251**	**$129,509**	**$142,342**	
Out Turn Cost		$1,976,256	$12,058,859	$8,441,034	$164,756	$172,500	$350,202	$189,096	$197,983	$494,746	$217,031	$227,231	$2,000,341	$249,093	$260,800	$273,058	$285,892	

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
	2027 - 2028	2028 - 2029	2029 - 2030	2030 - 2031	2031 - 2032	2032 - 2033	2033 - 2034	2034 - 2035	2035 - 2036	2036 - 2037	2037 - 2038	2038 - 2039	2039 - 2040	2040 - 2041	2041 - 2042	
Construction at P90																$0
Replace Nelson Bay River Bridge on Rebecca Road with Concrete Structure																$0
Replace Log Culverts on Rapid River Road																$0
Reseal Deteriorated seal on Blackwater Road								$199,068								$398,135
Reseal balance of Blackwater Road (except light coloured aggregate section) and sealed sections of Sumac Road and Tayatea Road											$928,607					$1,857,215
Apply Reseal over primerseal	$1,223,272	$1,223,272	$1,223,272		$0	$0	$0									$3,669,815
Apply Reseal over Primerseal with light coloured Agg	$1,345,652						$0									$1,345,652
Reapply rumble strip groups at 5 year	$134,797					$134,797					$134,797					$673,985
Reapply pavement marking at reseal	$72,746	$72,746	$72,746													$218,237
Routine Maintenance of Gravel Road																$0
Routine Maintenance of Sealed Roac	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$143,549	$4,019,382
Project Estimate	$1,574,363	$2,785,219	$1,439,566	$143,549	$143,549	$278,346	$143,549	$342,617	$143,549	$143,549	$1,206,954	$143,549	$143,549	$143,549	$143,549	$12,182,420
Cost Escalation	$1,708,493	$3,295,472	$1,851,010	$199,999	$216,146	$451,894	$250,752	$642,715	$288,687	$309,002	$2,776,909	$352,542	$375,858	$400,270	$425,830	
Out Turn Cost	$3,282,856	$6,080,691	$3,290,576	$343,549	$359,695	$730,240	$394,301	$985,332	$432,237	$452,552	$3,983,862	$496,091	$519,408	$543,820	$569,379	

Appendix E

Final guidelines

GUIDELINES FOR THE CONTENT OF A DRAFT PUBLIC ENVIRONMENT REPORT

Tarkine Forest Drive
Tasmania

Environment Protection and Biodiversity Conservation Act 1999

(Reference: EPBC 2011/6210)

GUIDELINES FOR A DRAFT PUBLIC ENVIRONMENT REPORT FOR TARKINE FOREST DRIVE
Tasmanian Department of Infrastructure, Energy and Resources

PREAMBLE

The Tasmanian Department of Infrastructure, Energy and Resources (DIER) proposes to upgrade and seal approximately 92.7 km of existing roads in north-west Tasmania to form the Tarkine Forest Drive from the southern abutment of the former Tayatea bridge on the Arthur River to the Arthur River township at the mouth of the Arthur River on the west coast of Tasmania. The primary purpose of the Tarkine Forest Drive is to promote tourism in the north-west region of Tasmania. The proposed road upgrade is expected to result in an as yet unquantified increase in the number of vehicles and people visiting the north-west region of Tasmania surrounding the road route.

The proposal was referred under the *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) to the Minister for Sustainability, Environment, Water, Population and Communities on 24 November 2011. The delegate of the Minister determined on 3 January 2012 that approval is required as the action has the potential to have a significant impact on the following matters of national environmental significance (NES) that are protected under Part 3 of the EPBC Act:

- listed threatened species and communities (section 18 and 18A)

The delegate also determined on 3 January 2012 that the proposed activity be assessed by a Public Environment Report (PER).

Information about the action and its relevant impacts, as outlined below, is to be provided in the PER. This information must be sufficient to allow the Minister to make an informed decision on whether or not to approve, under Part 9 of the EPBC Act, the taking of the action for the purposes of each controlling provision.

GENERAL ADVICE ON GUIDELINES

1 GENERAL CONTENT

The PER must be a stand-alone document that primarily focuses on the matters of NES listed above. It must contain sufficient information to avoid the need to search out previous or supplementary reports. The PER must take into consideration the EPBC Act Significant Impact Guidelines that can be downloaded from the following web site: http://www.environment.gov.au/epbc/guidelines-policies.html.

The PER must enable interested stakeholders and the Minister to understand the environmental consequences of the proposed development. Information provided in the PER must be objective, clear, and succinct and, where appropriate, be supported by maps, plans, diagrams or other descriptive detail. The body of the PER is to be written in a clear and concise style that is easily understood by the general reader. Technical jargon must be avoided wherever possible. Cross-referencing must be used to avoid unnecessary duplication of text.

Detailed technical information, studies or investigations necessary to support the main text must be included as appendices to the PER. It is recommended that any additional supporting documentation and studies, reports or literature not normally available to the public from which information has been extracted be made available at appropriate locations during the period of public display of the PER.

After receiving the Ministers approval to publish the report, the Proponent is required to make the draft PER available for a period of public comment. Specific instructions regarding publication requirements will be provided as part of the Minister's direction to publish.

If it is necessary to make use of material that is considered to be of a confidential nature, the Proponent must consult with the department on the preferred presentation of that material, before submitting it to the Minister for approval for publication.

The level of analysis and detail in the PER must reflect the level of significance of the expected impacts on the environment. Any and all unknown variables or assumptions made in the assessment must be clearly stated and discussed. The extent to which the limitations, if any, of available information may influence the conclusions of the environmental assessment must be discussed.

The Proponent must ensure that the PER assesses compliance of the action with principles of Ecological Sustainable Development as set out in the EPBC Act, and the objects of the Act at Attachment 1. A copy of Schedule 4 of the EPBC Regulations, - *Matters to be addressed by draft public environment report and environmental impact statement* is at Attachment 2.

2 FORMAT AND STYLE

The PER must comprise three elements, namely:

- the executive summary;
- the main text of the document, and

- appendices containing detailed technical information and other information that can be made publicly available.

The guidelines have been set out in a manner that may be adopted as the format for the PER. This format need not be followed where the required information can be more effectively presented in an alternative way. However, each of the elements must be addressed to meet the requirements of the EPBC Act and Regulations.

The PER must be written so that any conclusions reached can be independently assessed. To this end all sources must be appropriately referenced using the Harvard standard. The reference list must include the address of any Internet "web" pages used as data sources.

The main text of the PER must include a list of abbreviations, a glossary of terms and appendices containing:

- a copy of these guidelines;
- a list of persons and agencies consulted during the preparation of the PER;
- contact details for the Proponent; and
- the names of the persons involved in preparing the PER and work done by each of these persons.

Maps, diagrams and other illustrative material must be included in the PER. The PER must be produced on A4 size paper capable of being photocopied, with maps and diagrams on A4 or A3 size and in colour where possible.

The Proponent must consider the format and style of the document appropriate for publication on the Internet. The capacity of the website to store data and display the material may have some bearing on how the document is constructed.

SPECIFIC CONTENT

1 GENERAL INFORMATION

This must provide the background and context of the action including:

(a) the title of the action;

(b) the full name and postal address of the designated Proponent;

(c) a clear outline of the objective of the action;

(d) the location of the action (including maps of the locations of all supporting infrastructure such as quarries, access tracks and temporary storage facilities) ;

(e) the background to the development of the action;

(f) how the action relates to any other actions (of which the Proponent should reasonably be aware) that have been, or are being, taken or that have been approved in the region affected by the action, including current and anticipated linking road works or transport routes);

(g) the current status of the action; and

(h) the consequences of not proceeding with the action.

2 DESCRIPTION OF THE ACTION

In relation to the requirement to describe all components of the action, all construction and operational components of the action, where known or able to be predicted, must be described in detail. This includes date or time period over which construction will take place, exact dimensions of structures to be built and materials, equipment and machinery to be used.

The components of the action addressed in the above information must include (but not be limited to) specifications or details of:

(a) road dimensions and structure for all sections of the road, including details of sealed surface, verge, batters, embankment and road corridor clearance, along with specific design elements such as traffic speed controls, barriers, design features to minimise roadkill, etc;

(b) all watercourse crossings requiring additional infrastructure works, including bridge works, culverts, embankments, temporary in-stream barriers and flow diversion structures;

(c) service facilities developed in conjunction with the road route such as parking bays, toilets, access tracks, viewing platforms, camping and picnic facilities;

(d) water quality monitoring and management programs, including erosion, sediment and runoff controls, water quality testing and other measures to maintain or enhance aquatic habitats in the vicinity of the road route;

(e) any proposed additional development sites or support facilities not addressed in the referral, such as quarry operations to support the construction and maintenance of the upgraded road, additional access tracks to adjoining

recreational sites such as side tracks to Dempster Lookout and Milkshake Reserve;

(f) indicative details of supporting infrastructure for construction and road operations, such as machinery storage areas, access tracks, work or office sheds, wash down facilities, additional water, sewage, drainage and electricity facilities and associated installation works;

(g) waste management arrangements, including storage and disposal of fuels, chemicals and other waste products during construction and ongoing use of the road; and

(h) details of the induction provided to workers, particularly in relation to potential impacts on threatened species.

3 FEASIBLE ALTERNATIVES

Any feasible alternatives to the action to the extent reasonably practicable, including:

(a) if relevant, the alternative of taking no action;

(b) a comparative description of the impacts of each alternative on the NES matters protected by controlling provisions of Part 3 of the EPBC Act for the action, including alternative road design options for areas of known risk to listed threatened species ; and

(c) sufficient detail to make clear why any alternative is preferred to another.

Short, medium and long-term advantages and disadvantages of the options must be discussed.

4 DESCRIPTION OF THE ENVIRONMENT AND MATTERS OF NES

A description of the environment of the proposed road upgrade route and the surrounding areas that may be affected by the action, including listed threatened species and ecological communities that are likely to be present in the vicinity of the road route, including but not limited to:

- *Sarcophilus harrisii* - Tasmanian Devil (Endangered);
- *Dasyurus maculatus maculates* - Spotted-tail Quoll (Vulnerable);
- *Caladenia dienema* - Windswept Spider-orchid (Critically Endangered);
- *Corunastylis brachystachya (*also known as *Genoplesium brachystachyum*) - Shortspike Midge-orchid (Endangered);
- *Diuris lanceolata* - Snake Orchid – also known as Large Golden Moths (Endangered);
- *Prasophyllum favonium* - Western Leek-orchid (Critically Endangered);
- *Prasophyllum secutum* - Northern Leek-orchid (Endangered);
- *Pterostylis rubenachii* - Arthur River Greenhood (Endangered);
- *Pterostylis cuculata* subsp. *Cucullata* – Leafy Greenhood (vulnerable);
- *Aquila audax fleayi* – Wedge-tailed Eagle (Tasmanian) (Endangered);
- *Astacopsis gouldi* – Giant Freshwater Crayfish (Vulnerable);

- *Ceyx azureus* subsp. *Diemenensis* - Tasmanian Azure Kingfisher (Endangered);
- *Oreisplanus munionga larana* - Marrawah Skipper (Vulnerable).

In relation to these species the following must be addressed:

(a) information on the abundance, distribution, ecology and habitat preferences of the species or communities;

(b) discussion of the known threats to the species or community, with reference to threats posed by the proposed action;

(c) maps identifying all known occurrences of the species or community and potential habitat for the species;

(d) details of surveys for these species and their habitat in the vicinity of the proposed action, including details of survey effort, timing, location and methodologies for studies and surveys undertaken and the regional status, population size and distribution within the area surrounding the proposed action identified for these species;

(e) for all species that are considered unlikely to be impacted by the proposed action, but for which apparently suitable habitat is present and could be impacted by the proposed action, detailed information to demonstrate that impacts on the species are unlikely to occur; and

(f) discussion of the potential impacts on the above species of pest species, disease and fire outbreaks generated by the proposed action.

Consideration of each species must have regard to any recovery plan prepared by the Commonwealth, Tasmanian or other state government, in relation to the species, and any publicly available policy statement prepared by the department in relation to the species.

5 RELEVANT IMPACTS

The PER must include a description of all of the relevant impacts during the construction and operational phases of the action. The following information must be provided:

- a detailed assessment of the nature and extent of the likely short-term and long-term relevant impacts;
- a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;
- analysis of the significance of the relevant impacts; and
- any technical data and other information used or needed to make a detailed assessment of the relevant impacts.

Consideration of impacts must not be confined to the immediate areas surrounding the upgraded road corridor but must also consider the potential of the proposed action to impact on areas of the broader Tarkine region and adjoining areas that are likely to contain matters of NES.

Consideration of potential impacts must encompass direct and indirect, facilitated and cumulative impacts.

Indirect impacts are impacts that are not a direct result of the project but to which the proposed action contributes. They may include offsite or downstream impacts such as impacts on downstream hydrology and water quality, spread of pests and diseases or changes in species foraging, breeding and movement patterns.

Facilitated impacts are impacts resulting from the actions of third parties that are facilitated by the proposed action, such as increased road traffic or tourist and recreational activities facilitated through the upgrading of road infrastructure.

Cumulative impacts are impacts of the proposed action in combination with other past, present and reasonably foreseeable future actions (both related and unrelated), such as the increased threat of road kill and habitat disturbance generated from additional development and activities in the surrounding area.

In relation to direct impacts of the proposed action, the discussion must include (but not be limited to) assessment of:

(a) the direct loss of vegetation and terrestrial habitat from construction activities such as road work, bridge work, development of supporting infrastructure such as car parks, toilets and picnic areas;

(b) the changes to aquatic habitat in the vicinity of the road corridor and at water crossings from construction activities, including changes to water quality, hydrology, in-stream habitat and movement corridors for aquatic species; and

(c) noise, lighting and other disturbance effects during construction activities, including potential disruption to foraging, breeding and hunting activities.

In relation to indirect or facilitated impacts by the proposed action, the discussion must include (but not be limited to) assessment of:

(a) potential for the proposed road upgrade to act as vector for the spread of the Devil Facial Tumour Disease (DFTD), including characteristics of local Tasmanian Devil populations, the extent and rate of spread of DFTD, means of DFTD transfer, risks of DFTD spread posed by construction activities and ongoing use of the road route, likely higher risk points along the road route for DFTD incursion and the basis for calculating risks of DFTD spread. The analysis must investigate the level of certainty in the information provided;

(b) wildlife road mortality threats, including details of expected changes in traffic conditions, areas of likely impact, temporal impacts (daily and seasonal), species most at risk, basis for calculating impacts (including reference to studies on-site and other areas), disruption to wildlife foraging and movement patterns;

(c) changes in human activity in the area due to use of the upgraded road route, including details of projected tourist numbers (and methods for calculating numbers), changes in the types of traffic and road use in the area, likely future developments in the vicinity of the road route, expected impacts on vegetation communities and native species habitats, increased risk of poaching of listed

species, increased risk of environmental damage from increased off-road activities;

(d) risks of the introduction and spread of pathogens such as *Phytophthora cinnamomi* and Myrtle wilt caused by fungus *Chalara australis*;

(e) risks of the introduction and spread of exotic predators and non-native competitors such as the European Fox;

(f) risks of the introduction and spread of weed species; and

(g) risks of the increased incidence of fire.

6 PROPOSED SAFEGUARDS AND MITIGATION MEASURES

The PER must provide information on proposed safeguards and mitigation measures to deal with the relevant impacts of the action. Specific and detailed descriptions of proposed measures must be provided and substantiated, based on best available practices and must include the following elements:

(a) a consolidated list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including:

- a description of proposed safeguards and mitigation measures to deal with relevant impacts of the action, including mitigation measures proposed to be taken by State governments, local governments or the Proponent;
- assessment of the expected or predicted effectiveness of the mitigation measures;
- any statutory or policy basis for the mitigation measures;
- the cost of the mitigation and ongoing management measures and the resources available to meet these costs; and
- the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program;

(b) details of the structure and content of management plans proposed for the continuing management of relevant impacts of the action on matters of NES, including indicative construction and operational environmental management plans, flora and fauna management plans, disease and pest management plans, roadkill monitoring and mitigation plans (including specific measures to avoid or minimise wildlife road mortalities) and water quality plans, along with a schedule for the development and approval of these plans;

(c) details of ongoing research and monitoring programs to support an adaptive management approach and determine the effectiveness of the proposed mitigation measures (including evaluation of projects in the surrounding area using related mitigation approaches, such as the sealing of the Marrawah to Arthur River Road project);

(d) details of arrangements and resources provided to ensure compliance with measures to mitigate impacts, such as control of traffic speed, prevention of poaching and inappropriate off-road access, restricting fire outbreaks, minimising vehicle and human spread of soil and disease; and

(e) details of contingency arrangements for events that may impact on matters of NES, particularly in relation to unexpected or uncertain impacts of the spread of DFTD and increased wildlife road mortality.

Any management plans, surveys and monitoring programs (dealing with matters of NES) that have already been completed, along with any supporting documentation on matters of NES determined, suspected or thought to be present, must be attached to the PER as appendices.

Where impacts on matters of NES cannot be avoided or mitigated, the PER must provide a description of any strategies proposed to offset (compensate for) those impacts. The proposed strategies must have regard to any relevant publicly available guidance issued by the department in relation to offsets, and in particular must:

a) demonstrate how they will achieve long-term conservation outcomes;

b) have regard to the nature, scale and intensity of the impacts of the proposed action on the site; and

c) consider the approach of the relevant state or territory.

7 OTHER APPROVALS AND CONDITIONS

The PER must include information on any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. This must include:

(a) details of any local or State Government planning scheme, or plan or policy under any local or State Government planning system that deals with the proposed action, including:

- what environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy; and
- how the scheme provides for the prevention, minimisation and management of any relevant impacts;

(b) a description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the EPBC Act), including any conditions that apply to the action;

(c) a statement identifying any additional approval that is required; and

(d) a description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.

8 CONSULTATION

Include details of any consultation about the action, including:

(a) any consultation that has already taken place;

(b) proposed consultation about relevant impacts of the action, including consultation with relevant experts on the threatened species listed in section 4;

(c) if there has been consultation about the proposed action, any documented response to, or result of, the consultation; and

(d) identification of affected parties, including a statement mentioning any organisations or communities that may be affected and describing their views. This includes the relevant Save the Tasmanian Devil Program managers and researchers, with details provided in the PER on any of the Program's developments in relation to Tasmanian Devil mortalities and the resultant implications for the proposed action.

9 ENVIRONMENTAL RECORD OF PERSON PROPOSING TO TAKE THE ACTION

The information provided must include details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:

(a) the person proposing to take the action; and

(b) for an action for which a person has applied for a permit, the person making the application.

Also include in the PER any details of the Proponent's environmental policy and planning framework.

10 ECONOMIC AND SOCIAL MATTERS

The economic and social impacts of the action, both positive and negative, must be analysed. Matters of interest may include:

(a) details of any public consultation activities undertaken, and their outcomes;

(b) projected economic costs and benefits of the project, including the basis for their estimation through cost/benefit analysis or similar studies;

(c) employment opportunities expected to be generated by the project (including construction and operational phases);

(d) details of changes to public access to the area and surrounding regions arising from the road development;

(e) implications for tourism activities (both existing and projected) in the region; and

(f) any monitoring programs to monitor ongoing changes to economic and social characteristics potentially affected by the proposed action.

Economic and social impacts must be considered at the local, regional and national levels. Details of the relevant cost and benefits of alternative options to the proposed action, as identified in section 3 above, must also be included.

11 INFORMATION SOURCES PROVIDED IN THE PER/EIS

For information given in a draft PER, the draft must state:

(a) the source of the information;

(b) how recent the information is;

(c) how the reliability of the information was tested; and

(d) what uncertainties (if any) are in the information.

12 CONCLUSION

An overall conclusion as to the environmental acceptability of the proposal must be provided, including discussion on compliance with principles of ESD and the objects and requirements of the EPBC Act. Reasons justifying undertaking the proposal in the manner proposed must also be outlined.

Measures proposed or required by way of offset for any unavoidable impacts on NES matters, and the relative degree of compensation, must be restated here.

ATTACHMENT 1

THE OBJECTS AND PRINCIPLES OF THE *ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999* SECTIONS 3 AND 3A

3 Objects of the Act

(a) to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance;

(b) to promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources;

(c) to promote the conservation of biodiversity;

(d) to promote a co-operative approach to the protection and management of the environment involving governments, the community, land-holders and indigenous peoples;

(e) to assist in the co-operative implementation of Australia's international environmental responsibilities;

(f) to recognise the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity; and

(g) to promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in co-operation with, the owners of the knowledge.

3A Principles of Ecologically Sustainable Development

The following principles are principles of ecologically sustainable development.

(a) Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.

(b) If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

(c) The principle of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

(d) The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making.

(e) Improved valuation, pricing and incentive mechanisms should be promoted.

ATTACHMENT 2

MATTERS THAT MUST BE ADDRESSED IN A PER AND EIS (SCHEDULE 4 OF THE EPBC REGULATIONS 2000)

1 General information

1.01 The background of the action including:

(a) the title of the action;

(b) the full name and postal address of the designated Proponent;

(c) a clear outline of the objective of the action;

(d) the location of the action;

(e) the background to the development of the action;

(f) how the action relates to any other actions (of which the Proponent should reasonably be aware) that have been, or are being, taken or that have been approved in the region affected by the action;

(g) the current status of the action; and

(h) the consequences of not proceeding with the action.

2 Description

2.01 A description of the action, including:

(a) all the components of the action;

(b) the precise location of any works to be undertaken, structures to be built or elements of the action that may have relevant impacts;

(c) how the works are to be undertaken and design parameters for those aspects of the structures or elements of the action that may have relevant impacts;

(d) relevant impacts of the action;

(e) proposed safeguards and mitigation measures to deal with relevant impacts of the action;

(f) any other requirements for approval or conditions that apply, or that the Proponent reasonably believes are likely to apply, to the proposed action;

(g) to the extent reasonably practicable, any feasible alternatives to the action, including:

(i) if relevant, the alternative of taking no action;

(ii) a comparative description of the impacts of each alternative on the matters protected by the controlling provisions for the action; and

(iii) sufficient detail to make clear why any alternative is preferred to another;

(h) any consultation about the action, including:

(i) any consultation that has already taken place;

(ii) proposed consultation about relevant impacts of the action; and

(iii) if there has been consultation about the proposed action — any documented response to, or result of, the consultation; and

(i) identification of affected parties, including a statement mentioning any communities that may be affected and describing their views.

3 Relevant impacts

3.01 Information given under paragraph 2.01(d) must include

(a) a description of the relevant impacts of the action;

(b) a detailed assessment of the nature and extent of the likely short term and long term relevant impacts;

(c) a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible;

(d) analysis of the significance of the relevant impacts; and

(e) any technical data and other information used or needed to make a detailed assessment of the relevant impacts.

4 Proposed safeguards and mitigation measures

4.01 Information given under paragraph 2.01(e) must include:

(a) a description, and an assessment of the expected or predicted effectiveness of, the mitigation measures;

(b) any statutory or policy basis for the mitigation measures;

(c) the cost of the mitigation measures;

(d) an outline of an environmental management plan that sets out the framework for continuing management, mitigation and monitoring programs for the relevant impacts of the action, including any provisions for independent environmental auditing;

(e) the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program; and

(f) a consolidated list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including mitigation measures proposed to be taken by State governments, local governments or the Proponent.

5 Other Approvals and Conditions

5.01 Information given under paragraph 2.01(f) must include:

(a) details of any local or State government planning scheme, or plan or policy under any local or State government planning system that deals with the proposed action, including:

(i) what environmental assessment of the proposed action has been, or is being carried out under the scheme, plan or policy; and

(ii) how the scheme provides for the prevention, minimisation and management of any relevant impacts;

(b) a description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the Act), including any conditions that apply to the action;

(c) a statement identifying any additional approval that is required; and

(d) a description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.

6 Environmental record of person proposing to take the action

6.01 Details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against:

(a) the person proposing to take the action; and

(b) for an action for which a person has applied for a permit, the person making the application.

6.02 If the person proposing to take the action is a corporation — details of the corporation's environmental policy and planning framework.

7 Information sources

7.01 For information given the PER/EIS must state:

(a) the source of the information; and

(b) how recent the information is; and

(c) how the reliability of the information was tested; and

(d) what uncertainties (if any) are in the information.

Appendix F

Tarkine Drive - vertebrate carnivore assessment forum

Event: Tarkine Drive - Carnivore Assessment Forum

Date/time: 22 July 2009, 0900-1230

Attendees

- Randy Rose (retired academic from the School of Zoology at the University of Tasmania)
- Barrie Wells (Veterinarian)
- Chloe Lucas (Roadkill Network)
- Clare Hawkins (Threatened Species Zoologist, DPIPWE)
- Nick Mooney (Section Head, Wildlife Monitoring and Management, DPIPWE)
- David Pemberton (Threatened Species Section, DPIPWE)
- Andrew Sharman (Program Manager, Save the Tasmanian Devil Program, DPIPWE)
- Rodrigo Hamede (PhD student, "Contact Networks in Wild Tasmanian Devils: Social Behaviour & Devil Facial Tumour Disease")
- Shannon Troy (PhD student "Landscape Ecology of the Tasmanian Spotted-Tailed Quoll")
- Phil Cantillon (Tarkine Drive Project Director, DIER)
- Andrew North (Ecologist, North Barker, for P&S)
- Karen Ziegler (Ecologist, North Barker, for P&S))
- Menna Jones (Scientific Advisor, Save the Tasmanian Devil Program, DPIPWE)
- Andrew Harvey (Senior Natural Values Assessment Officer, Development and Conservation Assessment Section, DPIPWE)
- Gar Foong (Tarkine Drive Project Manager, DIER)
- Raymond Brereton (Senior Ecologist, Hydro Consulting, for P&S)
- Gavan Banks – Senior Project Engineer – Roads (Pitt & Sherry)
- Brian Williams – Principal Engineer Road Design (Pitt & Sherry)

Apologies: Dion Lester (Pitt & Sherry)

Facilitator: Timothy Phillips (Resonance Sustainability Services, for P&S)

NB: The following are summary notes of key discussion points from the Forum. They are not intended to be a verbatim record of discussions. They have been prepared based on the notes taken by the facilitator and members of the fauna/flora assessment project team. Furthermore, the views expressed in these notes are not necessarily those of the Tasmanian Government.

1. Background and welcome

Group was welcomed by the facilitator, who also explained his role, i.e. keeping group on track, following agenda, ensuring all attendees were given opportunity to speak etc.

It was noted that this is a controversial project with many divergent views and that attendance at this forum does not necessarily imply support for the project.

The forum objectives were presented and discussed.

- Provide attendees a briefing on the status of the Tarkine Drive assessment project, with particular reference to the assessment of impacts on vertebrate carnivores.
- Provide update on preliminary field work undertaken by North Barker within study area
- Identify and discuss information/ data requirements and sources for the assessment
- Identify and discuss potential issues and impacts regarding roadkill – priority areas, methodology, designs and treatments
- Identify and discuss potential issues and impacts regarding devil facial tumour disease

The program was revisited. There were no major questions or comments regarding the workshop objectives or program.

2. Introductions

All attendees were asked to introduce themselves and identify a specific issue they would like discussed at the forum. Issues raised included:

- Additional information about the project
- Role of the Tasmanian Devil program in this process and identify the existing relevant information as well as information gaps
- How animals use the landscape and roads
- The need for a facts and evidence based assessment
- Impact of vehicle speed
- Increase understanding of the traffic information, both existing and proposed
- Fauna assessment
- Just here to listen and learn
- Identify the potential increase risk regarding Devil Facial Tumour Disease (DFTD)
- What is the existing road network?
- Impact of road on quoll
- What is unique or different regarding NW devils
- Strong informative process
- Conflict between user expectations and mitigation

- DFTD
- Traffic information and roadkill
- Mitigation strategies
- Transferable outcomes, i.e. improved roadkill mitigation across road network

3. Project overview – Phil Cantillon (DIER)

Road will be built in three stages

- Stage 1. West Coast
- Stage 2. Middle section
- Stage 3. Wynyard section

The West Coast section of the road will have a 6 m pavement width with a 0.5 m verge on either side of the road.

The Wynyard section will a 4 m pavement width with a 0.75 m verge on either side of the road.

Of the $23 million budget for the road, $2.5 million is allocated to tourism infrastructure.

An understanding of the existing road use is critical to the assessment, including:

- Amount of use
- Nature of the use (e.g. forestry contractors, mining contractors, tourists)

Route and design as described is just a starting point, there is the possibility that it may change as new information comes in.

It is intended to seal the entire route.

Q. Why the Southern Spur?

A. There is access to a trig station with significant views, as well as a starting point for a walk into Tarkine Falls.

Q. What are the actual traffic volumes?

A. We are gathering that information and have a report in preparation.

4. Andy North – The current status of the assessment process

The three handouts (maps) were mentioned and discussed (see attached).

North Barker are using TASVEG to describe the habitats within the study area along with Forestry Tasmanian PI typing, other API and ground truthing.

Land use within the study area will also be described, existing and potential.

The study area covers 500 m either side of the road.

The difficulty of obtaining abundance data on devils and quolls was then discussed. In one study, 2 months of trapping had captured 15 spotted-tailed quolls and 137 Tasmanian devils, another study had trapped 22 spotted-tailed quolls over a year.

It was noted that quolls inhabit a range of habitats and that the highest densities had been found in coastal scrub.

It was suggested that walking the road verges to look for signs (scats, tracks) of devils and quolls would give some indication of presence/absence, which may help to identify areas of activity along the road.

Other sources of data included the RFA report "*Preliminary assessment of distribution and habitat associations of the spotted-tailed quoll and eastern quoll in Tasmania*" Jones, M.E., and Rose R. (1997).

5. Road kill – facilitated discussion

There was discussion about the value of having traffic data prior to construction. The projection for traffic volumes after construction, when all components of the road have been completed including tourist infrastructure, is in the order of 100,000 vehicles per year. It was noted that this was an estimate at the higher end.

It was noted that it is not only the volume of traffic that is important but also the type of traffic and it was necessary to measure the different types of traffic and when the use the road (e.g. forestry workers compared with tourist traffic).

Traffic variables to measure before and after construction of the road:

- type of traffic (e.g. forestry workers, tourists, locals, mining workers)
- time of day of vehicle movements
- traffic volume
- vehicle speed

The main risk periods for roadkill are dawn and dusk. The main risk factors for roadkill are where the traffic is local and commercial as evidenced by the Cradle Mountain road upgrade (Jones, M.E. 2000. Road upgrade, road mortality and remedial measures: impacts on a population of eastern quolls and Tasmanian devils. *Wildlife Research* 27:289-296) and the Arthur River road upgrade (Landscape impressions. 2008. *Assessment Report: Arthur River Road EPBC Decision 2003/90.* Report to Circular Head Council).

The "Warren Report" that DIER has had prepared has some data on current traffic use of roads within the study area.

Monitoring of roadkill impacts post upgrade / construction of the Tarkine Road will be required to mitigate potential roadkill hotspots.

Q.Is this the final route?

A. More or less +/- 150 metres (depending on site specific conditions)

5.1 Discussion on EPBC Assessment

The EPBC assessment of the proposed action will be about the change in use of the existing roads and new sections and the impact of the consequential impacts resulting from the change in use, i.e. the change in the risk profile of the road resulting from the:

- the increase in traffic volumes
- the increase in road use from other activities (e.g. forestry and mining)
- increase in traffic speed

The assessment will to require a description of the baseline traffic profile and a description of the change to the projected traffic profile following the construction of the road.

5.2 Roadkill continued

A risk profile of factors contributing to road kill are identified in Hobday, A. J. and Minstrell, M.L. 2008. Distribution and abundance of roadkill on Tasmanian highways: human management options. *Wildlife Research* 35: 712-716.

M. Jones (unpublished data from a study on Class C roads on the east coast of Tasmania) has identified predictors of road kill:

- visibility (poor straight line visibility resulted in increased roadkill)
- roadside barriers (e.g. fences and cuttings); (the presence of roadside barriers which prevented animals from getting off the road increased roadkill)
- escape routes (runways);
- increased traffic speed

A combination of features can increase the risk of roadkill. It was noted that a higher incidence of roadkill was observed in the inside of corners especially when associated with grassy habitats that attract herbivores.

6. Devil Facial Tumour Disease (DFTD)

6.1 Extent of DFTD

The western most occurrence of DFTD is at Upper Natone and Surrey Hills, however this is not a definitive boundary and this data is 12 months old.

The Program will be undertaking a new round of monitoring on the "front" in September and October

The identification of DFTD relies on gross pathology. Disease front monitoring is based on clinical testing. There is no pre-clinical test available yet. The development of a pre-clinical test is currently underway and trials are happening however, it is unlikely to be available until September or October at the earliest if it proves to be viable.

The disease front is not a straight line and "fingers" of the disease can occur following particular landscape features, for example as it moves up valleys. The disease could be further west of the current known localities.

On average, the current rate of DFTD spread is estimated to be 7 km/year. Although, there have been instances of spread at higher rates some local areas of up to 50 km/year.

There have been no local extinctions as a result of the disease. However, in the north east the devil population is at a very low level. It has declined signficiantly and the age structure of the population has changed. There are no animals over two years old. It is thought that in the northeast the disease has been 100% fatal. There is evidence that animals are breeding much earlier due to a combination of reasons including greater availability of food, denning habitat and lack of sexual suppression of young females that normally would have been living with their mothers for longer. When a population is very low stochastic events may impact severely on remaining animals.

It is inevitable that the disease will get into the north west, it is just a matter of when.

6.2 DFTD and Roadkill

Roadkill then becomes a much greater threat because of declining population levels. Roadkill could have a significant impact in the north west after the disease arrives.

If there is road kill monitoring it is essential that it is related to local devil or quoll population densities to assess the impact on these populations. The background populations may be slowly decreasing while roadkill remains at static levels for a period.

The paper by "McCallum, H., D. M. Tompkins, M. Jones, S. Lachish, S. Marvanek, B. Lazenby, G. Hocking, J. Wiersma, and C. Hawkins. (2007) Distribution and impacts of Tasmanian devil facial tumor disease. *EcoHealth* 4(3): 318-325" has the most up to date published information on the distribution and impact of the disease.

6.3 Different genetic provenance

There is evidence that the north west devil population is a different genetic provenance. Therefore DFTD may have a different impact on this population, mortality rates may be lower.

The pinch point for the genetic separation is at Mawbanna. The devil genetic provenance starts to change at about Devonport. There is a grey zone in the genetic provenance from Devonport to Stanley.

6.4 General discussion

The rate of the spread of DFTD will affect the nature of the response from the Devil Task Force. If there is an opportunity for DFTD to leap frog into new areas this would have a major impact on the Devil Disease Program.

Need a landscape context for the road as adjoining landuse could also impact devil movement. Therefore it is necessary to know forestry three and ten year plans.

There was a discussion about the use of roads by devils. Devils are forest and woodland animals that do not necessarily use roads to move around the landscape. They use runways in forests.

A landscape with many roads does not necessarily increase the home rang of devils. There is published data on devil movements.

An increase in roadkilled herbivores does not necessarily lead to an increase in devil road kill

6.5 Quolls and roadkill

Spotted-tailed quolls will sometimes use roads but to a lesser degree. Quolls prefer vegetation with an implicate structure (e.g. wet forest, but also occur in coastal scrub).

There is a predictive model for spotted-tailed quoll occurrence across Tasmania in the RFA report "*Preliminary assessment of distribution and habitat associations of the spotted-tailed quoll and eastern quoll in Tasmania*" Jones, M.E., and Rose R. (1997). However, further work is needed to define high quality habitat for quolls and devils.

There is little information on how quolls use the landscape (information gap). Questions include:

- How do they move in the landscape?
- Do they use roads?
- Do they use forests?
- Do they use coastal scrubs?

6.6 General discussion

The change in the rate of spread of DFTD is related to home range. The Devil Program is investigating the fencing of a disease free population in north west as a secure population. The implementation of this project requires information on how devils use the landscape. A study is planned for the north west at Woolnorth.

The new section of road at the eastern end may promote movement across a possible genetic barrier comprised of the rainforest in this area. Though this doesn't seems likely for the high frequency of devil scats seems on section 9 between the Lyons River and Wynsmith Track.

Is the opening up of the new section of road creating access to a landscape that would normally be a barrier/potential barrier to devils and will that change the rate spread of DFTD and allow access to a population that is not yet exposed to the disease.

Mitigation of movement of devils along the new section of road - can the road be fenced to keep devils out?

7. Roadkill revisited

Need information on traffic and the potential risk of roadkill to design mitigation measures. Some mitigation features e.g. straighter roads, decrease the value of road for tourist traffic.

The road should be designed for a traffic speed of 60 kmh or less to reduce the incidence of roadkill.

Road ecology is a large field and there is a range of available information on mitigation measures to reduce roadkill out there.

Adaptive management will come out of monitoring post construction.

Removal of roadkill herbivores on the Tasman Peninsula has shown to decrease devil road kill.

7.1 Devil dens

Maternity dens are an important resource for devils because they may only have one breeding attempt in a diseased population. Therefore any impacts on maternity dens from road construction and operation should be avoided. The location of dens is related to suitable denning habitat including rock outcrops, rock shelters, fallen large logs, and large tree root bowls.

A den survey is recommended for the new road construction. The survey area should be 30-50 m?? either side of the road. (There did not appear to be consensus on the survey area and we may need to go back to the Threatened Species Section and the Development and Conservation Assessment Section of DPIPWE for advice).

Roadside walks are recommended to identify hotspots for devil and quoll activity.

7.2 General discussion

The impacts on devil and quoll populations of roadkill can/could lead to local extinction in some circumstances where the population is already impacted by roadkill.

A study on the Freycinet Peninsula (Jones unpublished data) found that in a 12 month period 20% of the devil population was removed due to roadkill. The removal of roadkill herbivores from the road reduced the incidence of roadkill.

The Freycinet devil population was able to sustain this 20% loss without significant impact on the overall population. However, in the presence of DFTD this loss is unlikely to be sustainable.

It was recommended that a snapshot of the current incidence of roadkill is obtained based on the current levels of vehicle use. This information may be available from DIER and Forestry Tasmania.

It was suggested that overall best practice would be to mitigate the level of roadkill across the landscape within the study area by addressing the issue of traffic movements at night. This approach would require the involvement of Forestry Tasmania and other road users.

This landscape scale approach to mitigating roadkill may result in lowering the incidence of roadkill below current levels. This approach is unlikely to be considered an offset for the action in the EPBC assessment

Other threatened species within the study area that need to be addressed in the impact assessment included the grey goshawk and the wedge-tailed eagle

The induction of contractors with regard to roadkill should be included in the environmental management plans for the construction and operation of the road. Construction /Maintenance of the road could stipulate travel in daylight hours.

The road design should consider the road design speed, visibility and the different classes of use. The road should be designed for low speeds, however, there is limited information on designing low speed roads as existing standards and guidelines focus on performance issues associated with the road, and road safety.

There is some evidence that road pavement colour can influence the incidence of roadkill. Pale road surfaces may reduce road kill because animals are more visible on a lighter surface compared to a dark surface where they tend to blend in particularly at night.

8. Conclusion

The road designers, scientific team and project sponsors were asked for some concluding comments:

- Speed is obviously an issue, as well as the types of use
- There are limited design guidelines for lower speed roads, a real gap
- Impact of colour will be looked at further
- We need to know who will be driving this at night.

Attendees were advised that notes of the forum would be written up and distributed in the next few weeks. Members of the assessment team are likely to contact attendees for clarifications and/or additional information.

Attendees were thanked for coming along and invited to stay for a light lunch.

END NOTES

Appendix G

Roadkill survey area 2009/2010 map

Data sources:
Base image by TASMAP (C) State of Tasmania
Base data from The LIST (C) State of Tasmania
Environmental data from pitt&sherry

Map produced by pitt&sherry Date: 2/05/2012
Map ref: HB09080_H019_RoadkillSurveyArea20092010_12P_RevA

0 1 2 3 4 5 Kilometres

Scale: 1:125,000 Map Projection: GDA 1994 MGA Zone 55

Legend

- Roadkill Survey Area 2009/2010
- Proposed Alignment

DEPARTMENT OF INFRASTRUCTURE, ENERGY & RESOURCES

TARKINE ROAD PROJECT
ROADKILL SURVEY AREA 2009/2010

Appendix H

Roadkill counts

Common Name	Brown Bandicoot	Brushtail Possum	Cat	Echidna	Rabbit	Red-necked Wallaby	Ringtail Possum	Spotted-tail Quoll	Tasmanian Devil	Tasmanian Pademelon	Wombat	Tasmanian Native Hen	Short-tailed Shearwater	Tiger Snake
Headlight Survey	14	205	8	4	44	280	11	11	258	1484	134	0	0	0
Roadkill Survey	1	4	1	0	11	12	1	2	5	141	7	1	1	1

Total observations per survey and species

		Brown Bandicoot	Brushtail Possum	Cat	Echidna	Rabbit	Red-necked Wallaby	Ringtal Possum	Spotted-tailed Quoll	Tasmanian Devil	Tasmanian Pademelon	Wombat
Road Segment	A	0.2	5.1	-	-	2.9	3.8	0.4	0.2	8.0	16.0	2.9
	B	-	1.4	-	0.2	0.7	5.9	-	-	6.1	13.0	5.5
	C	0.4	-	-	-	0.2	10.7	-	-	0.9	3.1	2.9
	D	0.1	1.7	-	-	0.1	9.5	-	-	1.4	5.3	2.0
	E	0.1	0.7	-	-	-	0.4	0.2	0.2	2.6	11.8	0.4
	F	-	-	-	0.4	-	-	-	-	2.0	5.2	0.8
	G	0.5	2.7	-	-	-	0.5	0.2	1.2	3.1	57.8	-
	H	-	1.1	-	0.1	-	-	0.3	0.1	1.3	5.9	-
	I	0.7	7.4	-	-	-	3.7	-	-	1.5	121.5	-
	J	0.2	2.2	-	-	-	1.1	-	-	1.3	5.9	-
	O	-	-	-	-	-	-	-	-	-	0.2	-
	X	0.3	-	0.3	-	-	2.5	0.3	-	1.3	4.7	-
	Y	0.1	6.2	0.5	-	1.4	0.3	-	0.1	4.0	24.6	0.6

Observed headlight activity counts per road segment (expressed as counts per km)

		Brown Bandicoot	Brushtail Possum	Cat	Rabbit	Red-necked Wallaby	Ringtal Possum	Spotted-tailed Quoll	Short-tailed Shearwater	Tasmanian Devil	Tasmanian Native Hen	Tasmanian Pademelon	Tasmanian Tiger Snake	Wombat
Road Segment	A	-	-	-	-	0.2	-	-	-	-	-	0.4	-	-
	B	-	0.1	-	0.1	0.7	-	-	-	-	-	0.7	0.1	0.2
	C	-	-	-	-	0.2	-	-	-	-	-	-	-	-
	D	-	-	-	-	0.1	-	-	-	-	-	-	-	-
	E	-	-	-	-	-	-	-	-	-	-	0.7	-	0.1
	F	-	-	-	-	-	-	-	-	-	-	-	-	0.4
	G	0.2	-	-	-	-	-	-	-	-	-	1.0	-	-
	H	-	-	-	-	-	-	-	-	-	-	0.6	-	-
	I	-	-	-	-	-	-	-	-	-	-	-	-	-
	J	-	-	-	-	-	-	-	-	-	-	0.2	-	-
	O	-	-	-	-	0.3	-	-	-	-	-	-	-	-
	X	-	0.2	0.1	0.7	0.1	0.1	0.1	0.1	0.3	0.1	7.3	-	0.1
	Y	-	-	-	-	-	-	-	-	-	-	0.4	-	0.2

Observed road kill counts per road segment (expressed as counts per km)

		Brown Bandicoot	Brushtail Possum	Cat	Rabbit	Red-necked Wallaby	Ringtal Possum	Spotted-tailed Quoll	Short-tailed Shearwater	Tasmanian Devil	Tasmanian Native Hen	Tasmanian Pademelon	Tasmanian Tiger Snake	Wombat
Road Segment	A	1	23	-	-	13	17	2	1	36	72	13	1	23
	B	-	15	-	2	7	62	-	-	64	136	57	-	15
	C	2	-	-	-	1	59	-	-	5	17	16	2	-
	D	1	17	-	-	1	94	-	-	14	52	20	1	17
	E	1	8	-	-	-	5	2	3	31	143	5	1	8
	F	-	-	-	1	-	-	-	-	5	13	2	-	-
	G	2	11	-	-	-	2	1	5	13	240	-	2	11
	H	-	8	-	1	-	-	2	1	9	124	3	-	8
	I	1	10	-	-	-	5	-	-	6	27	-	1	10
	J	1	10	-	-	-	5	-	-	6	27	-	1	10
	O	1	-	1	-	-	8	1	-	4	15	-	1	-
	X	2	95	7	-	22	4	-	1	61	377	9	2	95
	Y	2	8	-	-	-	19	3	1	8	104	9	2	8

Total observed headlight counts per road segment

		Brown Bandicoot	Brushtail Possum	Cat	Rabbit	Red-necked Wallaby	Ringtal Possum	Spotted-tailed Quoll	Short-tailed Shearwater	Tasmanian Devil	Tasmanian Native Hen	Tasmanian Pademelon	Tasmanian Tiger Snake	Wombat
Road Segment	A	-	-	-	-	1	-	-	-	-	-	2	-	-
	B	-	1	-	1	7	-	-	-	-	-	7	1	2
	C	-	-	-	-	1	-	-	-	-	-	-	-	-
	D	-	-	-	-	1	-	-	-	-	-	-	-	-
	E	-	-	-	-	-	-	-	-	-	-	8	-	1
	F	-	-	-	-	-	-	-	-	-	-	-	-	1
	G	1	-	-	-	-	-	-	-	-	-	4	-	-
	H	-	-	-	-	-	-	-	-	-	-	4	-	-
	I	-	-	-	-	-	-	-	-	-	-	-	-	-
	J	-	-	-	-	-	-	-	-	-	-	1	-	-
	O	-	-	-	-	1	-	-	-	-	-	-	-	-
	X	-	3	1	10	1	1	2	1	5	1	111	-	1
	Y	-	-	-	-	-	-	-	-	-	-	4	-	2

Total observed roadkill counts per road segment

Appendix I

Symbolix technical analysis details

Attachment – technical analysis details

Background

The project is based upon the design for the BACI (Before-After, Control-Impact) design specified in the internal design document "Tarkine Forest Drive – Monitoring design for road kill risk mitigation reduction measures" (DocId: PITBACIR20111219).

Of note is that the treatments are randomly chosen from natural pairs. This is a very rare situation in ecological studies. It enables the distinct benefit of providing some surety that any changes detected are due to the treatments applied and not due to the individual specifics of an individual site.

For this study, we note that the "sites" being monitored are sections of road 3kms long. The reason behind this is that one must monitor sections of road around the applied treatment in order to generate enough data to be meaningful, and to see patterns.

The distance selection was done in the design document. It was specified to be 1500 metres up and down the road from each potential mitigation point. There is no claim that the mitigation will be active, or have an effect, for such a radius. However, if a study radius were selected after the implementation of mitigation measures, then there would be no meaningful confidence values in the findings. In deference to this simple fact, the study radii were selected beforehand (based on a measure of the scale of "clustering" of road kill events).

Such an *a priori* specification means that the effect size measured is intimately linked to the scale of the study radii. However, one must be mindful that selecting too great a radius will reduce the effect size (reducing our power of detection of any real impact) and selecting too small a radius will generate too small a sample size, again reducing our ability to quantify a difference. Ultimately, the radius of the impact need only be considered in the instance where no impact of the mitigation is found.

Finally, as is also outlined in the design document, specifying the location of the treatments and determining their efficacy was based upon the expected total amount of road kill. This is due only to the need to generate enough physical data to determine an impact. Initial studies determined a correlation between the numbers of Tasmanian Devil (the species of interest) and the overall road kill, implying that mitigation shown to be effective in reducing overall road strikes is likely to also reduce those of the Tasmanian Devil.

To accommodate this, the analysis of efficacy is performed using data for all species. However, data for the Tasmanian devil alone is also reported, for completeness.

Data

The data has been collected according to the design document and is of very high quality. One outlier (being a single night in a control site after the treatment) has been excluded for excessive leverage. Its inclusion in the analysis, or otherwise, does not affect the outcome nor conclusions reached (results were checked with and without it).

The number of nights of data collection is shown in Table 1, noting that there are two pairs of sites for each (i.e 63 nights each at sites One, Four and Six makes 189 site-nights of Before-Control).

	Before	After
Control	189	167*
Impact	189	168

Table 1: Site-Nights of data collection

Visualisation of the treatments

We have treated each night as a replicate of measurement of six separate sections of road. Each section is simply the radial distance of 1500 metres from the specified point where the mitigation was applied (or the midpoint for control sites). Within each section, the counts of carcasses are recorded.

In general, the baseline count between sections may differ due to factors such as road curvature (sections that are very circuitous will have more lineal metres of road in them than straight sections). Although the count difference between sections is not consistent, any differences in time (for a given section) are. It is this difference in time^ (before-after) at a given site that we are interested in for this analysis.

	Treated Sites			Control Sites		
	Two	Three	Five	One	Four	Six
Before	30	27	4	24	6	3
After	8	21	0	34	6	0
	↓	↓	↓	↑	○	↓

Table 2 : Raw Counts of detection at each Site

Importantly, all treated sites saw an absolute decline in numbers after the treatment (Table 2). The Control sites witnessed an increase, a steady hold, and a decrease. These are visualised as box-whisker plot in Figure 1 below. Rather than the simple counts of Table 2, Figure 1 also allows some insight into the spread of road-kill detections within the sites.

---

* *Note the excision of one night's data due to leverage*

^ *Technically, the ratio*

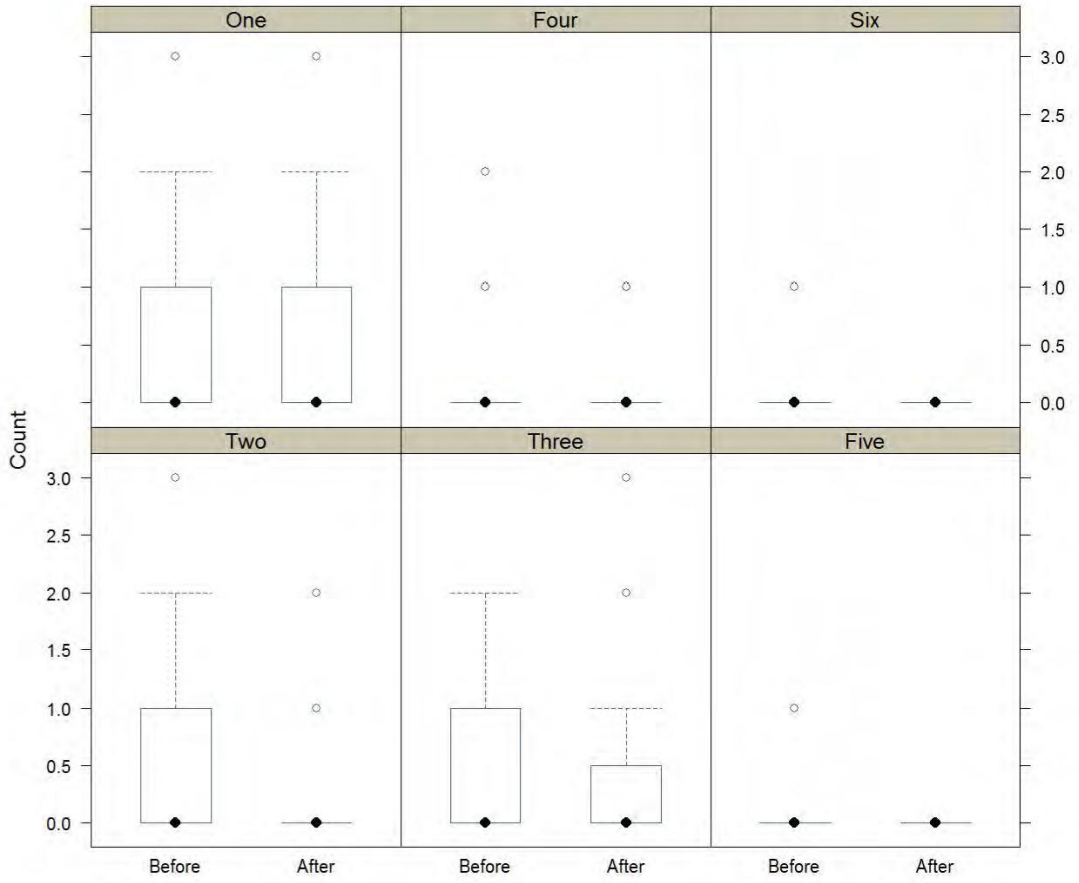


Figure 1: Distribution of nightly road kill counts, before and after mitigation was employed. Sites Two, Three and Five are the treated sites, and One, Four and Six are their paired control sites.

The upper panels hold the randomly allocated Control sites. Treated sites are in the lower panels.

Clearly, there is a reduction in the number of nights recording carcasses. Site Two has a very strong effect, with Site Three having less of an impact. Site Five has a very strong absolute effect (see Table 2), but it is difficult to see on this visual. After treatment, the interquartile range (the range of road kill counts that 50% of the nights record, shown as the 'box' part of the box-whisker plot) has completely collapsed at Site Two, and halved at Site Three.

The three control sites (upper panels) show no significant change across the treatment dates.

Also of note, looking at the upper panels and the lower panels, we can see that there is very little difference between the group of treatment sites and the group of controls before. Sites One, Two and Three were always identified as a higher count sites, which can be seen in the visual clearly. Site Four, Five and Six were identified as lower count regions, and as with the three higher count sites, are indistinguishable before the treatment.

The shortcoming of the visual method is the potential for the "noise" existing between the higher and lower groups to be representative of the reduction we see in the treatments on Sites Two,

Three and Five. This makes it difficult to determine whether the observed reduction in Table 2 and the lower panels of Figure 1 are merely due to chance variation, and not due to the placement of the treatment in these road sections.

We examine this possibility using more complex, quantitative methods below.

Formal Testing

The test we use is that of a two factor ANOVA (Analysis of Variance of the Means). The response variable was the log-transformed road kill count. Table 3 shows the full results from the analysis.

	Variation	Degrees of Freedom	Mean Square	F
Between Treatments (Control/Impact)	0.2399	1	0.2399	2.406
Between Time (Before/After)	0.2476	1	0.2476	2.484
Interaction	0.6092	1	0.6092	6.111
Random	70.68	709	0.0997	
Total	71.77	712		

Table 3: Results of two-factor (Before-After, Control-Impact) ANOVA

In such a system, we have three possible hypotheses we wish to test:

- $H_0^{(1)}$: All treatment averages (Control/Impact sites) are equal (see first row in Table 3)
- $H_0^{(2)}$: All time averages (Before/After treatment date) are equal (second row)
- $H_0^{(3)}$:There are no interactions between treatments and time (third row).

The three possibilities outlined above cover all explanations of possible differences, which is the benefit of this particular technique. The test looks for differences in the nightly groups of data.

The first hypothesis states that (independently) the average count is the same across Control and Impact sites. If we can reject this hypothesis, then any detected change can be attributed to the fact that the sites themselves are different, irrespective of the before/after timeline.

The second hypothesis surmises that there is no difference in the averages of the groups before and after the implementation date. If we can reject this hypothesis, it would suggest that, independent of the implementation of a control or mitigation treatment, the averages moved. Any changes then detected may be attributed to the "Seasonal" difference of "Before" and "After" and not to the implementation of a treatment.

The third hypothesis is the one that we hope to be able to reject if mitigation has been successful. It surmises that there is no change in the average when you combine ("interact") the impact site definition with the before after timeline. If mitigation has been effective, we expect to find a significant difference between how the control and impact sites react from before to after the implementation. If we can reject hypothesis 3, we check that the different behaviour detected is due neither to a simple time effect (Hypothesis 2) or poor choice of test sites (Hypothesis 1).

We test the third hypothesis first.

In this case, the F ratio is 6.11, over 1 and 709 degrees of freedom. We can conclude with 99% confidence that such a ratio is unlikely to arise due to chance alone.

We confidently decide to reject the null hypothesis that the treatments do not interact with time. This simply means that, the convergence of treatment and date creates a much stronger change than would be expected through the individual contributions of simply time and site. The treatments appear to create a strong change that is unlikely to be due to chance.

For completeness, we like to check whether there are potential factors that may lead to a false conclusion. Issues such as differences in sites' responses to seasonality, perhaps. These are checked by testing the first two hypotheses (Table 3).

- We are unable to reject the null hypothesis that Control sites are different to Impact sites ($H_0^{(1)}$). This is the expected outcome, as the sites were chosen randomly from a paired set, i.e. they were chosen to be the same independent of the treatment. If we had chosen sites that were fundamentally different, it would appear in this value.
- We are unable to reject the null hypothesis that "before" is the same as "after" in time ($H_0^{(2)}$). Again, this is as we expected. If a seasonal effect had crept into our study, it would appear in this value.

Conclusions from the ANOVA

Simply put, the ANOVA has excluded from consideration interference from site selection, and season. It concludes, to 99% confidence ($p \sim 0.013$), that the interaction of treatment to placement date is significant. That is, the treatments are effective, and the differences that we can see in the boxplots are real and not readily attributed to chance, or to factors.

The ANOVA does not provide insight into the size of the effect of mitigation. To do that, we employ a generalised linear model.

Final Analysis - GLM

Finally, we can move to the modern test of a Generalised Linear Model. GLMs are more intricate in their interpretation, but succeed in performing both the visual aid of the boxplot, and quantifying a difference in treatment effect in one sitting.

The GLM is computationally similar to the ANOVA, but provides an estimate of the effect size (Table 4). It differs in its parametric assumption, in that the ANOVA assumed a standard count data distribution, whereas we allow for zero-inflation in the GLM.

A hurdle model was applied[1], which allows us to model the response variable in two connected parts: 1) the probability that there will be no road kill detected in a single night and 2) if road kill is detected, the likely number of detections in an observation. Time (Before or After), Treatment (Control or Impact) and the interaction of the two were chosen as predictors for both the zero-count probability and the predicted non-zero count (i.e. the same factors as for the ANOVA).

The parameter values determined by the modelling process suggest that, if road kill is detected, the average count is constant between all groups (an unsurprising result given the design of the monitoring program itself). It also suggests that the likelihood of finding zero road kill increases from Before to After at the Impact sites (but not Control). The full model parameters are provided for the more technical reader in Table 4, with significant predictors indicated in bold.

	Coefficient Estimate	S.E	Z value	P value
Count model coefficients		(truncated Poisson with log link)		
Intercept (cluster size)	-0.5482	0.1556	-3.523	<0.01
Zero-inflation model components		(Binomial with Log link)		
Intercept	-1.822	0.1762	-10.341	<0.01
Before	-0.2007	0.2564	-0.783	>0.4
Impact	-0.2573	0.2697	-0.954	>0.3
Before:Impact	0.8886	0.3513	2.529	~0.01

Table 4: Summary of model Count ~ Time + Treatment + Time*Treatment using a hurdle (zero-inflated) Poisson parametric assumption.

The two relevant, statistically significant values are the count intercept ($p<0.01$) and the interaction term (Before:Impact) ($p\sim0.01$). Again, note that the estimate for Before/After implementation of treatment is not significantly different from zero. The differences between sites selected for treatment and control definitions are also not significantly different from zero.

[1] *See for example Zuur et al. 2009. 'Mixed effects models and extensions in ecology with R.' Springer: United Kingdom.*

With the ANOVA, the counts were log transformed for stability and bias reasons. In this instance, we have retained the log transform for its ease of interpretation.

The coefficient of the interaction term suggests that the probability of zero road strikes increases (on average) by a factor of 2.4 ($=e^{0.886}$) after the treatment is applied.

This equates to a 59% overall average reduction in road strikes in the area due to the treatment being applied.

Species of interest – the Tasmanian devil

There are simply too few instances of Tasmanian devil road strikes during the study to quantify the efficacy of the treatment on the specific species of interest alone. Initial studies on this road did determine that the correlation between the general road kill risk and that of the devil was significant. From this one can surmise that what is effective for overall risk is effective for the Tasmanian devils. Given both the numerical relationship, and the ecological relationship, there is no reason to suspect otherwise.

Despite its inability to be statistically "conclusive," the data that can be presented is as follows:-

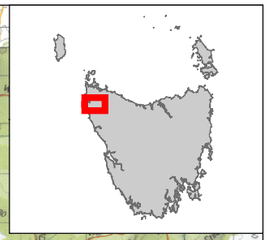
Period	Date	Site	Distance from Centre	Site type
Before	14/01/2010	Two	1320	Impact
	28/01/2010	Four	800	Control
	29/01/2010	Two	50	Impact
	30/01/2010	Two	50	Impact
After	16/03/2012	(Four)	1522	Control
	17/03/2012	Four	1430	Control
	17/03/2012	(Four)	1651	Control

Table 5: Tasmanian devil road strike data included in analysis of all species

We have included all the data in the table above. Note that two of the "post treatment" detections were outside of the study area, and so are excluded in the following table.

	Control	Treatment
Before	1	3
After	1	0

These numbers are consistent with the overall ANOVA and GLM, if we assume that the numerical relationship between Tasmanian devil risk and total road kill is maintained, even vaguely.



SPEED LIMIT 80

SPEED LIMIT 80

SPEED LIMIT 70

SPEED LIMIT 70

SPEED LIMIT 50

SPEED LIMIT 50

Data sources:
Base image by TASMAP (C) State of Tasmania
Base data from The LIST (C) State of Tasmania
Proposed speed limit zones by pitt&sherry

Map produced by pitt&sherry Date: 19/11/2012
Map ref: HB09080_H058_SpeedLimitZones_12P_RevC

pitt&sherry

0 1 2 3 4 5 Kilometres

N

Scale: 1:125,000 Map Projection: GDA 1994 MGA Zone 55

Legend

Proposed Speed Limits — 50 km/h — 70 km/h — 80 km/h

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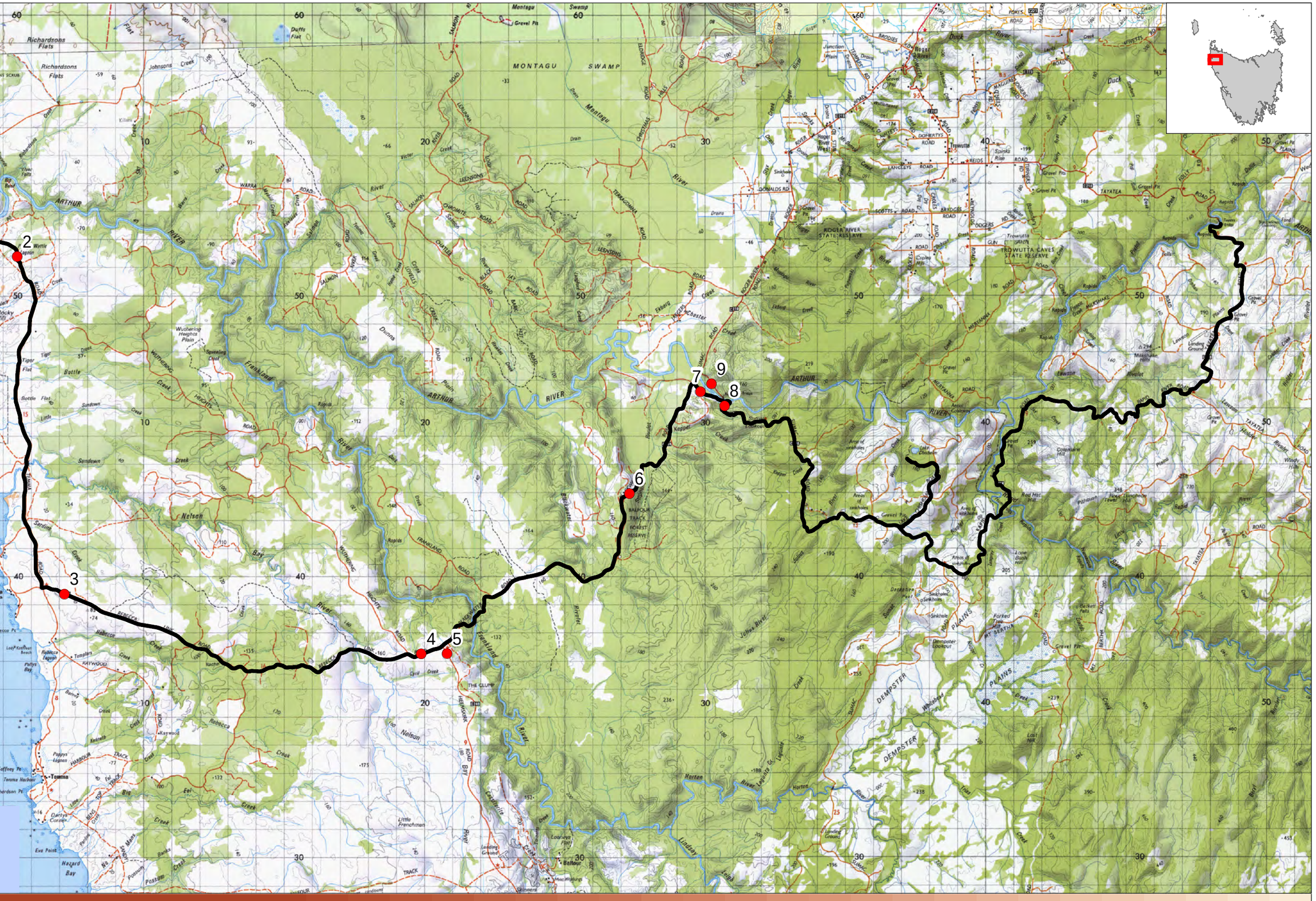
TARKINE FOREST DRIVE
PROPOSED SPEED LIMITS



Data sources:
Base image by TASMAP (C) State of Tasmania
Base data from The LIST (C) State of Tasmania
Environmental data from North Barker & Associates

Map produced by pitt&sherry Date: 2/05/2012
Map ref: HB09080_H012_TrafficCounters_12P_RevD

Scale: 1:125,000 Map Projection: GDA 1994 MGA Zone 55

Legend

- Traffic Counters
- Proposed Alignment

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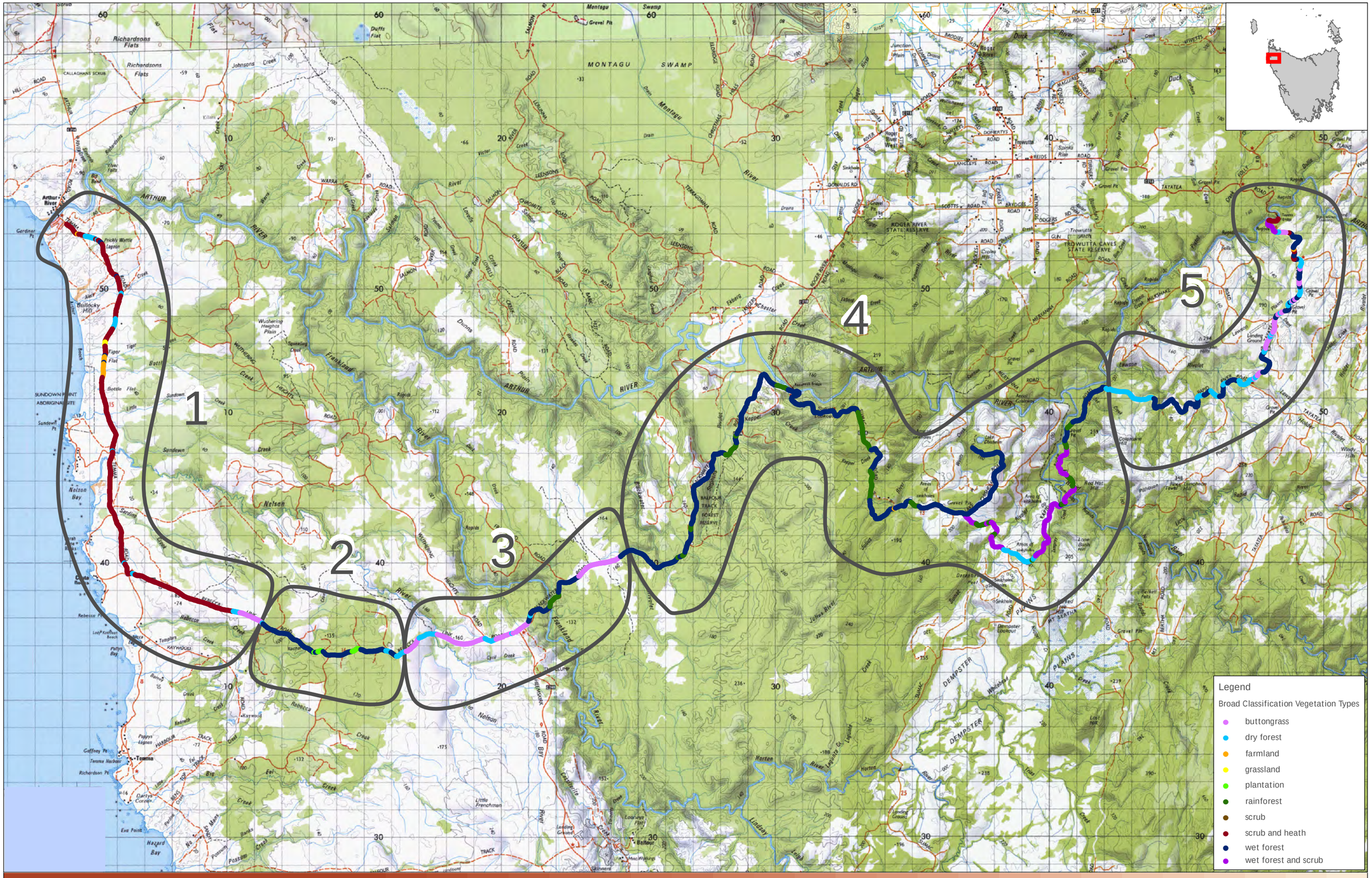
TARKINE ROAD PROJECT
TRAFFIC COUNTERS 2009/2010



Data sources:
Base image by TASMAP (C) State of Tasmania
Base data from The LIST (C) State of Tasmania
Vegetation data from NorthBarker & Associates and TasVeg 2.0

Map produced by pitt&sherry Date: 4/05/2012
Map ref: HB09080_H008_RoadRefVegTypes_12P_RevE

pitt&sherry

0 1 2 3 4 5 Kilometres

Scale: 1:125,000 Map Projection: GDA 1994 MGA Zone 55

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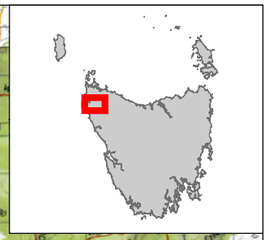
TARKINE ROAD PROJECT
BROAD CLASSIFICATION OF VEGETATION TYPES



Data sources:
Base image by TASMAP (C) State of Tasmania
Base data from The LIST (C) State of Tasmania
Environmental data from North Barker & Associates

Map produced by pitt&sherry Date: 3/05/2012
Map ref: HB09080_H020_DevilScats_12P_RevC

pitt&sherry

0 1 2 3 4 5 Kilometres

Scale: 1:125,000 Map Projection: GDA 1994 MGA Zone 55

Legend

▲ *Sarcophilus harrisii* (Tasmanian Devil) Scat Locations

Proposed Alignment
- Sealed
- Unsealed

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TARKINE ROAD PROJECT
TASMANIAN DEVIL SCAT LOCATIONS

Primary

Tertiary

Secondary

Tertiary

Data sources:
Base image by TASMAP (C) State of Tasmania
Base data from The LIST (C) State of Tasmania
Proposed deterrent sites by pitt&sherry

Map produced by pitt&sherry Date: 6/12/2012
Map ref: HB09080_H017_MitigationStrategy_12P_RevJ

0 1 2 3 4 5 Kilometres

Scale: 1:125,000 Map Projection: GDA 1994 MGA Zone 55

Legend

- Rumble strips
- Additional rumble strips sites
- Other proposed mitigation works
- Light coloured pavement
- Proposed alignment

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TARKINE FOREST DRIVE
MITIGATION STRATEGY MAP

(1) Fill dip to improve visibility of high animal activity area

(3) Remove crest to improve visibility

(5) Regrade (to remove small rise & following dip) to improve visibility

Location Map

(2) Install site bench on left and right hand side of the road in this location to improve vehicle and animal visibility

(4) Bench rise to improve vehicle and animal visibility

Data sources:
Base image by TASMAP (C) State of Tasmania
Base data from The LIST (C) State of Tasmania
Proposed deterrent sites by pitt&sherry

Map produced by pitt&sherry Date: 11/05/2012
Map ref: HB09080_H018_MitigationStrategyInset_12P_RevB

0 250 500 Metres

Scale: 1:15,000 Map Projection: GDA 1994 MGA Zone 55

Legend

- Other Proposed Mitigation Works
- Rumble Strips
- Light Coloured Pavement
- Proposed Alignment

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TARKINE ROAD PROJECT
MITIGATION STRATEGY INSET MAP