

NSW Roads and Maritime Services

WOOLGOOLGA TO BALLINA | PACIFIC HIGHWAY UPGRADE THREATENED FISH MANAGEMENT PLAN

Version 3.0

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Glossary and Abbreviations

Term	Definition
BMF	Biodiversity Mitigation Framework
BOD	Biological Oxygen Demand
CEMP	Construction Environmental Management Plan
CoA	Conditions of Approval
Construction footprint	The direct area of the design alignment (also referred to as the clearance limits)
CSWMP	Construction Soil and Water Management Plan
ESD	Ecologically Sensitive Design
Direct impact	An impact that causes direct harm within the project boundary (i.e. clearing of vegetation)
DoE	Commonwealth Department of the Environment (previously known as Commonwealth Department of Sustainability, Environment, Water, Population and Communities)
DP&E	NSW Department of Planning and Environment (formally known as Department of Planning and Infrastructure)
DPI (Fisheries)	NSW Department of Primary Industries (Fisheries)
EP&A Act	NSW <i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
EIS	Environmental Impact Statement (Biodiversity Assessment Working Paper)
FM Act	NSW <i>Fisheries Management Act 1994</i>
FFMP	Flora and Fauna Management Plan
Indirect impact	An impact that causes harm outside of the project boundary as a result of a direct impact (i.e. edge effects, erosion etc.)
MCoA	NSW Minister's Conditions of Approval
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
OPP	Oxleyan Pygmy Perch
Performance threshold	This is a prescribed outcome that should it be reached, an assessment as to why the objectives are not being met will be undertaken and then appropriate corrective actions implemented.
PSG	Purple Spotted Gudgeon
Trigger for corrective action	This is a measurable target that, should it be reached, will trigger an assessment as to why the mitigation objectives are not being met and the implementation of appropriate corrective action.
The Project	Refers to all the proposed works in all eleven sections which includes the construction footprint with a 10 metre construction buffer, ancillary and compound sites and design changes.
Roads and Maritime	NSW Roads and Maritime Services
SPIR	Submissions / Preferred Infrastructure Report 2013
SWMP	Soil and Water Management Plan
TFMP	Threatened Fish Management Plan (this plan)
Threatened fish	For the purposes of this plan 'threatened fish' refers to Oxleyan Pygmy Perch (<i>Nannoperca oxleyana</i>)
TSC Act	<i>Threatened Species Conservation Act 1995</i>
W2B	Woolgoolga to Ballina Pacific Highway Upgrade
WQMP	Water Quality Management Program

1. Introduction

1.1 Project overview

NSW Roads and Maritime Services (Roads and Maritime) has received approval for the Woolgoolga to Ballina (W2B) Pacific Highway upgrade project (the project / the action), on the NSW North Coast. Approvals were granted under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 24 June 2014 and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 14 August 2014. The location of the project is shown in **Figure 1-1**.

Since 1996, both the Australian and NSW governments have contributed funds to the upgrade of the 664 kilometre section of the Pacific Highway between Hexham and the NSW/Queensland border, as part of the Pacific Highway Upgrade Program. Around 155 kilometres of highway will be upgraded as part of the project, which, on completion, will represent the last priority (known as 'Priority 3' in the upgrade program) in achieving a four-lane divided road between Hexham and the NSW/Queensland border. The project therefore forms a major part of the overall Pacific Highway Upgrade Program. For the purposes of the EIS the project has been divided into 11 sections as illustrated in **Figure 1-1**.

Key features of the upgrade include:

- Duplication of 155 kilometres of the Pacific Highway to a motorway standard (Class M) or arterial road (Class A), with two lanes in each direction and room to add a third lane if required in the future
- Split-level (grade-separated) interchanges at Range Road, Glenugie, Tyndale, Maclean, Yamba / Harwood, Woombah (Iluka Road), Woodburn, Broadwater and Wardell
- Bypasses of South Grafton, Ulmarra, Woodburn, Broadwater and Wardell
- About 40 bridges over rivers, creeks and floodplains, including major bridges crossing the Clarence and Richmond rivers
- Bridges over and under the highway to maintain access to local roads that cross the highway
- Access roads to maintain connections to existing local roads and properties
- Structures designed to encourage animals over and under the upgraded highway where it crosses key animal habitat or wildlife corridors
- Rest areas located at about 50 kilometre intervals at Pine Brush (Tyndale), north of Mororo Road and north of the Richmond River
- A heavy vehicle checking station near Halfway Creek and north of the Richmond River.

Construction and delivery of the project will be undertaken in a number of separate stages. These stages are detailed in the Staging Report prepared to satisfy NSW Government Approval – Minister's Condition of Approval (MCoA) A7.

The project is separated into 11 Sections as outlined below:

- Section 1 – Woolgoolga to Halfway Creek
- Section 2 – Halfway Creek to Glenugie
- Section 3 – Glenugie interchange to the Tyndale interchange
- Section 4 – Tyndale interchange to the existing highway at the Maclean interchange
- Section 5 – Maclean interchange to the Iluka Road interchange at Woombah
- Section 6 – Iluka Road at Woombah to Devil's Pulpit
- Section 7 – Devils Pulpit to Trustums Hill
- Section 8 – Trustums Hill to Broadwater National Park
- Section 9 – Broadwater National Park to the Richmond River
- Section 10 – Richmond River to the interchange at Coolgardie Road
- Section 11 – Coolgardie Road to the tie-in with the Pimlico to Teven project.

The project is jointly funded by the NSW and Australian governments. Both governments have a shared commitment to finish upgrading the highway to a four-lane divided road as soon as possible. Construction timing for Stage 1 is estimated for commencement in April 2015 and completion of the entire project is planned for the end of 2020. The project does not include the Pacific Highway upgrades at Glenugie and Devils Pulpit (as illustrated in **Figure 1-1** Woolgoolga to Ballina project sections). These are separate projects, with both of these additional projects now complete. Altogether, these three projects will total to an upgrade of 164 kilometres of the Pacific Highway. The project does include a partial upgrade of the existing dual carriageways at Halfway Creek.

For a more detailed project description (as approved in late 2014) refer to the Roads and Maritime Services Woolgoolga to Ballina Pacific Highway Upgrade Submissions/Preferred Infrastructure Report (SPIR) dated November 2013 and the Woolgoolga to Ballina Staging Report (2015).

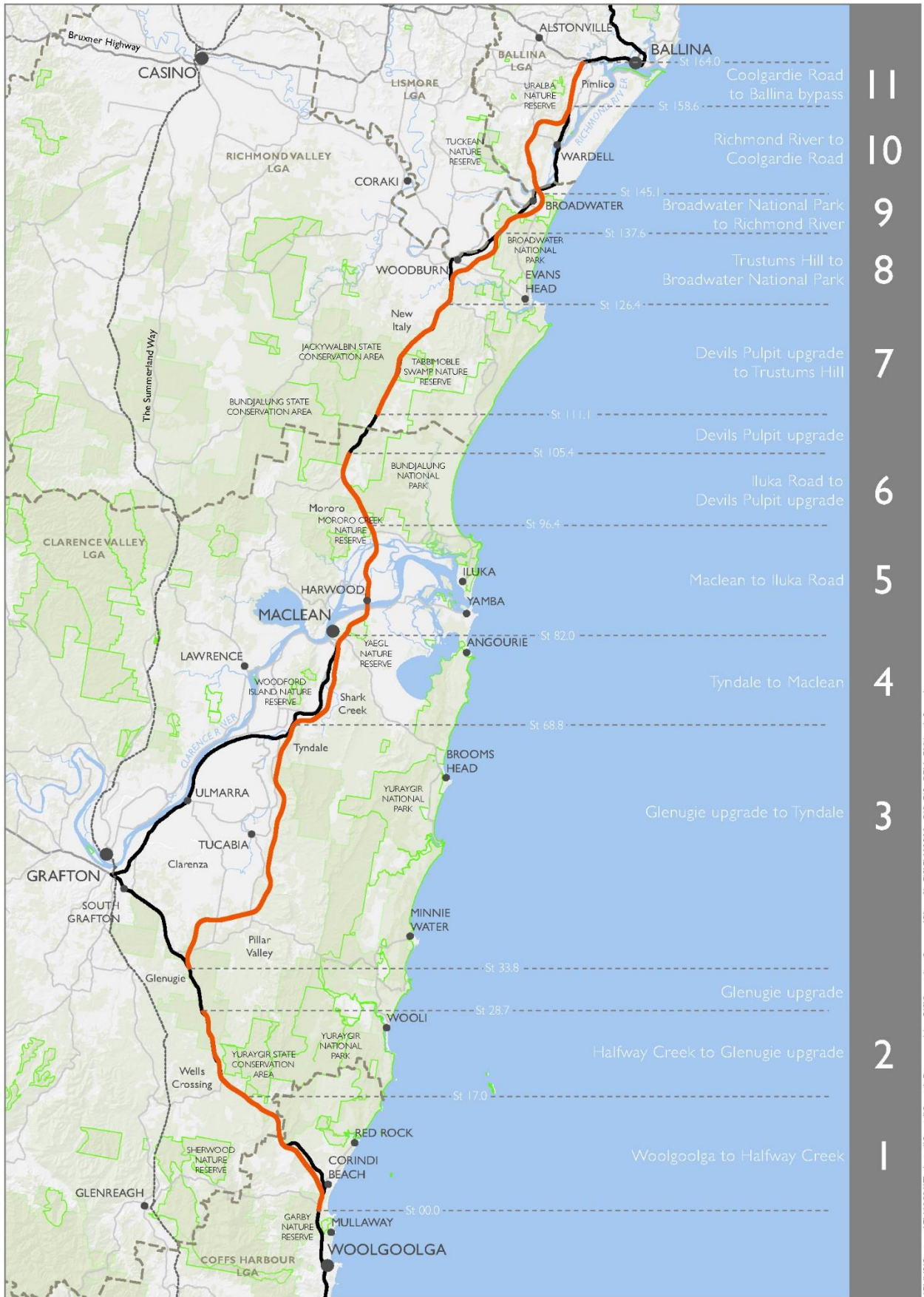


Figure 1-1 Woolgoolga to Ballina project sections

1.2 Purpose of this plan

This Threatened Fish Management Plan (TFMP) has been developed to meet the requirements of the MCoA D8, and Commonwealth EPBC Act Approval CoA 3 and 14. The requirements of each approval and where it is addressed in this report are detailed in **Table 1-1**.

Table 1-1 Project approval requirements and where addressed

Approval requirement	Where addressed
NSW approval	
MCoA definition for Oxleyan Pygmy Perch spawning period"	The spawning period for the Oxleyan Pygmy Perch is October to April. This definition is referenced where relevant throughout the document.
MCoA definition for "High risk activities in known Oxleyan Pygmy Perch habitat"	Includes but is not limited to the following construction activities adjacent to or in known Oxleyan Pygmy Perch habitats: <ul style="list-style-type: none"> • Piling in the waterway and within the bed and banks; • Construction of temporary works platforms within the waterway; • Installation and removal of temporary waterway crossings; • Concreting of bridge abutments, deck and parapets; • Vegetation clearing within 50 metres of Oxleyan Pygmy Perch habitat waterways; • Placing fill (bulk earthworks) on the floodplains within 50 metres of Oxleyan Pygmy Perch habitat waterways; • Lime stabilisation work within 50 metres of Oxleyan Pygmy Perch habitat waterways; or • Underboring of Oxleyan Pygmy Perch habitat waterways. This definition is referenced where relevant throughout the document.
MCoA B7	High risk construction activities in known Oxleyan Pygmy Perch habitat shall not be undertaken during the Oxleyan Pygmy Perch spawning period, or on days when the relevant Bureau of Meteorology site predicts a 90% chance of 10 mm of rain or more, unless otherwise agreed by DPI (Fisheries). The requirements of this condition are addressed in this plan. Addressed in Section 6.3.4.
MCoA B8	Temporary bridge or arch structures in known Oxleyan Pygmy Perch habitat shall be used if the crossing is intended to be in place for more than 3 months. The requirements of this condition are addressed in this plan. Addressed in Section 6.3.3.
MCoA B9	Where temporary crossings in known Oxleyan Pygmy Perch habitat are proposed with culverts or pipes, the Applicant shall, in consultation with DPI (Fisheries): (a) determine the size of the culverts or pipes to facilitate fish passage (b) Identify the minimum size of clean rock to be used to ensure that rock material will not wash into the waterway in periods of high flows. (c) Temporary culvert or pipe crossings shall be removed prior to the start of the Oxleyan Pygmy Perch spawning period. The requirements of this condition are addressed in this plan. Addressed in Section 6.3.3.
MCoA B10	Subject to conditions B11 and B12, the Applicant shall revise the Connectivity Strategy identified in the documents listed in condition A2(e), based on the outcomes of the Mitigation Framework required by condition D1. Workshop was held between Roads and Maritime and DPI Fisheries in February 2015. Meeting minutes provided in Attachment F. The Mitigation Framework has been completed and approved by all relevant agencies.
MCoA B12	Investigations into the location and design of connectivity structures, including but not limited to those identified in the documents listed under conditions A2(c) and A2(e), shall be undertaken during detailed design with the input of a suitably qualified and experienced ecologist. The investigations shall be undertaken in consultation with the EPA, DPI (Fisheries) and DoE and include workshops and on-site ground verification. The results of these investigations shall be detailed in the Connectivity Strategy required under condition D2. This condition has partially been addressed in this plan. Addressed in Section 6.3.3.
MCoA B13	The Applicant shall minimise riparian vegetation clearing during construction and undertake a targeted rehabilitation program post construction to restore in-stream and riparian habitat to at least the pre-construction condition or better, unless otherwise agreed by DPI (Fisheries). All areas disturbed by the SSI that are in the vicinity of known Oxleyan Pygmy Perch habitat waterways shall be stabilised prior to the The requirements of this condition are partially addressed in this plan. A detailed Habitat Restoration Plan will be produced separately.

Approval requirement		Where addressed
	Oxleyan Pygmy Perch spawning period.	Addressed in Section 6.3.10.
MCoA B38	Watercourse crossings shall be designed and constructed in consultation with the DPI (Fisheries), EPA, DoE, and where feasible and reasonable, be consistent with the Guidelines for Controlled Activities Watercourse Crossings (Department of Water and Energy, February 2008), Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge, 2003), Policy and Guidelines for Fish Friendly Waterway Crossings (NSW Fisheries, February 2004), and Policy and Guidelines for Fish Habitat Conservation and Management (DPI Fisheries, 2013). Where multiple cell culverts are proposed for crossings of fish habitat streams, at least one cell shall be provided for fish passage, with an invert or bed level that mimics watercourse flows.	The requirements of this condition are addressed in this plan. Addressed in Section 5.3. Addressed in Section 6.3.
MCoA B40	Unless otherwise agreed by DPI (Fisheries), all crossings of Class 1 watercourses in known Oxleyan Pygmy Perch habitat shall be designed and constructed with a bridge or arch structure and, where feasible and reasonable, no supporting structures shall be installed within affected waterways.	The requirements of this condition are addressed in this plan. Addressed in Section 6.3.3.
MCoA B41	Where an Oxleyan Pygmy Perch habitat waterway is realigned or its stream profile is changed, or an in-stream structure is installed in the waterway (both permanent and temporary construction structures), the Applicant shall ensure that the final design of that waterway does not result in water velocities exceeding 0.4 metres per second under normal flow conditions. The Applicant shall determine normal flow conditions to the satisfaction of DPI (Fisheries) through baseline monitoring of known Oxleyan Pygmy Perch habitat waterways.	The requirements of this condition are addressed in this plan. Addressed in Section 6.3.5.
MCoA B42	The Applicant shall ensure that the SSI does not increase the afflux of waterways with known Oxleyan Pygmy Perch habitat by more than the relevant flood management objective in the documents referred to in condition A2 for flood events up to the 1 in 100 year event.	The requirements of this condition are addressed in this plan. Addressed in Section 6.3.5.
MCoA B73	The sites for ancillary facilities that are associated with the construction of the SSI and that have not been identified and assessed in the documents listed in condition A2 shall: (a) be located more than 50 metres from a waterway (100 metres from a State Environmental Planning Policy No. 14 wetland or known Oxleyan Pygmy Perch habitat waterway) (f) be located more than 50 metres from threatened species and endangered ecological communities and their habitats.	The requirements of this condition are addressed in this plan. Addressed in Section 6.3.
MCoA D8	The Applicant shall prepare and implement Threatened Species Management Plans to detail how impacts of the project (referred to as SSI) will be minimised and managed specifically for each species identified as significantly impacted in the documents listed in condition A2 or in accordance with condition D1. The Plans shall be developed from the draft Threatened Species Management Plans included in the documents listed in condition A2(c) (subject to condition D9), in consultation with OEH, DPI (Fisheries) and DoE, and to the satisfaction of the Secretary, and shall include but not necessarily be limited to: (a) demonstration that adequate surveys have been undertaken to assess the impacts of the SSI with reference to the Mitigation Framework developed under condition D1, including baseline data collected from surveys, undertaken by a suitably qualified and experienced ecologist on threatened species and ecological communities within all habitat areas to be cleared of vegetation for the SSI, that are likely to contain these species and that are likely to be adversely impacted by the SSI (as determined by a suitably qualified expert). The data shall address the densities, distribution, habitat use and movement patterns of these species (b) identification of potential impacts on each species (c) details of and demonstrated effectiveness of the proposed avoidance and mitigation and management measures to be implemented for each threatened species including measures to at least maintain habitat values of habitat areas compared to baseline data and maintain connectivity for the relevant species (d) an adaptive monitoring program to assess the use of the mitigation measures identified in conditions B10 and D2. The monitoring program shall nominate appropriate and justified monitoring periods, performance parameters and criteria against which effectiveness of the mitigation measures will be measured and include	The requirements of this condition are addressed in this plan. (a) is addressed in Section 1.4 and Section 2. (b) is addressed in Sections 4.1, 5.1 and 6.1. (c) is addressed in Sections 4, 5 and 6. (d) is addressed in Section 8. (e) is addressed in Section 7.3.1 and Section 8. (f) is addressed in Section 4.5 and Section 8. (g) not applicable to fish (h) Section 8 (i) Section 7.4 (j) Section 1.3 and Section 8.6. (k) is addressed in Section 8. (l) is addressed in Section 8.6. Expert and agency recommendations regarding the

Approval requirement		Where addressed
	<p>operational road kill and fauna crossing surveys to assess the use of fauna crossings and exclusion fencing implemented as part of the SSI</p> <p>(e) monitoring methodology for threatened flora and fauna adjacent to the SSI footprint</p> <p>(f) goals and performance indicators to measure the success of mitigation measures, which shall be specific, measurable, achievable, realistic and timely (SMART), and be compared against baseline data</p> <p>(g) methodology for the ongoing monitoring of road kill, the species densities, distribution, habitat use and movement patterns, and the use of fauna crossings during construction and operation of the SSI, including the proposed timing, and duration of that monitoring</p> <p>(h) provision for the assessment of monitoring data to identify changes to habitat usage and whether this can be attributed to the SSI</p> <p>(i) details of contingency measures that would be implemented in the event of changes to habitat usage patterns, entities, distribution, and movement patterns attributable to the construction or operation of the SSI, based on adequate baseline data</p> <p>(j) mechanisms for the monitoring, review and amendment of these plans</p> <p>(k) provision for ongoing monitoring during operation of the SSI (for operation/ongoing impacts) until such time as the use and effectiveness of mitigation measures can be demonstrated to have been achieved over a minimum of three successive monitoring periods, unless otherwise agreed by the Secretary in consultation with the OEH, DPI (Fisheries) and DoE</p> <p>(l) provision for annual reporting of monitoring results to the Secretary and the OEH, DPI (Fisheries) and DoE, or as otherwise agreed by those agencies.</p>	<p>TFMP are summarised and details as to how they have been addressed in this plan are provided in Appendix C and D.</p> <p>Targeted survey reports are provided in Appendix E.</p>
MCoA D12	<p>The Applicant shall prepare and implement a Water Quality Monitoring Program, to monitor the construction and operation impacts of the SSI on surface and groundwater quality and resources and wetlands, prior to construction. The program shall be prepared in consultation with the OEH, EPA, DPI (Fisheries), NOW, DoE and Rous Water (in relation to Woodburn borefields), to the satisfaction of the Secretary, and shall include:</p> <p>(c) identification of works and activities during construction and operation of the SSI, including emergencies and spill events, that have the potential to impact on surface water quality of potentially affected waterways and known Oxleyan Pygmy Perch habitat.</p>	<p>The requirements of this condition pertaining to Oxleyan Pygmy Perch are addressed in this plan. References where appropriate are also made to the Water Quality Monitoring Program.</p> <p>Water quality monitoring is addressed in Section 8.3.</p>
MCoA D26	<p>As part of the Construction Environmental Management Plan for the SSI, the Applicant shall prepare and implement:</p> <p>(c) Construction Soil and Water Quality Management Plan to manage surface and groundwater impacts during construction of the SSI. The Plan shall be developed in consultation with the EPA, DPI (Fisheries), NOW, Rous Water (in relation to the Woodburn borefield), DoE and the relevant council and include, but not necessarily be limited to:</p> <p>vii) an Oxleyan Pygmy Perch habitat waterway management framework to detail the measures and construction methods that will be employed to avoid direct discharge of construction water to known Oxleyan Pygmy Perch habitat waterways and downstream impacts to suitable habitat;</p>	<p>The requirements of this condition are partially addressed in this plan, but is addressed in more detail in the Project Construction Environmental Management Plan. Addressed in Section 6.3.</p>
Commonwealth approval		
Condition 3	<p>In order to minimise impacts to the Oxleyan Pygmy Perch the approval holder must undertake the actions in accordance with the Minister's conditions B7, B8, B9, B13, B40, B41 and B42.</p>	As detailed above.
Condition 14	<p>In order to minimise impacts to threatened species the approval holder must prepare Threatened Species Management Plans required by NSW approval conditions 8 and 9.</p>	This report forms the Threatened Fish Management Plan.
SPiR Environmental Management Measure		
B11	<p>The threatened species management plans prepared for the project will be finalised, as relevant to the element of the project to be constructed. Development of the plans will include responding, where feasible and reasonable to:</p>	<p>This report forms the Threatened Fish Management Plan.</p> <p>Expert recommendations, conditions</p>

Approval requirement		Where addressed
	<ul style="list-style-type: none"> Recommendations from expert review undertaken as part of the Submissions / Preferred Infrastructure Report (and detailed in section 1.4 of the management plans) Any conditions of approval Results from baseline monitoring undertaken. <p>The threatened species management plans will be finalised in consultation with the relevant State and Federal government agencies</p>	of approval and baseline surveys have been considered and addressed in this plan.
B19	Instream structures such as bridges and culverts will be designed and managed to minimise any potential impact to flow regimes and fish passage, in accordance with Fairfull and Witheridge (2003).	The requirements of this condition are addressed in this plan. Addressed in Section 6.3.
B23	The pre-clearing process will be consistent with Roads and Maritime Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA projects (RTA, 2011) and include pre-clearing surveys to map the location of any threatened flora and/or fauna species, Threatened Ecological Communities and habitat.	Targeted threatened fish surveys have been completed. The surveys and findings are summarised in this plan in Section 2. Pre-construction measures are described in Section 5.
B20	<p>During detailed design, the waterway class will be confirmed and the design will be reviewed to include appropriate crossing structures for the relevant waterway class at the following locations:</p> <ul style="list-style-type: none"> Unnamed waterway station 114.0 Oaky Creek station 122.5 Nortons Gully station 123.6 Unnamed waterway station 133.4 Unnamed waterway at station 134.7 Tributary of Macdonalds Creek at station 135.5 Montis Gully tributary at station 141.8 Eversons Creek station 143.6. 	Workshop was held between Roads and Maritime and DPI Fisheries in February 2015. Meeting minutes provided in Attachment F.
B21	All drainage structures between stations 134.5 to 143.0 will be reviewed in consultation with Department of Primary Industries (Fisheries) to ensure suitable connectivity for threatened fish species is maintained.	Workshop held between Roads and Maritime and DPI Fisheries in February 2015. Drainage structures were discussed and meeting minutes provided in Attachment F.
B22	<p>Each permanent waterway crossing is to be designed to ensure no physical, hydraulic and behavioural barriers to aquatic fauna movements. Impacts would be minimised by ensuring that:</p> <ul style="list-style-type: none"> The natural stream flow and velocity are maintained as closely as possible Surface level of any causeway is the same or lower than the natural stream bed to reduce interference with flow Habitat within a culvert is as natural as possible (e.g. allow rock and bed materials to infill the culvert base) There is the maximum light penetration Fauna and fish passage standards are maintained, as detailed in the Connectivity Strategy, including minimum design widths, including for natural banks, while also providing for scour protection and cut and fill batters Bridges will be designed and sized to ensure peak flood velocities are not increased by more than one metre per second than the existing flood event, where Oxleyan Pygmy Perch have been confirmed. 	The requirements of this condition are addressed in this plan. Addressed in Section 5.3. Addressed in Section 6.3. Addressed in Section 7.3.
B23	<p>Bridge structures will be designed to minimise impacts to flow regimes and fish passage. Where feasible and reasonable the following principles will apply:</p> <ul style="list-style-type: none"> Bridges are to be single span bridges with piers to be located outside the main channel Bridge structures to be designed to prevent an increase of backup of water during times of flood, will enable Plague Minnow to access waterbodies where they are currently not found (e.g. Broadwater National Park) Construction would not alter or reduce flow where there are existing or potential Oxleyan Pygmy Perch populations (primarily within Sections 7, 8 and 9). 	The requirements of this condition are addressed in this plan. Addressed in Section 5.3. Addressed in Section 6.3. Addressed in Section 7.3.

Approval requirement		Where addressed
B25	Where possible, existing crossings will be used. Where this is not feasible or reasonable, the temporary crossings will be designed to minimise impacts on the existing aquatic ecology and water quality.	The requirements of this condition are addressed in this plan. Addressed in Section 5.3. Addressed in Section 6.3.
B27	Temporary waterway access track mitigation measures include: <ul style="list-style-type: none"> • Installation and subsequent decommissioning of temporary crossings will be undertaken outside of Oxleyan Pygmy Perch spawning seasons (October to December), where Oxleyan Pygmy Perch have been confirmed • Temporary crossings will be constructed from clean fill using pipe or box culvert cells to carry flows • All temporary works (e.g. crossings, flow diversion barriers) will be removed as soon as practicable and in a way that does not promote future channel erosion • The preferred temporary structure for crossing waterways will be consistent with Witheridge (2002) where the use of bridges is the preferred structure for Class 1 (major fish habitat waterways) • Scour protection works will be established at temporary crossings as required • At the completion of construction, the temporary crossings will be removed and rehabilitated. 	The requirements of this condition are addressed in this plan. Addressed in Section 5.3. Addressed in Section 6.3.
B28	Fish that become stranded due to temporary access crossings or construction of temporary or permanent creek diversions must be captured and translocated following the Department of Primary Industries Fisheries Guidelines – A Guide to Acceptable Procedures and Practices for Aquaculture and Fisheries Research.	Translocation Strategy to be developed as detailed in Section 6.3.8.
B41	All construction sediment and erosion control measures will be put in place during the construction process and may include sediment and erosion control curtains in the waterways to control turbidity generated during the construction and restoration process.	The requirements of this condition are partially addressed in this plan in Section 4.2 and 6.4. A CEMP will be created to address this in more detail.
B42	No turbid water generated from the construction corridor or construction area is to be discharged to any waterway unless in accordance with relevant Environment Protection Licence conditions and developed in consultation with Environment Protection Agency and Department of Primary Industries (Fisheries).	The requirements of this condition are partially addressed in this plan in Section 6.3.8. A CEMP will be created to address this in more detail.
B43	No in stream work will occur in known Oxleyan Pygmy Perch habitat during the Oxleyan Pygmy Perch spawning season (October to December inclusive) or within 24 hours of the commencement of any rainfall event (>10 millimetres).	The requirements of this condition are addressed in this plan. Spawning Season is defined in this plan as October to April. Addressed in Section 6.3.
B45	Instream and riparian disturbance will be minimised and sediment, woody snags or debris removed from a stream or stream channel will be minimised. Trimming or 'lopping' of branches and logs will be considered as a first option before moving.	The requirements of this condition are addressed in this plan. Addressed in Section 6.3. Addressed in Section 7.3.
B46	Any instream woody debris removed during construction will be replaced at the completion of the works within the same waterways from which it was removed, where feasible and reasonable.	The requirements of this condition are addressed in this plan. Addressed in Section 6.3. Addressed in Section 7.3.
B49	Where feasible and reasonable within the road corridor, existing pools will be retained upstream and downstream of crossings within known habitat of the Oxleyan Pygmy Perch to provide resting and refuge habitat near crossing structures.	The requirements of this condition are addressed in this plan. Addressed in Section 6.3.
B50	Appropriate plant species will be incorporated into the rehabilitation of disturbed aquatic habitats and drains as a result of construction.	The requirements of this condition are addressed in this plan. Addressed in Section 6.3. Addressed in Section 7.3.
B56	Discharges from sediment basins and/or treatment wetlands located in Oxleyan Pygmy Perch habitat that do not meet the water quality parameters for Oxleyan Pygmy Perch (to be determined through pre-construction water quality monitoring) will not be discharged directly into waterways, with other methods or uses employed to	The requirements of this condition are addressed in this plan. Addressed in Section 6.3.

Approval requirement		Where addressed
	<p>discharge. This could include, but not be limited to:</p> <ul style="list-style-type: none"> Spraying onto but rather sprayed into adjacent open grass areas or used for construction purposes such as dust suppression to avoid changing water depth and physio-chemical conditions in potential threatened fish habitat Treating the water to ensure the pH is between 5.0 and 6.5 and total suspended solids of less than 50 mg/L, before discharging, depending on environment protection licensing requirements. 	Addressed in Section 7.3.
B58	Water quality monitoring will be undertaken to assess the effectiveness of (and where necessary amend) water, sediment and erosion management strategies that aim to protect native fish species the Oxleyan Pygmy Perch and Purple-spotted Gudgeon, their habitat and other aquatic flora and fauna species. Water quality monitoring program would be undertaken in line with details in Appendix B of the Working paper – Biodiversity.	<p>The requirements of this condition are addressed in this plan.</p> <p>Addressed in Section 6.3.</p> <p>Addressed in Section 7.3.</p> <p>Addressed in Section 8.</p>
B60	Specific management measures will be implemented to limit impacts from stockpiling of material for bridgeworks at known and potential areas of Oxleyan Pygmy Perch during the spawning breeding seasons of October to December.	<p>The requirements of this condition are addressed in this plan.</p> <p>Addressed in Section 6.3.</p>
B61	Batch plants will be located at least 300 metres away from Oxleyan Pygmy Perch habitat where sediment erosion would not runoff into waterways (due to the risk of high alkaline runoff).	<p>The requirements of this condition are addressed in this plan.</p> <p>Addressed in Section 6.3.</p>
HF5	Scour protection and erosion protection measures at temporary and permanent waterway crossings will be provided upstream and downstream of the highway, particularly within 50 metres of Class 1 waterways or within the range of the Oxleyan Pygmy Perch as identified in Section 3.9.6 of the Working paper – Biodiversity and the supplementary biodiversity report in Appendix J of the PIR. This will be undertaken in consultation with the Department of Primary Industries (Fisheries).	<p>The requirements of this condition are addressed in this plan.</p> <p>Addressed in Section 6.3.</p>
HF6	Waterway diversions will be designed in consultation with Office of Environment and Heritage, NSW Office of Water and Department of Primary Industries (Fisheries) in a manner so that the final diversion mimics to the greatest extent possible, where feasible and reasonable, the characteristics of the waterway that is being diverted. Characteristics include flow regime, flow velocity, base material, vegetation and habitat for aquatic fauna.	<p>The requirements of this condition are addressed in this plan.</p> <p>Addressed in Section 5.3.</p> <p>Addressed in Section 6.3.</p>
HF8	Velocities of flood flows through watercourse and floodplain structures (i.e. bridges and culverts) will need to be assessed during detailed design in areas identified as known and potential habitat for the Oxleyan Pygmy Perch and the Purple-spotted Gudgeon in consultation with Department of Primary Industries (Fisheries). The design of these structures will need to consider the predicted changes to watercourse and floodplain velocities from the existing case due to the project.	<p>The requirements of this condition are addressed in this plan. Purple-spotted Gudgeon is not addressed in this plan as supported by DPI Fisheries.</p> <p>Addressed in Section 6.3.</p> <p>Addressed in Section 7.3.</p>
SSW57	<p>Discharges from the sediment basins during construction that do not meet the water quality parameters for Oxleyan Pygmy Perch habitat should not be discharged into the waterways that are known habitat for Oxleyan Pygmy Perch. Strategies will be implemented during construction to manage discharge of basin water, so that water depth and physico-chemical conditions are not changed in areas of Oxleyan Pygmy Perch habitat.</p> <p>Discharge protocols and criteria will be developed in consultation with Department of Primary Industries (Fisheries) and Office of Environment and Heritage during detailed design.</p>	<p>The requirements of this condition are addressed in this plan.</p> <p>Addressed in Section 6.3.</p>

The TFMP identifies the potential impacts of the upgrade on threatened fish species listed under the EPBC Act, *NSW Threatened Species Conservation Act 1995* (TSC Act) and *NSW Fisheries Management Act 1994* (FM Act) which were considered to be directly impacted or at greater risk of impact from the project.

This TFMP identifies proposed mitigation measures that will be applied to populations of threatened fish and a program for monitoring the effectiveness of these mitigation measures to ensure long-term viability of these species within the area associated with the project. The plan focusses on one threatened fish species identified in the EIS as at greatest risk from the project, being Oxleyan Pygmy Perch (*Nannoperca oxleyana*). The Oxleyan Pygmy Perch is listed as endangered under the FM Act, TSC Act and EPBC Act and has been confirmed within Sections 6, 7, 8 and 9 of the project. As such, this version of the plan pertains to these sections only.

The Purple Spotted Gudgeon (*Mogurnda adspersa*) is listed as endangered under the FM Act and has been the subject of targeted surveys. Potential habitat for the species was identified in Sections 1 - 3 and 6 - 10 of the project. However, as this species was not detected during targeted surveys in these sections it has been recommended by the expert reviewer (Matthew Birch) and agreed with Roads and Maritime and NSW Department of Primary Industries (Fisheries) (DPI Fisheries) that the species does not need to be included in this version of the TFMP. Baseline information on the Purple Spotted Gudgeon has been retained and if the species is detected in subsequent aquatic surveys, the TFMP will be updated accordingly. It should also be noted the mitigation measures proposed for the Oxleyan Pygmy Perch will cater for and benefit the Purple Spotted Gudgeon should any be detected in future aquatic surveys.

This plan is intended to provide:

- An effective threatened fish management plan which addresses the concerns of main stakeholders, including expert and agency review
- An overarching management framework for the Oxleyan Pygmy Perch for the project
- A summary of the locations where threatened fish populations were detected during pre-construction targeted surveys along with the proposed monitoring sites identified for pre-construction baseline monitoring, construction and post construction monitoring
- Management and mitigation measures to be implemented during pre-construction, construction and operation of the project to minimise impacts on threatened fish populations
- A monitoring program to be implemented during pre-construction, construction and operation of the project to assess the effectiveness of the mitigation measures proposed, evaluate any changes in fish populations and inform an adaptive management approach.

1.3 Management structure and plan updates

1.3.1 Management structure

This plan is intended to provide an overarching threatened fish management framework for the project focusing on Sections 6, 7, 8 and 9. This plan provides up-to-date information based on the results of targeted surveys which have identified the occurrence of Oxleyan Pygmy Perch within the project area, habitats that are likely to be impacted, or at a greater risk of impact. This plan identifies known populations of Oxleyan Pygmy Perch, the likely impacts to the species and habitats as a result of project activities, and specifies mitigation measures that are to be put in place.

This plan also provides for monitoring and reporting programs, by describing the final monitoring sites, methods, variables and timing of this program (detailed in **Section 8**). Details have also been provided for the parameters of site selection for the final monitoring sites (impact and control/reference sites) which have been identified through targeted surveys undertaken for the project.

This plan operates in conjunction with the Construction Environmental Management Plan (CEMP), project specific flora and fauna management plan (FFMP), Water Quality management Program (WQMP), Construction Soil and Water Management Plan (CSWMP), and aspects associated with updates and delivery incorporated into the Biodiversity Mitigation Framework. An overview of how this TFMP relates to other project documentation is provided in **Figure 1-2**.

General responsibilities for environmental management will be outlined in the CEMP and FFMP. Following approval of the plan, the construction contractor(s) and the contractors ecologists engaged for the relevant project sections would be responsible to oversee implementation of the plan.

Roads and Maritime have finalised this plan in consultation with the NSW Department of Planning and Environment (DP&E), NSW Environment Protection Authority (EPA), DPI Fisheries and Commonwealth Department of the Environment (DoE).

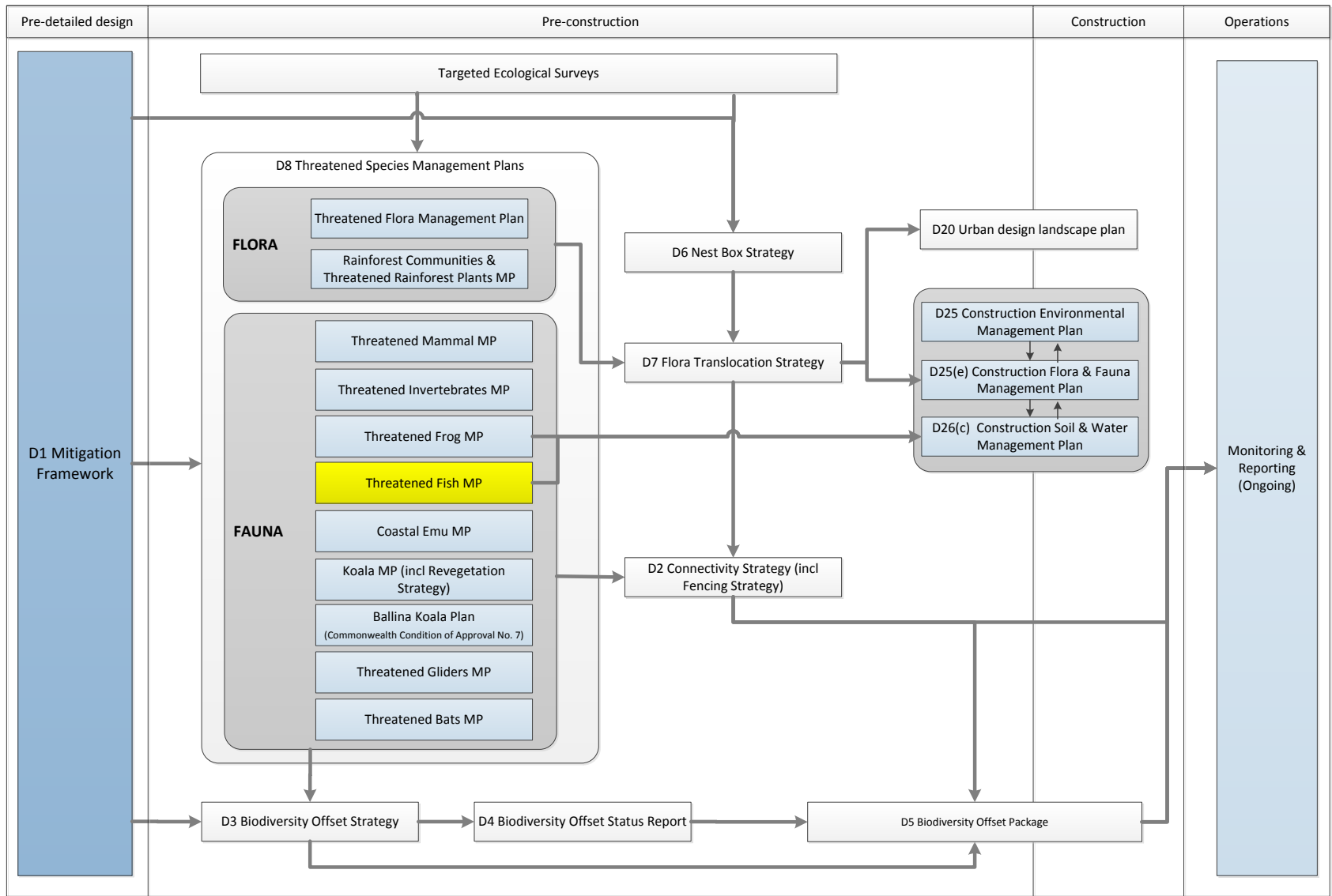


Figure 1-2 Project documentation overview

1.3.2 Plan updates

This plan is intended to be a dynamic document subject to continual improvement. This TFMP has been updated to ensure it incorporates the results of targeted threatened fish surveys, meets the mitigation and management measures committed to in the Environmental Impact Statement (EIS) and SPIR, and complies with MCoA D8.

Roads and Maritime have updated this plan in two versions. The first update (Version 1 of the TFMP) incorporated the majority of independent expert review and comments. This was completed in November 2013 and included with the submission of the SPIR documentation. The expert's CV is provided in **Appendix A** and comments are summarised in **Appendix B**.

The second update (Version 2 of the TFMP) was undertaken to address the approval conditions received, remaining subject matter expert comments, and to incorporate results of targeted threatened fish surveys completed to date and pre-construction baseline surveys. Connectivity structures for fish for Sections 6, 7, 8 and 9 have also been discussed and agreed upon with DPI (Fisheries) which are now reflected in this plan. A summary as to how the independent expert and agency comments have been addressed is detailed in **Appendix C**.

This updated TFMP (Version 3) has included revisions required as a result of agency feedback received on Version 2. These comments and how they have been addressed are outlined in **Appendix D**. The agencies that have reviewed the plan include EPA, DP&E, DPI (Fisheries) and DoE, and their final approval of the TFMP will occur prior to construction commencing for sections 6, 7, 8 and 9. Triggers for further review and update of this plan may be required where unknown populations of threatened fish are observed during the course of construction or operational activities, or during future surveys in waterways where the fish were not observed during the targeted surveys. In such instances, an assessment of the Plan will be undertaken and additional measures will be implemented as required.

A summary of the process for updating the plan is illustrated in **Figure 1-3**.

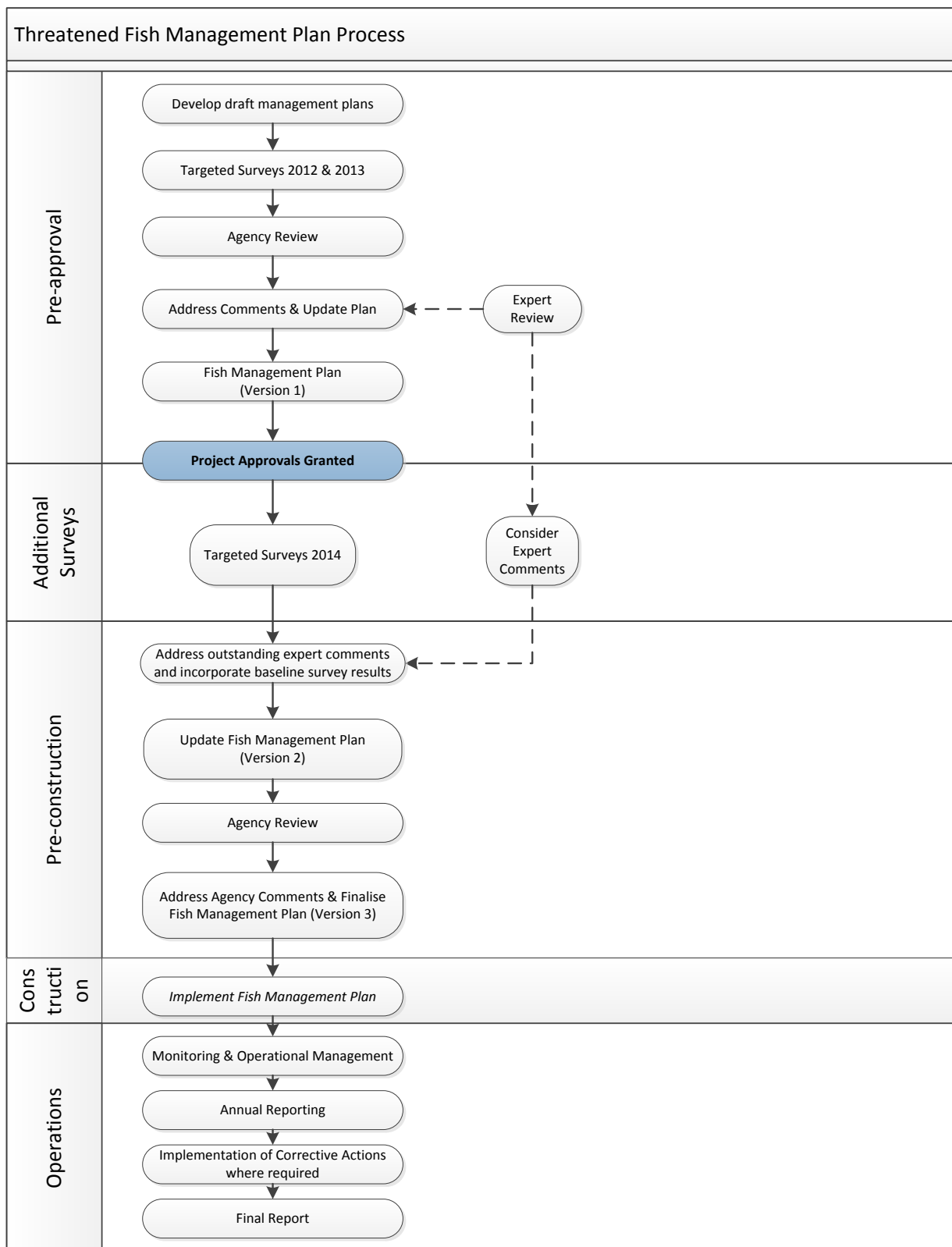


Figure 1-3 Process for development and updating of this TFMP

1.4 Plan authors and expert review

1.4.1 Authors

Version 1

The first version of the TFMP was by Andrew Sharpe, Sarah Douglas, Chris Thomson and Kate Byrnes of Jacobs (previously known as Sinclair Knight Merz (SKM)) and addressed expert reviewer comments from Matthew Birch (as outlined in **Appendix A** and **Appendix B**). A summary of personnel involved including their experience and qualifications are summarised in **Table 1-2**.

Version 2

Supplementary targeted fish surveys and pre-construction baseline studies have been undertaken by GeoLINK Environmental Management and Design (GeoLINK 2014) for the Oxleyan Pygmy Perch and Purple Spotted Gudgeon. Simon Williams was the aquatic ecologist to lead these surveys and his experience and qualifications are summarised in **Table 1-2**. Revisions of this TFMP (Version 2) to incorporate the results of targeted surveys and address expert and agency comments have been prepared by Dr Mark Davey of Amec Foster Wheeler and Dr Timothy Howell of Amec Foster Wheeler / Freshwater Ecology with input from GeoLINK Environmental Management and Design as required. This included GeoLINK Environmental Management and Design preparing a translocation strategy for Oxleyan Pygmy Perch. GeoLINK Environmental Management and Design has also been engaged to provide pre-construction baseline monitoring for Oxleyan Pygmy Perch for Sections 6, 7, 8 and 9.

Version 3 has included revisions to the plan based on agency feedback by Amec Foster Wheeler.

An overview of the experience and qualifications of the authors of the revisions to this TFMP are provided in **Table 1-2**.

Table 1-2 Authors qualifications and experience

Personnel	Qualifications	Experience
Dr Andrew Sharpe, Senior Ecologist Jacobs	PhD, BSc (Hons)	Andrew is an aquatic ecologist with a strong background in experimental design and in developing environmental monitoring programs. He has conducted fish surveys and water quality monitoring through SE Australian estuaries.
Sarah Douglass, Senior Aquatic Ecologist Jacobs	MEnvMgt, BSc (EnvBio)	Sarah has extensive experience in assessing water quality and aquatic biota in streams throughout SE Australian and Northern Australia through. She is highly experienced at conducting fish surveys using a variety of methods including electrofishing, seine netting, gill netting, and bait trapping. Sarah is also experienced in the identification of fish and macroinvertebrates.
Kate Byrnes, Senior Environmental Scientist Jacobs	BSc (Hons)	Kate has conducted and assisted in fish and macroinvertebrate surveys throughout eastern NSW using electrofishing, seine netting, gill netting and bait trapping methods. She has a strong background in water quality monitoring and analysis, particularly for large infrastructure projects.
Chris Thomson, Senior Ecologist Jacobs	BAppSc, GradCertNatRes	Chris has seventeen years' experience in ecology and natural resource management. His strengths include ecological survey design and implementation, species identification, habitat evaluation and assessment, natural resource management and ecological impact assessment. He has comprehensive knowledge of environmental and threatened species legislation in Australia and has extensive experience combining land-use planning and conservation area management, including management of threatened flora and fauna species.
Simon Williams GeoLINK	BEnvP, MEnvLaw, MEIANZ, RABQSA	Simon is an environment and planning specialist with over 15 years' experience in the consulting industry. Simon has qualifications in Environmental Planning and Law, with professional expertise in the areas of environmental impact assessment, natural resource management, expert evidence / witness, community consultation, environmental auditing, and approvals and permitting. Simon is a member of the Environmental Institute of Australia and New Zealand and is a RABQSA Registered Auditor (Certification No. 114849) with specific expertise in managing large multi-disciplinary environmental

Personnel	Qualifications	Experience
		projects and approvals.
Grant McLean GeoLINK	BEnvSc	Grant has recently completed an Environmental Science and Management (Environmental Resource Management major) degree at Southern Cross University. During his last year of study, Grant was employed as a Coastal Support Officer by a local council. Grant then undertook the role of National Green Jobs Corps - Wollongong Team Leader, training youth in Conservation and Land Management, before joining GeoLINK in October 2011. Grant has also undertaken studies in Soil Processes, Water and Catchment Management, Coastal Biogeochemistry, Environmental Chemistry, Coastal Geomorphology and Sedimentology and Ecotechnology.
Dr Timothy Howell Principal Aquatic Ecologist Amec Foster Wheeler	PhD AquatSc BSc (AquatSc)	Tim is an aquatic ecologist with a strong background in threatened fish surveys and management. He undertook his PhD studies on the re-instatement of large woody debris in the Hunter River catchment and worked as a field technician and project manager for NSW Fisheries for over three years. In recent years he has undertaken fish surveys predominantly in Queensland which have included targeted surveys for Oxleyan Pygmy Perch, and other non-targeted surveys capturing Purple Spotted Gudgeon from both coastal and Murray-Darling populations.
Dr Mark Davey Principal Scientist Amec Foster Wheeler	PhD Marine Ecology GCert Marine Science BAppSci Aquatic Science	Mark is an aquatic ecologist with approximately 20 years' experience in environmental monitoring, environmental approvals, research, and project management. He has a strong research background and extensive experience in conducting environmental impact assessments for infrastructure projects.

1.4.2 Expert review

An expert review of the plan was undertaken in August 2013 by Matthew Birch. Curriculum vitae for Matthew Birch is provided in **Appendix A**. Matthew has a Bachelor of Science (Hons) and is currently undertaking a Doctor of Philosophy in Applied Aquatic Ecology at the University of New England. He has been working as a professional aquatic scientist for 10 years which includes five years in the northern rivers area.

A copy of the review undertaken by Matthew Birch and his recommendations are provided as **Appendix B**. A description of how each of the expert recommendations have been addressed in this TFMP is provided as **Appendix C**.

1.5 Consultation

Roads and Maritime has consulted on a regular basis with the NSW DPI (Fisheries) during the development and revisions to this plan. Version 2 of this TFMP was submitted to DPI (Fisheries), DP&E, EPA and DoE. Feedback received and Roads and Maritime responses to issues raised have been included in **Appendix D** of this TFMP.

A summary of agency comments received on Version 2 TFMP and how they have been addressed is outlined in **Table 1-3**.

Table 1-3 Summary of agency consultation and how comments have been addressed

Document Version	Summary of Comments	Section of Report Addressing Comments
Department of Primary Industries (Fisheries)		
Version 2	<p>Recommended additions to the dot points are:</p> <ul style="list-style-type: none"> No more than 30 OPP to be held in captivity at any one time OPP are to be held for no longer than one hour prior to release OPP are held separately from other aquatic fauna Increasing the size of holding gear to allow for separate holding of OPP Retaining any dead OPP for potential scientific information such as aging or genetics. 	These additional points have been included in Section 6.3.8.
Version 2	<p>Recommended additional procedures to be added to the Translocation strategy:</p> <ul style="list-style-type: none"> No more than 30 OPP to be held in captivity at any one time OPP are to be held for no longer than one hour prior to release OPP are held separately from other aquatic fauna Increasing the size of holding gear to allow for separate holding of OPP Retaining any dead OPP for potential scientific information such as aging or genetics. 	The Translocation Strategy has been finalised, but is superseded by this TFMP. The Translocation Strategy is included in Appendix E(f) of this plan and therefore both documents will inform measures to be implemented. However the TFMP will take precedence. These requested additions are specified in Section 6.3.8 of the TFMP and will be implemented.

Document Version	Summary of Comments	Section of Report Addressing Comments
Department of Planning and Environment (DPE)		
Version 2	One of the management objectives includes the identification of high quality habitat. The term high quality habitat is used in various chapters in the Plan, however, there is no definition of high quality. The Plan must describe what a high quality habitat comprises and how such a habitat is monitored in terms of the features that define it as high quality.	High quality habitat was referenced from a previous round of comments. It has no bearing on the information in the report and it is considered that contextually, the use of term "known habitat" will be more effective. Only the term "Known Habitat" or "OPP Habitat" are now used.
Version 2	Oxleyan Pygmy Perch Management Areas are presented in Figures 6-3 to 6-5 and these are based on proximity to high risk activities. The Plan does not provide details of the purpose of these areas and the controls and/or management measures that are relevant to activities carried out in these areas. How were the management areas defined/determined? The Plan should provide more details on these management areas.	Oxleyan Pygmy Perch Management Areas are areas in which high risk activities (as defined) are not to be conducted during high risk times (as defined). This includes OPP spawning or after rainfall events as

Document Version	Summary of Comments	
Department of Planning and Environment (DPE)		
		defined. This is clarified in Section 6.3.4.
Version 2	Consultation with DPI-Fisheries should include management measures for in-stream works as well as timing.	Reference to consultation with DPI has been included.
Document Version	Summary of Comments	
Department of the Environment (DoE)		
Version 2	Figure 6.2 does not indicate any connectivity structure between location 137 and 141 although numerous OPP are known to occur in this area. Please explain.	Noted. This appears to be due to the fact that the habitat does not cross the road in this area. DPI Fisheries have approved the location and design of all connectivity structures proposed.
Version 2	It is unclear why water quality monitoring is limited to following a rainfall event. Does this mean if there is no rainfall event during construction period there will be no water quality monitoring? How does water quality monitoring after a rainfall event provide a representative water quality of the OPP habitat and any deviation from baseline water quality levels?	Water quality monitoring is proposed to occur weekly during construction and also post a rainfall event. Runoff has the potential to become a particular issue after a rain event when larger quantities of water flows into habitat areas, increasing the risk to OPP. Therefore water quality monitoring should also occur post a rainfall event (more than 15 mm in 24 hours) in addition to regular monitoring.
Version 2	There is no monitoring of OPP proposed during operations.	An additional row has been added to Table 7.3 regarding direct OPP monitoring during operations.
Version 2	This Plan does not address compliance with B 41 and B42 requirements.	Section 6.3.5 addresses both of these conditions.
Document Version	Summary of Comments	
Department of the Environment (DoE)		
Version 2	Release of stored water to OPP areas as a last resort. What constitutes a last resort? Haven't there been placed enough measures to ensure this doesn't get considered as an option?	Excessive flooding may initiate a release of stored water. Where this is predicted relevant agencies will be consulted prior to any such event.
Version 2	Have high risk/low risk activities been categorised in consultation with expert or DPI fisheries	Yes. The DPI (Fisheries) has been consulted throughout this process regarding potential risks, mitigation and design. High risk activities are defined in the approval and in this TFMP. Low risk activities are also defined in Section 6.3.4.

2 Supplementary targeted fish surveys

The body of data collection for the W2B Project has been gathered over a period of nine years (2005 – 2014). In line with the objectives of the Biodiversity Mitigation Framework (BMF), this TFMP draws on information from seasonal surveys undertaken during the preparation of the EIS, and refines the avoid/mitigate/offset measures of the EIS through inclusion of data from targeted surveys for threatened fish completed between 2012 and 2014. The methods and results of the recent targeted fish surveys have provided more detail on the location of key threatened fish habitats and informed the design of the primary mitigative strategies including management areas, connectivity structures and translocation sites.

No further targeted fish surveys are proposed to be conducted. The details of recent survey efforts are described within this section.

2.1 Historic records

Oxleyan Pygmy Perch have previously been recorded (DPI (Fisheries) historic records) in Sections 6, 7 and 8 of the project at the following locations:

- Section 6: Small dam adjacent to Tabbimoble Floodway No. 2
- Section 6: Tabbimoble Floodway (1.2 km downstream of confluence of floodway No. 2 and No. 3)
- Section 7: Unnamed waterway at chainage 114.000 in Tabbimoble State Forest
- Section 8: Unnamed waterway at chainage 134.700 near Lang Hill
- Section 8: Broadwater National Park / MacDonaldis Creek.

2.2 Targeted threatened fish surveys

A number of targeted pre-construction surveys for threatened fish have been undertaken within areas associated with the Project. The purpose of these pre-construction surveys was to enable preparation works along the Project to occur, particularly in Sections 6-9 where the Oxleyan Pygmy Perch (*Nannoperca oxleyana*) has historically been recorded. Data gathered during these surveys was used to present baseline information and inform the design of the threatened fish monitoring program which will be employed throughout the duration of construction works, and post-construction. The technical survey reports are included in **Appendix E**.

2.2.1 Woolgoolga to Glenugie (Sections 1 and 2) Surveys

GeoLINK were commissioned by Roads and Maritime to undertake pre-construction threatened fish surveys on the Woolgoolga to Glenugie (Sections 1 and 2) component of the larger Woolgoolga to Ballina Pacific Motorway Upgrade project. The two threatened fish species of concern during these surveys were the Oxleyan Pygmy Perch (*Nannoperca oxleyana*) and the Purple-spotted Gudgeon (*Mogurnda adspersa*).

The first stage of targeted surveys for these two species was undertaken in September 2012 by GeoLink. No Oxleyan Pygmy Perch or Purple-spotted Gudgeon were encountered during this first round, although a recommendation was made for another round of monitoring to be undertaken following the known breeding season of both species.

To address the recommendations made in Stage 1 surveys, Aquatic Science and Management (2013) were commissioned to undertake further targeted surveys for Oxleyan Pygmy Perch or Purple-spotted Gudgeon. This survey failed to find either species, and a recommendation was made that is considered unlikely that any populations of these species are currently located along the Pacific Highway upgrade corridor between Woolgoolga and Glenugie. Based on these findings, and following consultation with DPI (Fisheries), no further surveys are required in these areas and management of these species in these areas is not deemed necessary.

2.2.2 Woolgoolga to Ballina (Sections 6 to 9) Surveys

The first round of targeted surveys for Oxleyan Pygmy Perch and Purple-spotted Gudgeon undertaken beyond Sections 1 and 2 were in August and September 2013 and covered Sections 6 – 9 and 11 (GeoLINK 2013). In this first round of monitoring the Oxleyan Pygmy Perch was recorded from thirteen sites across seven locations. No Purple-spotted Gudgeon were identified during the first round of monitoring. They are considered unlikely to inhabit the highway corridor in Sections 6 – 9 or 11. Additionally, the sites in Section 11 are considered unlikely to provide suitable habitat for Oxleyan Pygmy Perch and Purple-spotted Gudgeon and, as such, they were not resurveyed during the second round of monitoring. DPI (Fisheries) agreed Purple-spotted Gudgeon did not need to be addressed in this TFMP.

In the stage 2 survey OPP were only captured at one of the thirteen sites where they were captured in the stage 1 survey. This indicates that natural variation in OPP populations can be extreme. Drought conditions between September 2013 and March 2014 caused a number of the sites to dry out and prompted a study of drought refuges for OPP in and around the upgrade corridor (GeoLINK 2014). The drought refuge study provided important contextual information for the results of the second round of monitoring. More detail regarding the results of these surveys are provided in **Section 2.2.4**.

2.2.3 Survey Methods

Historical records and aerial photography were used to identify potential habitat for Oxleyan Pygmy Perch within Sections 6-9 of the W2B project. Survey sites were selected based on known habitat preferences of the target species (Pusey, Kennard and Arthington 2004) and/or were considered generally representative of the range of aquatic habitat types found in that waterway. During the first round of monitoring (August/September 2013) 44 sites within 18 locations (one location in Section 11) were sampled for threatened fish species. During the second round of monitoring (August/September 2014) the surveys were expanded to include 64 sites within 25 locations. All but two of the sampling locations from the first round of monitoring were utilised in the second round of monitoring. Additional monitoring locations within the study area were identified by RMS or during a drought refuge investigation (GeoLINK 2014). The waterways included backwaters on flood-prone land, ephemeral swamps, farm drainage lines, natural creeks, dams, excavations and flood control infrastructure. A number of control sites were also selected to use during construction and post-construction monitoring.

Between 1 and 6 monitoring sites were chosen within each location. In order to assess waterways for their habitat potential the waterway classifications of Fairfull and Witheridge (2003) were applied (**Table 2.1**). The sampling strategy applied to waterway classes included:

- Class 3 and Class 4 intermittent streams were only sampled at one site located at, or downstream of, the site of potential construction impact
- Class 2 streams were sampled at the site of potential construction impacts and a further site located downstream
- Class 1 waterways were sampled at a minimum of 3 sites, located at the site of, upstream of, and downstream of potential construction impacts.

Table 2-1 Summary of waterway classification as per Fairfull and Witheridge (2003)

Classification	Characteristics of waterway type	Minimum recommended crossing type
Class 1 – major fish habitat	Major permanently or intermittently flowing waterway (e.g. river or major creek), or known habitat of a threatened fish species .	Bridge or arch structure
Class 2 – moderate fish habitat	Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks and with semi-permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and/or fish observed inhabiting the area.	Bridge, arch structure, culvert or ford
Class 3 – minimal fish habitat	Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.	Culvert or ford
Class 4 – unlikely fish habitat	Named or unnamed watercourse with intermittent flow during rain events only, little or no defined drainage channel, little or no free standing water or pools after rain event (e.g. dry gullies or shallow floodplain depression with no permanent wetland aquatic flora).	Culvert, causeway or ford

Field surveys were scheduled to avoid the Oxleyan Pygmy Perch breeding season which peaks between October and April, and also after enough rainfall to ensure that water would be present at the majority of sites. While most sites did not have significant flows at the time of the surveys, there was sufficient water to sample effectively at the majority of sites. The pre-construction field survey schedule was:

- Survey period 1 – 26 August to 18 September 2013 (not concurrent; 10 survey days total)
- Survey period 2 – 25 August to 26 September 2014 (not concurrent; 14 survey days total).

Fish sampling was undertaken using a combination of back-pack electro-fisher and unbaited box traps in accordance with relevant survey guidelines. Water quality and habitat descriptions were also recorded at each site.

2.2.4 Survey results

Targeted pre-construction surveys were undertaken in Sections 1-2 in 2012 and 2013 and Sections 6-11 between 2013 and 2014, the details of which are provided as **Appendix E (a, b, c and d)**. These surveys failed to detect any Purple Spotted Gudgeon in waterways within the Project footprint (GeoLINK 2012, 2013, 2014). As this species has not been detected during targeted surveys to date it has been recommended by the expert reviewer (Matthew Birch) and agreed with Roads and Maritime and the DPI (Fisheries) that the species does not need to be included in this version of the TFMP. Baseline information on the Purple Spotted Gudgeon has been retained and if the species is detected in subsequent aquatic surveys, the TFMP will be updated accordingly. It should also be noted the mitigation measures proposed for the Oxleyan Pygmy Perch will cater for and benefit the Purple Spotted Gudgeon should any be detected in future aquatic surveys.

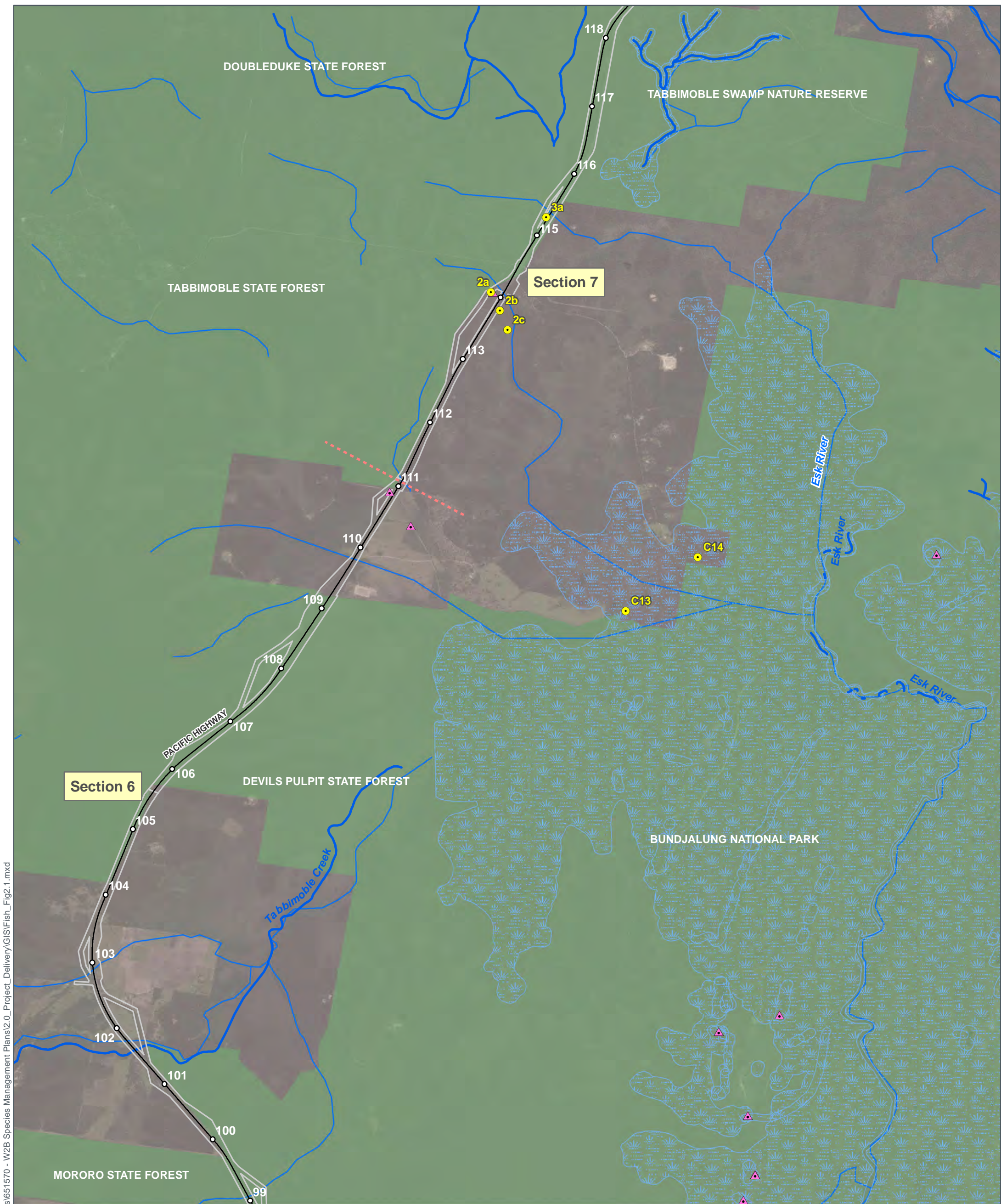
Targeted pre-construction surveys undertaken in Sections 1 and 2 of the project in September 2012 and May/June 2013 failed to detect any threatened fish species (GeoLINK 2012; Aquatic Science and Management 2013), despite favourable habitat existing in Cassons Creek, Redbank Creek and tributaries. Therefore, this TFMP is currently not relevant to Sections 1 and 2.

Targeted pre-construction surveys in Sections 6-9 undertaken in 2013 and 2014 (GeoLINK 2013, 2014), recorded the threatened species Oxleyan Pygmy Perch from a number of waterways intersecting Sections 7, 8, and 9 the project, and also at a number of control sites, including:

- Section 7: Unnamed waterway south of Serendipity Rd (chainage 114.000)
- Section 7: Tabbimoble Floodway No. 1 (chainage 115.300)
- Section 8: Unnamed waterway south of MacDonaldis Creek (chainage 134.600)
- Section 8: MacDonaldis Creek tributary (chainage 135.520)
- Section 8: MacDonaldis Creek (chainage 136.600)

- Section 8: Unnamed waterway (dam) within Broadwater National Park (chainage 139.600)
- Section 8: Numerous sites within Broadwater National Park along McDonalds Creek and tributaries (control sites)
- Section 9: Montis Gully tributary upstream of chainage 141.180
- Section 9: Montis Gully (dam) tributary upstream of chainage 141.500
- Section 9: Montis Gully tributary upstream of chainage 141.890.

Oxleyan Pygmy Perch historic records (DPI (Fisheries)), W2B pre-construction survey records and critical habitat within Sections 6 to 9 of the project are illustrated in **Figure 2-1** and **Figure 2-2**.



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Figure 2.1 Oxleyan Pygmy Perch Records and Critical Habitat, Sections 6 and 7		LEGEND		LOCATION DIAGRAM			
<ul style="list-style-type: none"> ○ Chainage (kilometres) — Alignment - - - Section change ▭ Project boundary ● Oxleyan Pygmy Perch record (W2B) ▲ Oxleyan Pygmy Perch historic record — Key fish channels ▭ Oxleyan Pygmy Perch habitat 		 1:50,000 (A3) GCS GDA 1994					
WORK REQUEST NUMBER: RMS		ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
DATA SOURCES: Topographic Vector Series 3 © Commonwealth of Australia (Geoscience Australia) 2006		15/05/2015	JH	CC	BE	0	Issued for Use
		24/03/2015	JH	MD	BE	A	Issued for Review

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ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans LEGEND LOCATION DIAGRAM

Figure 2.2
Oxleyan Pygmy Perch Records and Critical Habitat, Sections 8 and 9

- Chainage (kilometres)
- Alignment
- - - Section change
- ▭ Project boundary
- Oxleyan Pygmy Perch record (W2B)
- ▲ Oxleyan Pygmy Perch historic record
- Key fish channels
- ▭ Oxleyan Pygmy Perch habitat

WORK REQUEST NUMBER: RMS

DATA SOURCES:
 Topographic Vector Series 3 © Commonwealth of Australia (Geoscience Australia) 2006

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15/05/2015	JH	CC	BE	0	Issued for Use
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3 Threatened fish populations

3.1 Background

3.1.1 Conservation status

The Oxleyan Pygmy Perch (*Nannoperca oxleyana*) is listed as endangered under the FM Act, TSC Act and EPBC Act due to their limited distribution, rarity, dependence on specific habitat characteristics, and their vulnerability to threatening processes.

3.1.2 Breeding, spawning and feeding

The MCoA defines the spawning period for the Oxleyan Pygmy Perch as between October to April. This is consistent with literature which report the breeding season of the Oxleyan Pygmy Perch may extend from September to May, with spawning generally occurring between September and April when water temperatures exceed 20 °C (Knight et al. 2012). Note that peak spawning activity is generally between September to December and February to April, with reduced activity in January (Knight et al. 2007). When spawning, Oxleyan Pygmy Perch scatter their eggs over sandy substrates or aquatic vegetation.

Once hatched, developing larvae feed on rotifers and protozoans. While adult Oxleyan Pygmy Perch feed on a broad range of foods including copepods, cladocerans, caridnian shrimp, aquatic insects (particularly chironomid larvae), diatoms, filamentous algae and some terrestrial insects (Pusey et al. 2004).

3.1.3 Habitat requirements

The Oxleyan Pygmy Perch is found in swamps, streams and dune lakes of the lowland coast 'wallum' heaths located from the north-eastern coast of NSW through to south-eastern Queensland (Arthington 1996; Pusey et al. 2004; Knight & Arthington 2008). Such 'wallum' habitats are typically characterised by little to no flow and specific physicochemical water quality conditions including pH between 3.3 and 6.9 and conductivity between 90 and 830 µS/cm. Waters can either be clear or tannin stained. Areas of known Oxleyan Pygmy Perch habitat within the project area are shown in **Figure 2-1 and Figure 2-2**.

Oxleyan Pygmy Perch require physicochemical water quality within a specific range, preferring well oxygenated, slightly acidic waters, between select temperature, conductivity, and suspended sediment concentrations. Water quality information from sites where Oxleyan Pygmy Perch have been historically been recorded in NSW is presented in **Table 3.1**.

Table 3-1 Summary of water quality information from sites in NSW where Oxleyan Pygmy Perch have been collected (Knight and Arthington 2008)

Measure	Range	Mean ± SE
Temp (°C)	10.9 – 28.3	16.1 ± 0.34
Dissolved Oxygen (mg/L)	2.15 – 10.02	6.42 ± 0.189
pH	3.32 – 6.9	4.47 ± 0.087
Conductivity (µS/cm)	68 – 2148	186 ± 22.7
Turbidity (NTU)	0 – 80	14 ± 3.6

Previous studies have correlated the presence of Oxleyan Pygmy Perch with an abundance of structural microhabitat in the form of dense aquatic vegetation and/or steep undercut banks fringed with woody debris root overhang from riparian vegetation (Knight and Arthington 2008). Oxleyan Pygmy Perch require relatively clean siliceous sand substrates with some plant debris and dense stands of emergent or submerged vegetation (McDowall 1996). They are often found in association with dense stands of the sedge *Eleocharis ochrostachys* as well as *Baumea articulata*, *Sphagnum falcatulum*, *Philydrum lanuginosum*, *Lepironia articulata* and *Restio pallens*.

Although Oxleyan Pygmy Perch do not require high flows to trigger spawning, they are thought to disperse widely during floods or high flows. This type of dispersal allows the species to colonise new systems and/or recolonise previously disturbed areas (Knight et al. 2009). The occurrence of Oxleyan Pygmy Perch across the study area may vary based on movement facilitated by dispersal during high rainfall or flooding events. This dispersal behaviour means that local distribution patterns can change substantially after heavy rainfall or floods, with relatively large number of individuals potentially colonising wetlands, lakes or streams that may have previously been dry.

3.2 Key threats

Key threats to Oxleyan Pygmy Perch as identified in the literature include:

- Habitat loss or degradation
- Water pollution
- Changes to hydrological regimes
- The creation of instream barriers
- Competition and predation pressure from introduced species.

Potential impacts to Oxleyan Pygmy Perch broadly associated with the W2B project are described below. More specific impact assessments for pre-construction, construction and operation have been undertaken and described in **Sections 4, 5, 6 and 7**.

3.2.1 Habitat loss or degradation

Oxleyan Pygmy Perch rely on dense stands of submerged or emergent vegetation, undercut banks and submerged logs for breeding, and to provide cover from predators and protection from high velocity flows. They also require clean sand substrates for egg development. Any activities that disturb the stream bed or stream bank, remove stands of emergent or submerged vegetation, or remove submerged wood and rocks have the potential impact Oxleyan Pygmy Perch populations. This may cause mortality of Oxleyan Pygmy Perch within the disturbed area due to trauma and/or stress associated with removal of suitable habitat and food sources. Removal of habitat may also increase the vulnerability of Oxleyan Pygmy Perch to predators, and may result in populations dispersing to adjacent undisturbed waterways, where they may experience increased predation and competition for resources. Fish that remain in disturbed areas may suffer reduced breeding success due to disturbance of suitable substrate require for egg development, and/or due to reduction in suitable food for developing larvae. Unmitigated disturbances have the potential to significantly reduce and/or fragment local populations of Oxleyan Pygmy Perch.

3.2.2 Water pollution

Run-off from construction sites has the potential to severely affect water quality and pH in receiving waterways. The pH of receiving waters may change due to lime pollution and/or disturbance of acid sulphate soils. Lime pollution could occur as a result of runoff from concrete preparation areas that would make receiving waters more alkaline and therefore unsuitable for Oxleyan Pygmy Perch. Disturbance of acid sulphate soils in the project area can produce sulphuric acid when exposed to oxygen. Rainfall can flush the acid into adjacent waterways with detrimental impacts. The impacts of changes in the acidity of receiving waters can extend further downstream beyond the initial impact point and beyond the construction area.

The introduction of sediment from construction sites throughout the project area could adversely affect Oxleyan Pygmy Perch. Fine sediment could smother the sand substrate, potentially suffocating developing eggs already attached to the substrate, or preventing eggs from successfully settling on the substrate. Suspended sediment can also reduce light penetration through the water column, affecting the growth of aquatic plants that Oxleyan Pygmy Perch rely. Fine sediment may also coat hard surfaces that normally support biofilm production, an important food source for macroinvertebrates, which are in turn an important food source for Oxleyan Pygmy Perch. Lastly, increased particulate matter associated with elevated turbidity can clog fish gills, reducing their health and potentially causing mortality.

Chemical or fuel spills from construction activities and petrochemical run-off from the road during operation could have a toxic effect on Oxleyan Pygmy Perch in receiving waters.

Leachate from mulch heaps at the project area during construction, and from landscaped areas when operational may introduce organic matter into adjacent waterways, reducing light penetration and creating a chemical imbalance, potentially impacting the Oxleyan Pygmy Perch. Leachate and tannins may also carry other pollutants into adjacent waterways, including polyphenols, volatile fatty acids, and lignins, all detrimental to Oxleyan Pygmy Perch at high concentrations. Leachate can also increase stream Biological Oxygen Demand (BOD), decreasing dissolved oxygen concentrations and affecting aquatic life.

3.2.3 Hydrological changes and barriers to movement

Oxleyan Pygmy Perch are not strong swimmers with an estimated upper velocity limit of 4 m/s (Knight 2000). During floods or other high flow events in natural streams, they seek refuge in stands of submerged or emergent vegetation or move to shallow, slow flowing areas. Despite this, floods or other high flow events are thought to play an important role for the species, allowing dispersal to previously isolated aquatic habitats re-connected by floods or high flow events. Although safe velocity limits for Oxleyan Pygmy Perch during floods are not known, this strategy is likely to be important to maintain populations as it allows individuals to colonise aquatic habitats that may have previously been dry, or where local populations may have declined due to natural or pressures such as predation or physical disturbance.

Hydrological changes that alter the frequency, timing or duration of floods or high flow events, or change hydrological flow patterns, may affect the ability of Oxleyan Pygmy Perch to disperse and could lead to substantial population declines. Similarly hydrological changes, such as increased velocity of run-off from impervious surfaces following floods or high flow events may make existing habitats unsuitable for Oxleyan Pygmy Perch.

If not designed appropriately, culverts, bridges and other infrastructure used to cross natural waterways can impede fish movement by:

- Constricting the natural flow path and increasing flow velocity in stream channels to a level that is detrimental to Oxleyan Pygmy Perch
- Preventing floodwaters from breaking out onto adjacent floodplains. Although this effect is likely to be restricted to the floodplain in the immediate vicinity of the structure, it may be sufficient to prevent Oxleyan Pygmy Perch from moving past the barrier in either direction and could therefore fragment populations that would have naturally been connected during floods
- Erosion downstream of the structures can lower the natural streambed relative to the floor of the structure and may create a vertical drop that Oxleyan Pygmy Perch cannot navigate
- Reduced aquatic vegetation in the section of stream that runs through or underneath structures. Plants may have been physically removed as part of the construction or installation and/or the installation causes shading preventing plants from growing. Reduce habitat and cover and light may deter Oxleyan Pygmy Perch from moving through these structures or may make them more susceptible to predators as they move through them.

Any barriers to movement or migration would be likely to limit the extent to which Oxleyan Pygmy Perch can disperse throughout their range. As a result the population could become fragmented and susceptible to local depletion or extinction.

3.2.4 Competition and predation pressure from introduced species

Oxleyan Pygmy Perch are susceptible to predation and competition from introduced species, particularly the Eastern Gambusia (*Gambusia holbrooki*, sometimes called plague minnow). Eastern Gambusia are a similar size to Oxleyan Pygmy Perch, populate similar habitats and have overlapping diets. Eastern Gambusia form large schools and aggressively defend their territories by 'fin-nipping' other species, including Oxleyan Pygmy Perch. Such behaviour can exclude Oxleyan Pygmy Perch and other small-bodied native fish from their preferred habitat.

Eastern Gambusia are able to tolerate a wider range of habitat conditions than many native fish and they are often abundant at sites that have been physically disturbed or that have degraded water quality. Eastern Gambusia are present in most waterways throughout the study area; however, they are not sufficiently abundant to exclude Oxleyan Pygmy Perch from the identified habitat. Substantial disturbance to any Class 1 or Class 2 waterways in the project would be likely to favour Eastern Gambusia and increase pressure on Oxleyan Pygmy Perch populations.

4 Potential impacts and management approach

This section provides an overview of potential impacts to Oxleyan Pygmy Perch with reference to the more detailed impact assessment presented in the EIS Biodiversity Working Paper. It describes the potential impacts to the species at specific locations along the project upgrade and during pre-construction, construction and post-construction (operational) stages of the project. The mitigation approach presented in the EIS and documented in **Sections 5 - 7** of this TFMP target the predicted impacts.

4.1 Potential impacts associated with the project

The construction and operation of the project has the potential to impact aquatic ecosystems due to changes in existing hydrological conditions, changes in water quality, habitat loss and creation of instream barriers. A number of ecological assessments have been undertaken in order to inform planning decisions around avoiding and minimising impacts of the project on Oxleyan Pygmy Perch.

The impacts to Oxleyan Pygmy Perch likely to occur during the construction and operation of the project are summarised below and management measures outlines in **Sections 5 - 7**. Impacts may result from:

- Loss of riparian and aquatic habitat, including food resources, shelter and refuge areas during non-breeding and breeding life-cycle events
- Fragmentation of aquatic habitat as a result of barriers to fish passage
- Changes to water quality as a result of works in or adjacent to aquatic habitats
- Alterations to natural hydrological flows
- Invasion and spread of aquatic weeds and pest species
- Potential spread of disease pathogens.

4.1.1 Loss of riparian and instream habitat

Construction activity around waterways can result in the loss of aquatic habitat associated with the removal of woody snags, changes to in-stream substrate and loss of aquatic plants. Construction of waterway crossings typically results in temporary localised disturbance with the potential loss of riparian habitat at either the crossing location, or in locations where the road runs closely parallel to riparian habitats. Construction works in close proximity to waterways can also potentially impact on bank stability and water quality through excavation, clearing or placement of construction stockpiles, and scouring.

The removal of large woody debris or snags is listed under Schedule 6 of the FM Act as a key threatening process. Woody debris plays an important role in aquatic ecosystems by providing essential habitat for aquatic organisms, refuge from predation and flow, as well as providing important refuge and breeding habitat for fish including threatened species. While not quantified, woody debris formed a significant component of aquatic habitat throughout all waterways crossed by the project. Construction of the project may reduce the presence and availability of woody debris if not managed appropriately.

4.1.2 Fragmentation of habitat

Construction and operation of both permanent and temporary waterway crossings such as bridges, causeways, fords and culverts are known to have substantial impacts on fish passage. Short-term impacts would include localised disturbance to riparian and in-stream habitats such as increased sedimentation and shading. Long-term impacts would include the impediment of fish movements within their natural range, habitat changes and pollution. Inappropriate design of both temporary (during construction) and permanent (during operation) waterway crossings and in-stream structures and/or construction procedures may exacerbate instream barriers to aquatic fauna passage. Such barriers could prevent the dispersal of Oxleyan Pygmy Perch if waterway crossings have not been designed and implemented appropriately.

4.1.3 Changes to water quality

The construction and operation of the project has the potential to impact on water quality in adjacent waterways. Impacts to water quality during construction would result from stockpiling of earthworks and vegetation, and construction works in proximity to known and potential habitat such as cut and fill, removal of borrow material, haulage routes and general earthworks. For example a major borrow site occurs at Lang Hill adjacent to known Oxleyan Pygmy Perch habitat.

Potential impacts include increased turbidity and nutrients in waterways as a result of sediments from cleared areas being washed into waterways. Vegetation stockpiles resulting from land clearing for the alignment may leach tannins and organics into adjacent waterways. This can increase stream BOD, decreasing dissolved oxygen which can affect aquatic life.

Increased pollutant load in road runoff is the main impact to water quality associated with the operation of the project. Pollutants in road runoff include nutrients, heavy metals, pesticides, herbicides and hydrocarbons, which can impact negatively on the aquatic environment.

Site specific physico-chemical parameters for waterways known to support Oxleyan Pygmy Perch have been collected during aquatic ecological monitoring (GeoLink 2013, 2014), the Oxleyan Pygmy Perch flood refuge assessment (GeoLink 2014a) and the Project baseline water quality assessments (Golders 2014). These water quality monitoring sites are shown in **Figure 8-1**, **Figure 8-2** and **Figure 8-3**. An assessment of this water quality data has been undertaken and the minimum and maximum ranges for each parameter is summarised in **Table 4-1** which is to be used as baseline information for various water quality parameters. Currently, the information contained within this report is the most accurate and robust water quality data available for Oxleyan Pygmy Perch monitoring sites as it has been collected over various seasons and climatic conditions. This information may be further refined during the establishment of the Woolgoolga to Ballina Water Quality Management Program (WQMP), required under MCoA D12. It should be noted control sites were not established when Golders were undertaking water quality monitoring therefore there are no results for those sites.

The current known water quality values associated with waterways known to contain Oxleyan Pygmy Perch that will be impacted by the Project are detailed in **Table 4-1**.

Table 4-1 Water quality baselines in waterways known to contain Oxleyan Pygmy Perch

Location	Oxleyan Pygmy Perch monitoring sites	Water quality value	Golders (2014)	GeoLink (2013, 2014 and 2014a)*	Combined range
Unnamed waterway south of Serendipity Rd Ch. 11400	2a, 2b, 2c	Temp (°C)	13.3 – 23.6	14.54 - 15.2	13.3 – 23.6
		Dissolved Oxygen (mg/L)	5.9 - 10	4.11 – 6.07	4.11 - 10
		pH	5 – 6.9	4.98 - 6.08	5 – 6.9
		Conductivity (µS/cm)	0.009 – 0.368	0.082 - 0.117	0.009 – 0.368
		Turbidity (NTU)	0.9 - 118	21.2 – 23.6	0.9 - 118
Tabbimobile floodway no. 1 Ch. 115300	3a	Temp (°C)	12.8 - 24	13.72 – 16.35	12.8 - 24
		Dissolved Oxygen (mg/L)	1.3 - 199	7.48 – 8.07	1.3 - 199
		pH	4.4 – 7.2	5.74 - 5.86	4.4 – 7.2
		Conductivity (µS/cm)	0.009 – 0.140	0.072 - 0.096	0.009 – 0.140
		Turbidity (NTU)	18.9 – 97.1	36 - 132	18.9 – 132
Unnamed waterway south of MacDonalds Ck Ch. 134600	10b, 10c	Temp (°C)	16.6 - 29	22.24 – 23.81	16.6 - 29
		Dissolved Oxygen (mg/L)	3.4 - 10	3.17 – 5.75	3.17 - 10
		pH	4 – 9.3	4.01 – 4.46	4 – 9.3
		Conductivity (µS/cm)	0.102 - 0.537	0.461 – 0.603	0.102 – 0.537
		Turbidity (NTU)	1.3 - 122	27.1 – 800	1.3 - 800
MacDonalds Ck Tributary Ch. 135200, 135530 and 136450	11b, 11d, 22b, 22c	Temp (°C)	15.4 – 26.7	19.59 – 21.73	15.4 – 26.7
		Dissolved Oxygen (mg/L)	3.1 – 8.9	2.27 – 5.96	2.27 – 8.9
		pH	3.8 – 8.9	5.26 – 5.33	3.8 – 8.9
		Conductivity (µS/cm)	0.092 – 0.606	0.179 – 0.206	0.092 – 0.606
		Turbidity (NTU)	2.4 - 138	5.2 – 11	2.4 - 138

WOOLGOOLGA TO BALLINA | PACIFIC HIGHWAY UPGRADE

Location	Oxleyan Pygmy Perch monitoring sites	Water quality value	Golders (2014)	GeoLink (2013, 2014 and 2014a)*	Combined range
MacDonalds Ck Ch. 136600	12a	Temp (°C)	14.9 - 26	15.39 - 15.74	14.9 - 26
		Dissolved Oxygen (mg/L)	1.7 – 8.1	1.74 – 3.48	1.7 – 8.1
		pH	3.6 – 6.3	3.9 - 4.37	3.6 – 6.3
		Conductivity (µS/cm)	0.164 – 0.406	0.246 - 0.395	0.164 – 0.406
		Turbidity (NTU)	0.7 - 14	0 – 0.3	0 - 14
Broadwater NP Swampland Ch. 139000	16a, 16b, 27b, 27e	Temp (°C)	No data available	18.6 – 21.45	20.11 – 21.45
		Dissolved Oxygen (mg/L)	No data available	1.83 – 5.39	1.83 – 5.39
		pH	No data available	4.15 – 4.63	4.29 – 4.63
		Conductivity (µS/cm)	No data available	0.128 – 0.178	0.128 – 0.171
		Turbidity (NTU)	No data available	0 - 703	0 - 703
Montis Gully Tributary 1 Ch. 141180 and 141850	13c, 13e, 26d	Temp (°C)	17.6 – 30.9	17.23 - 18.53	17.23 – 30.9
		Dissolved Oxygen (mg/L)	2.1 – 9.4	2.71 – 3.81	2.1 – 9.4
		pH	4 - 7	3.7 – 4.51	3.7 - 7
		Conductivity (µS/cm)	0.026 - 159	0.14 – 0.209	0.026 – 0.209
		Turbidity (NTU)	2.3 - 108	0 – 225	0 - 225
To the west of Bundjalung NP Approximately 4 km east of Ch. 110000	C13, C14	Temp (°C)	No data available	18.09 – 19.11	18.09 – 19.11
		Dissolved Oxygen (mg/L)	No data available	2.24 – 4.38	2.24 – 4.38
		pH	No data available	4.56 – 5.47	4.56 – 5.47
		Conductivity (µS/cm)	No data available	0.086 – 0.112	0.086 – 0.112
		Turbidity (NTU)	No data available	0 – 8.7	0 – 8.7
Broadwater NP 6.5 km east of Ch.	C11, C12	Temp (°C)	No data available	15.91 – 18.49	15.91 – 18.49
		Dissolved Oxygen (mg/L)	No data available	2.9 – 5.59	2.9 – 5.59

Location	Oxleyan Pygmy Perch monitoring sites	Water quality value	Golders (2014)	GeoLink (2013, 2014 and 2014a)*	Combined range
130000		pH	No data available	3.85 - 4	3.85 - 4
		Conductivity (µS/cm)	No data available	0.124 – 0.149	0.124 – 0.149
		Turbidity (NTU)	No data available	0 – 2.3	0 – 2.3
MacDonalds Ck Tributary 0.5 km east of 136600 and 1 km east of 137800	C2, C5	Temp (°C)	No data available	16.87 – 17.78	16.87 – 17.78
		Dissolved Oxygen (mg/L)	No data available	4.58 – 4.69	4.58 – 4.69
		pH	No data available	3.7 – 4.22	3.7 – 4.22
		Conductivity (µS/cm)	No data available	0.115 – 0.158	0.115 – 0.158
		Turbidity (NTU)	No data available	0	0
Broadwater NP 1 km east of 138000	C1, C3	Temp (°C)	No data available	17.2 - 18.91	17.2 - 18.91
		Dissolved Oxygen (mg/L)	No data available	4.55 - 9.18	4.55 - 9.18
		pH	No data available	3.97 – 4.49	3.97 – 4.49
		Conductivity (µS/cm)	No data available	0.089 - 0.176	0.089 - 0.176
		Turbidity (NTU)	No data available	0 – 1.4	0 – 1.4
Broadwater NP 2 km east of 136400	C8	Temp (°C)	No data available	17.98	17.98
		Dissolved Oxygen (mg/L)	No data available	5.77	5.77
		pH	No data available	3.95	3.95
		Conductivity (µS/cm)	No data available	0.236	0.236
		Turbidity (NTU)	No data available	12.1	12.1

* These figures are based on the cumulative water quality data obtained from all Oxleyan Pygmy Perch sites that occur on each waterway. Where only one Oxleyan Pygmy Perch site occurs on a waterway, where water quality data was only captured from one site or where there was only one sampling event the data range is represented by a single figure.

4.2 Alterations to hydrologic and hydraulic conditions

Construction activity around waterways has the potential to result in changes to hydrologic and hydraulic conditions. Changes to hydrologic and hydraulic conditions can be temporary or permanent and may include diversion of waterways, barriers that impede flow and changes to flow velocities. Changes in hydrologic and hydraulic flow (such as flow velocities and levels) as a result of temporary or permanent culverts and bridges can create barriers to aquatic fauna movements, and change aquatic habitat through gradual decrease in water depth and increased sediment and turbidity.

Oxleyan Pygmy Perch are thought to use flood and high flow events to facilitate dispersal, therefore waterway crossings have the potential to inhibit natural flow of floodwaters, potentially impacting the ability of the Oxleyan Pygmy Perch to colonise adjacent floodplains. Oxleyan Pygmy Perch are also susceptible to impacts from water velocities above 4 m/s, therefore any changes to flow velocities due to waterway crossings may impact local populations. A strategy for balancing flow and flood requirements for Oxleyan Pygmy Perch would be developed.

4.3 Mitigation and monitoring

A number of measures to mitigate and monitor the impact of the project on threatened fish species during construction and operation of the project were suggested in the EIS (Biodiversity Working Paper). In general these measures relate to:

- A targeted connectivity strategy
- Suitable design of temporary and permanent waterway crossings
- Construction measures, including timing and method of construction, water quality and sediment and erosion control
- Aquatic habitat management measures including revegetation of disturbed areas of waterway
- Develop a monitoring program to monitor impacts, the effectiveness of mitigation measures and incorporate adaptive management actions where impacts are noted.

A summary of the proposed approach to management of potential impacts to Oxleyan Pygmy Perch throughout the pre-construction (Section 5), construction (Section 6) and operational phases (Section 7) of the project is illustrated in **Figure 4-1**. Further detail is provided in the relevant sections of this TFMP.

4.4 Effectiveness of mitigation measures

A range of mitigation measures have been identified to minimise the impact of habitat loss and fragmentation on threatened fish species potentially impacted by the project. The effectiveness and success of these measures would be assessed using a measureable and targeted monitoring program that would be implemented prior to the construction of each section of the project.

A summary of the proposed mitigation measures and evaluation of their effectiveness based on past experience with other highway upgrades is described in **Table 4-2**.

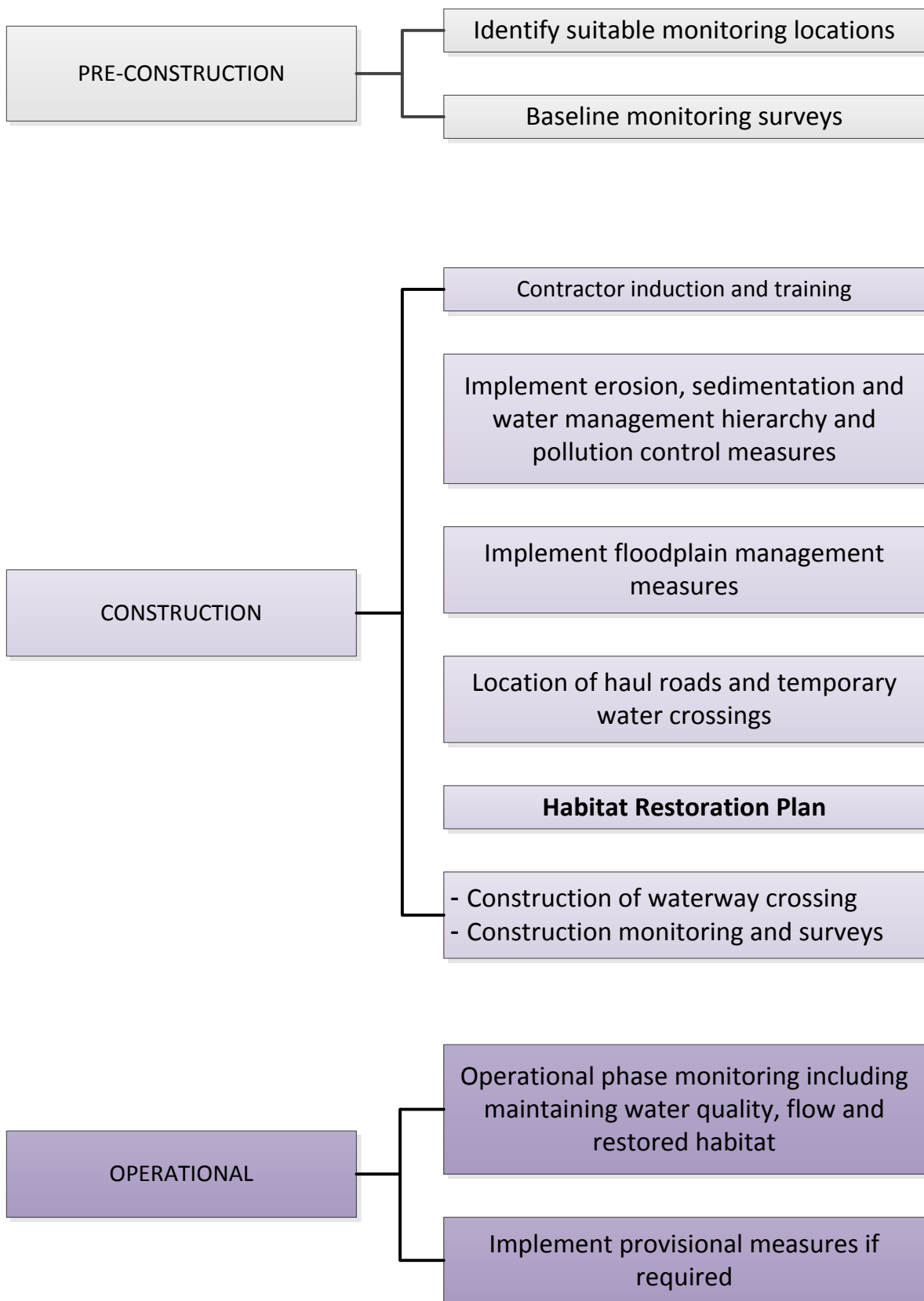


Figure 4-1 Proposed staging of management measures

Table 4-2 Mitigation measures and evaluation of their effectiveness for threatened fish species

Issue	Mitigation / control measure	History of success	Effectiveness rating
Impacts to threatened fish habitat adjacent to the project	<ul style="list-style-type: none"> • Strict controls of temporary watercourse crossings. • Development of construction methodologies to reduce disturbance to instream habitats. • Management of instream woody debris. • Implementation of water quality control measures. • Management of sedimentation and erosion. • Management of aquatic weeds and pests. • Bed and bank reinstatement, habitat restoration. 	<p>DPI Fisheries has been consulted on a number of occasions with regard to implementing mitigation measures to facilitate fish passage on Roads and Maritime highway projects. This involvement has extended over the last 14 years of the Pacific Highway upgrading program.</p> <p>Specific procedures have been drafted for the Oxleyan Pygmy Perch in consultation with NSW Fisheries. Experiences and findings from Devils Pulpit have been used to inform this plan for the Woolgoolga to Ballina project. Initial monitoring for Devils Pulpit has shown no change in water quality during construction.</p>	High
Artificial structures creating a barrier to fish passage	<ul style="list-style-type: none"> • Design to prevent and/or minimise in-stream barriers, including appropriate design of bridges and culverts to ensure no physical, hydraulic and behavioural barriers to aquatic fauna movements. • Minimise culvert length where possible. Fisheries data has shown that fish passage is affected when culvert length reaches 60-70 m. • Bridges on class 1 waterways with no piers in the channel. • Natural substrate in the floor of culvert for potential habitat. • Inspection, maintenance and cleaning of culvert structures to prevent blockages and restricted fauna movements. 	<p>Watercourse crossing (bridges and culverts) for the Devils Pulpit upgrade have been designed and constructed to be consistent with the Guidelines for Controlled Activities Watercourse Crossings (DWE 2008) and Why do Fish need to Cross the Road? Fish Passage requirements for waterway Crossings (Fairful & Witheridge 2003). This standard of bridge design meets with Roads and Maritime management goals of maintaining natural streamflow and velocity, and connectivity for threatened fish.</p> <p>Monitoring of fish passage would be undertaken during the operation of the Devils Pulpit upgrade and any findings would be used to inform fish passage within the Woolgoolga to Ballina Upgrade going forward.</p>	Moderate, monitor success and implement corrective actions
Altered water quality conditions	<ul style="list-style-type: none"> • Sediment and erosion control during construction including protocols for discharge of basins and monitoring water quality. • Strict controls on temporary watercourse crossings. • Implementation of water quality control measures, including detention basins and operational spill basins at key locations. • Monitor water quality before discharge from basins, only discharge if appropriate conditions and no discharge to OPP habitat. • Apply methods to prevent change of pH during concrete construction in waterways (e.g. silt curtains on bridges). 	<p>Specific procedures have been drafted for the Oxleyan Pygmy Perch in consultation with NSW Fisheries. Experiences and findings from Devils Pulpit have been used to inform this plan for the Woolgoolga to Ballina project. Initial monitoring for Devils Pulpit has demonstrated no notable change in water quality during construction.</p>	High

Issue	Mitigation / control measure	History of success	Effectiveness rating
Fish trapped in pools adjacent to construction zone	<ul style="list-style-type: none"> • Development and implementation of a translocation strategy. • Translocation of fish outside the construction zone. 	<p>Roads and Maritime has successfully translocated fish as part of the Banora Point Upgrade however this has not included translocation of Oxleyan Pygmy Perch.</p> <p>Oxleyan Pygmy Perch have been successfully maintained in aquaria (McDowall, 1996) and therefore it would be feasible that these species could be cleared from the immediate impact area and held in aquaria for the duration of the proposed construction activities.</p>	Unknown, monitor success and implement corrective actions as required.

4.5 Adaptive management approach

This TFMP includes an adaptive management approach based on firstly identifying specific goals for management, followed by the implementation of management actions and finally the monitoring of the performance of these measures against the goals and identified thresholds. Prescribed corrective actions will be applied to improve mitigation where required.

To ensure the success of this approach the management goals presented in the plan were based on the following S.M.A.R.T. principles:

- **Specific**
- **Measurable**
- **Achievable**
- **Results-based**
- **Time-based.**

Details of the proposed monitoring program are provided in **Sections 8** and include measures to monitor the effectiveness of waterway crossing structures, water quality and pollution control measures, erosion and sediment controls and habitat restoration measures.

5 Pre-construction measures

5.1 Potential impacts during pre-construction

Potential impacts to Oxleyan Pygmy Perch during pre-construction for the project include activities associated with the construction of ancillary facilities.

5.2 Management objectives

The objectives of the management strategy include:

- Targeted surveys of threatened fish species for input into the final design of waterway crossing structures and detention basins in consultation with DPI (Fisheries)
- Identify the presence or absence of potential habitat, areas of known habitat and potential corridors between existing populations of threatened fish
- Establish baseline water quality and habitat conditions of the monitoring locations
- Identify the final set of monitoring locations for Oxleyan Pygmy Perch.

5.3 Management measures

Details on the site specific mitigation measures to be implemented for Oxleyan Pygmy Perch during the pre-construction phase are detailed below and summarised in Targeted threatened species surveys.

The Woolgoolga to Ballina EA Biodiversity Technical Report (**Table 4-19** within the report) identified all sites with likely or known Oxleyan Pygmy Perch and/or Purple Spotted Gudgeon habitat as Class 1 in accordance with the standard NSW Fisheries Guidelines *Fish Passage Requirements for Waterway Crossings* (Fairfull and Witheridge 2003).

As smaller ephemeral, unnamed and often undefined watercourses are sometimes utilised by Oxleyan Pygmy Perch, such sites in close proximity to identified Oxleyan Pygmy Perch habitat were classified conservatively as Class 2 rather than Class 3 or 4 as they would normally be classified.

Two seasons of pre-construction targeted surveys were completed for Sections 1 and 2 (Woolgoolga to Glenugie) (GeoLINK 2012, Aquatic Science and Management 2013), and for Sections 6 to 11 (Iluka Road to the Richmond River) (GeoLINK 2013, 2014). Methods and results of these targeted surveys are summarised in **Section 2.2**.

The objectives of these surveys were to:

- Re-assess the likelihood of presence of threatened fish species for input into the final design of waterway crossing structures, and temporary and permanent detention basins in consultation with DPI (Fisheries)
- Identify a final list of monitoring sites that focuses on known or potential threatened fish species
- Establish baseline conditions for the habitat and water quality parameters at known threatened fish sites for ongoing monitoring during the construction and operational stages of the project.

The continuation of the aquatic monitoring program during construction and operation will focus on waterways with confirmed presence of Oxleyan Pygmy Perch based on the results of these surveys.

Inspection, monitoring and maintenance of restored habitat areas are documented in the monitoring program in **Section 8**.

5.4 Mitigation goals and corrective actions

The mitigation goals and corrective actions for Oxleyan Pygmy Perch required to be conducted prior to the commencement of construction are summarised in **Table 5.1**.

Table 5-1 Mitigation goals and corrective actions - Pre-construction

Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions	Responsible party for corrective action implementation
Re-assess the likelihood of presence of threatened fish species for input into the final design of crossing structures and basins in consultation with DPI Fisheries.	Conduct targeted surveys during detailed design focused on all waterways identified as potential habitat for the targeted species. Use outcomes of the survey to inform the detailed design and locations of mitigation measures.	Two targeted surveys are to be conducted in all waterways identified as potential habitat prior to construction. This is to be timed between June and September.	Targeted surveys and baseline monitoring has not been completed during the appropriate season prior to construction of the relevant section. *These targeted surveys have been completed and summarised in Section 2.	Delay construction of project sections until targeted surveys and baseline monitoring has been undertaken in the appropriate season. *These targeted surveys have been completed and summarised in Section 2.	Project Contractor Project Ecologist
Identify the presence or absence of potential habitat, known habitat, and potential corridors between existing populations.	Identify any areas of known habitat or potential corridors between existing populations during the habitat monitoring.	Two surveys conducted prior to construction at the same time as fish surveys.	*These targeted surveys have been completed and summarised in Section 2.		
Identify baseline water quality conditions.	Conduct water quality surveys to establish thresholds for ongoing monitoring.	Monthly, commencing at least 6 months prior to construction. Then weekly during construction.	Baseline water quality monitoring has not been completed prior to the commencement of construction of the relevant section.	Delay construction in relevant sections until the required period of baseline water quality monitoring has been achieved.	Project Contractor Project Ecologist
Identify final set of monitoring locations.	Develop a pre-construction monitoring program to adequately monitor annual variation in abundance of Oxleyan Pygmy Perch.	Initial site inspection prior to the pre-construction environmental monitoring program. Monitoring to include water quality, fish surveys and habitat assessment. Monitoring to be conducted outside breeding season. Annual pre-construction surveys at selected sites.	Pre-construction site inspection and monitoring has not been completed. Monitoring sites have not been selected and agreed with DPI (Fisheries).	Delay construction in the relevant sections until the site inspections and monitoring have been completed, and monitoring sites selected and agreed with DPI (Fisheries).	Project Contractor Project Ecologist

6 Construction management measures

6.1 Potential impacts during construction

Potential impacts to Oxleyan Pygmy Perch during construction for the project include:

- Disturbance and degradation to stream habitat
- Pollution, contaminant runoff or other reduction/alteration in water quality
- Changes in hydrological conditions
- Loss of connectivity/barriers to movement
- Altered flow conditions creating instream barriers to threatened fish movements
- Proliferation of instream weeds and littoral rainforest weeds associated with loss of riparian vegetation. These weeds are known to dominate native riparian vegetation, and disrupt the natural structure and function.
- Disturbance of acid sulfate soils decreasing pH in downstream areas outside the construction corridor if not contained
- Creation of suitable habitat and conditions for noxious aquatic flora and fauna, especially Eastern Gambusia.

6.2 Management objectives

The objectives of the management strategy for Oxleyan Pygmy Perch during construction include:

- No negative impact to threatened fish species.
- Minimal change to in-stream habitat i.e. macrophyte, woody debris, benthic material and riparian habitat
- No deterioration in water quality relative to the thresholds established during pre-construction monitoring in the vicinity or downstream of the construction works
- No change in natural stream flow and velocity
- No increase in abundance of Eastern Gambusia or other noxious aquatic flora and fauna
- Promote awareness among construction staff, contractors and the general community of threatened species and sound environmental practices
- Successful translocation of threatened fish species.

6.3 Management measures

6.3.1 Work method statements

Work method statements will be prepared for specific activities to ensure sound environmental practices are implemented and to minimise the risk of environmental incidents or system failures, in accordance with the CEMP. This management plan will be included as an annexure to the project CEMP.

Work method statements will be prepared in consultation with DPI (Fisheries), Roads and Maritime and the relevant project environmental manager prior to the commencement of identified activities to address all Oxleyan Pygmy Perch management requirements during construction.

6.3.2 Inductions and training

Inductions and training will be conducted with all staff and contractors working in Sections 6 to 9 of the project area where there is known Oxleyan Pygmy Perch habitat. This training will inform contractors and other staff of known and potential locations for Oxleyan Pygmy Perch. Training will include identification of habitat characteristics for the species, outline of key threats related to work being undertaken, and requirements for minimising and mitigating potential impacts. The importance of following the protocols in this plan will be made clear for all personnel requiring access to the site.

6.3.3 Construction near waterways and waterway crossings

Significant threats to Oxleyan Pygmy Perch during construction include:

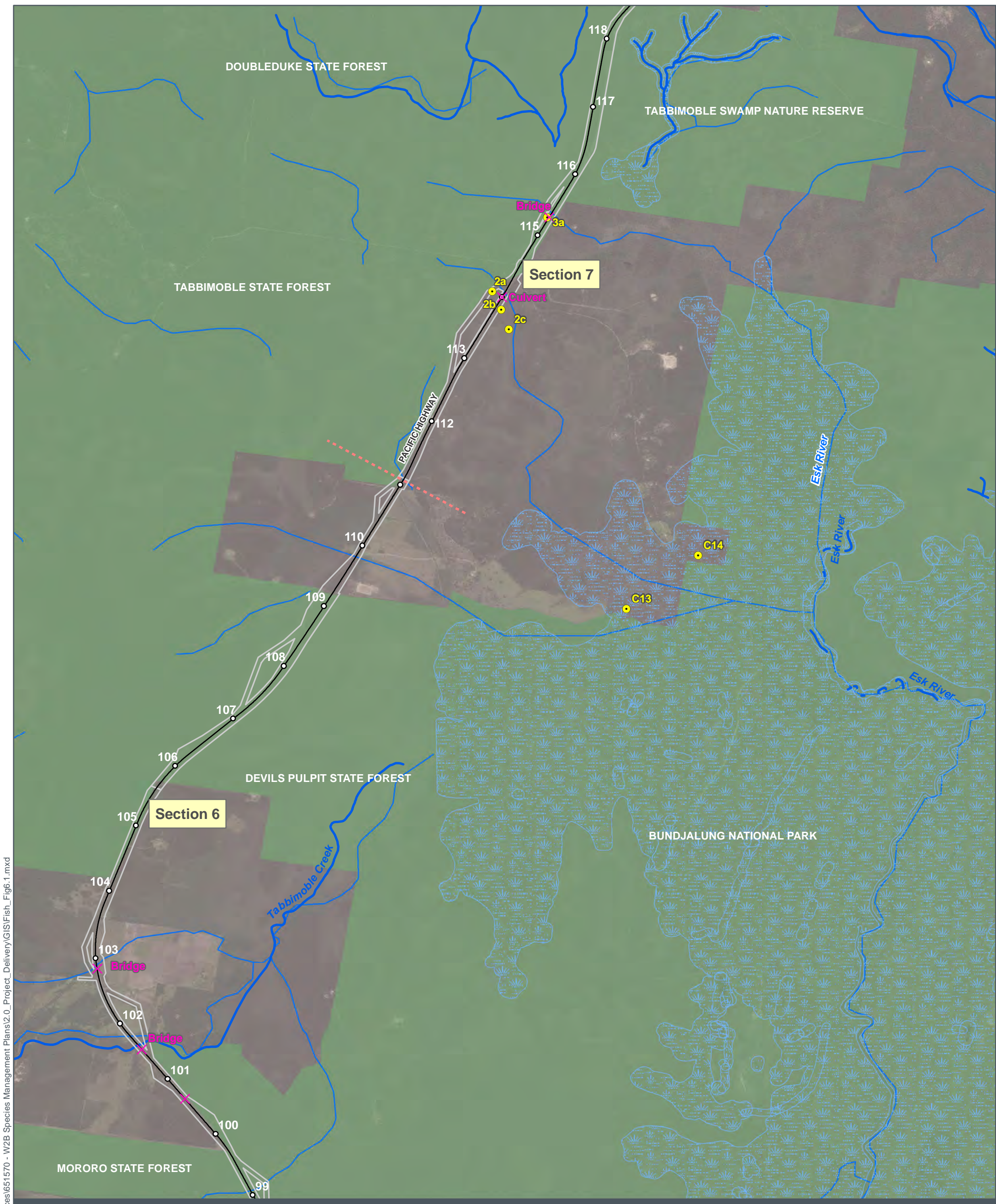
- Disturbance and loss of habitat
- Creation of habitats conducive to infestation by noxious aquatic flora and fauna species, particularly Eastern Gambusia
- Habitat and population fragmentation occurring either side of the current highway, within and outside of the construction zone
- Changes to hydrologic and hydraulic regimes
- Creation of temporary and permanent instream barriers
- Reduction in water quality.

Bridges are planned for all Class 1 waterways (Fairfull and Witheridge 2003) in accordance with MCoA B40, unless otherwise agreed with DoE and DPI (Fisheries). Where feasible, bridge supports will not be constructed in the main channel and on stream banks, so as to minimise alteration to water flow and/or damage to stream bank vegetation. Due to the dispersal methods and habitat preferences of the Oxleyan Pygmy Perch unnamed ephemeral drainage lines with marginal Oxleyan Pygmy Perch habitat were conservatively classified as Class 2 (rather than Class 3 or 4). The proposed structure for these waterways were further discussed with DPI (Fisheries) (refer to workshop notes **Appendix F**) will be further addressed based upon the results of the pre-construction surveys.

The Oxleyan Pygmy Perch connectivity structures required for Sections 6 to 9 of the project include:

- Section 7: Unnamed waterway south of Serendipity Rd (chainage 114.000) (DPI Fisheries is satisfied with the proposal of a culvert extension due to the advice provided by Mat Birch that there is no significant OPP habitat upstream)
- Section 7: Tabbimoble Floodway No. 1 (chainage 115.300)
- Section 8: Unnamed waterway south of MacDonalds Creek (chainage 134.600)
- Section 8: MacDonalds Creek tributary (chainage 135.520)
- Section 8: MacDonalds Creek (chainage 136.600)
- Section 9: Montis Gully tributary upstream of chainage 141.180
- Section 9: Montis Gully tributary upstream of chainage 141.890

Oxleyan Pygmy Perch connectivity structures are illustrated in **Figure 6-1** and **Figure 6-2**. The requirement, or otherwise, for Oxleyan Pygmy Perch connectivity structures has been discussed with, and agreed upon, by the DPI (Fisheries).



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ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans LEGEND LOCATION DIAGRAM

Figure 6.1
Oxleyan Pigmy Perch
Connectivity Structures
Sections 6 and 7

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○ Chainage (kilometres)	● Oxleyan Pigmy Perch record (W2B)
— Alignment	✕ Connectivity structure
- - - Section change	— Key fish channels
▭ Project boundary	▭ Oxleyan Pigmy Perch habitat

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Figure 6.2
Oxleyan Pigmy Perch
Connectivity Structures
Sections 8 and 9

○ Chainage (kilometres)	● Oxleyan Pigmy Perch record (W2B)
— Alignment	✕ Connectivity structure
- - - Section change	— Key fish channels
▭ Project boundary	▨ Oxleyan Pigmy Perch habitat

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6.3.4 Risk Assessment

A risk assessment will be undertaken to identify high and low risk construction activities. Low risk activities are considered those which require little or no ground disturbance within a 25 m radius, and have minimal pollution sources with the potential to reach the waterways. High risk activities will be subject to design principles and timing requirements.

Low risk activities may include:

- Crainage
- Decking work
- Formwork reinforcement
- Scaffolding
- Stripping of formwork
- Waterproofing
- Guard rail installation.

High Risk activities as defined in the MCoA include:

- Piling in the waterway and within the bed and banks
- Construction of temporary works platforms within the waterway
- Installation and removal of temporary waterway crossings
- Concreting of bridge abutments, deck and parapets
- Vegetation clearing within 50 metres of Oxleyan Pygmy perch habitat waterways
- Placing fill (bulk earthworks) on the floodplains within 50 metres of Oxleyan Pygmy Perch habitat waterways
- Lime stabilisation work within 50 metres of Oxleyan Pygmy Perch habitat waterways
- Underboring of Oxleyan Pygmy Perch habitat waterways.

Oxleyan Pygmy Perch management areas have been identified based on proximity to proposed high risk activities and include:


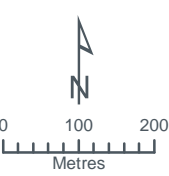

- Section 6: Tabbimoble Creek (chainage 101.100 to 102.000)
- Section 6/Section 7: Tabbimoble Floodway No.1 (chainage 113.500 to 115.600)
- Section 6/Section 7: Devils Pulpit, Oxleyan Pygmy Perch management required for Class M upgrade, consistent with Devils Pulpit Upgrade management measures
- Section 9: Lang Hill – Broadwater (chainage 134.200 to 142.500)

Oxleyan Pygmy Perch management areas are presented in **Figure 6-3**, **Figure 6-4** and **Figure 6-5**. These management areas are areas in which no high risk activities can occur during the Oxleyan Pygmy Perch spawning period (October to April), or on days when the relevant Bureau of Meteorology site predicts a 90% chance of 10 mm of rain or more as is consistent with MCoA B7.

The requirement, or otherwise for Oxleyan Pygmy Perch management areas was discussed and agreed upon with DPI (Fisheries).

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Figure 6.3 Oxleyan Pigmy Perch Management Area Section 6		<ul style="list-style-type: none"> ○ Chainage (kilometres) — Alignment - - - Section change □ Project boundary 	<ul style="list-style-type: none"> ↘ Flow direction — Contours — Key fish channels ▨ Oxleyan Pigmy Perch habitat ▨ Management area 	  1:10,000 (A3) GCS GDA 1994																		
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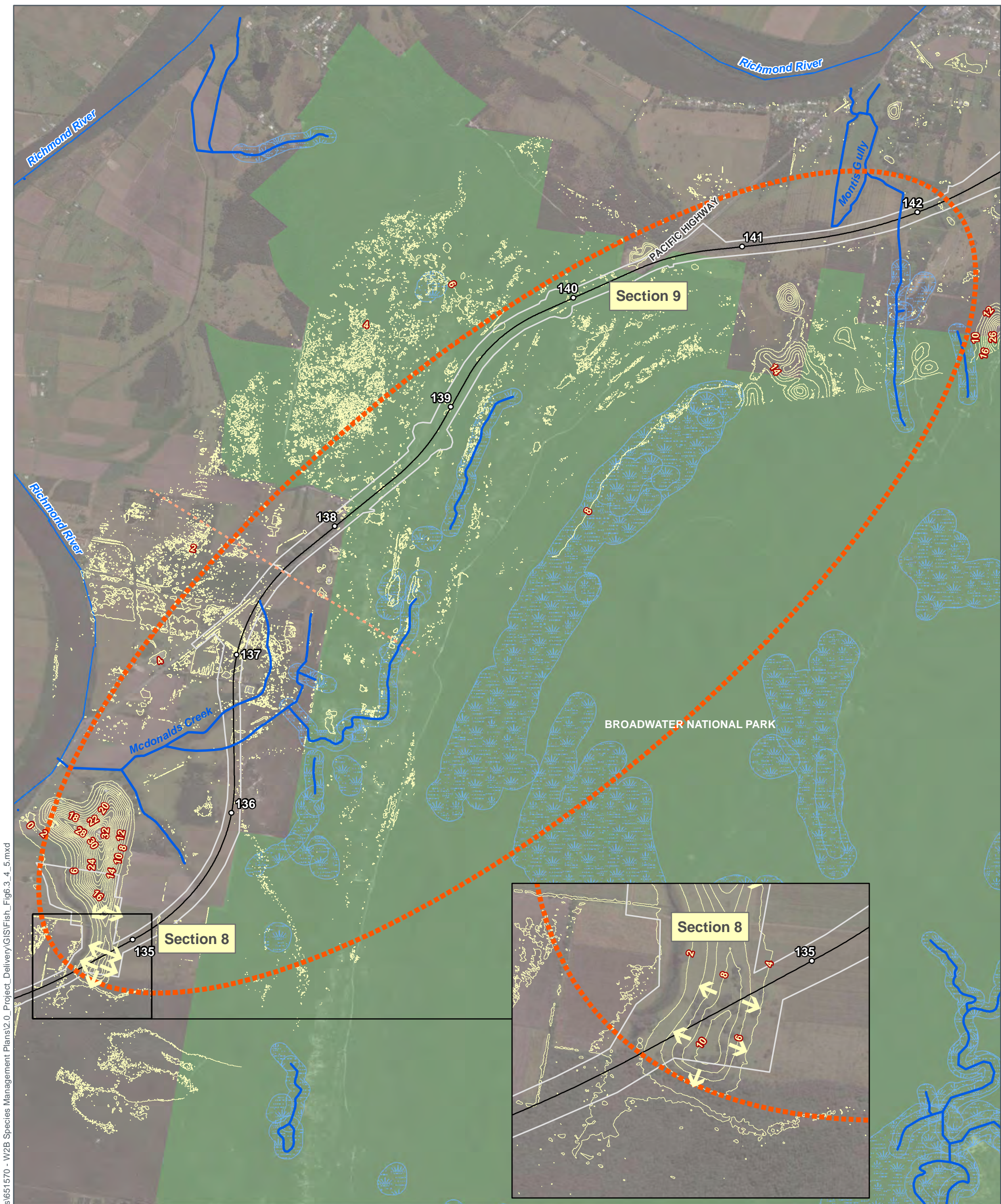
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Figure 6.4 Oxleyan Pigmy Perch Management Area Section 7		LEGEND		LOCATION DIAGRAM																			
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ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans LEGEND LOCATION DIAGRAM

Figure 6.5 Oxleyan Pigmy Perch Management Area Sections 8 & 9

- Chainage (kilometres)
- Alignment
- - - Section change
- ▭ Project boundary
- ➔ Flow direction
- Contours
- Key fish channels
- ▨ Oxleyan Pigmy Perch habitat
- ▭ Management area

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6.3.5 Design principles

In locations where Oxleyan Pygmy Perch are known to occur, a number of design principles and management measures apply. These design principles meet the principles for Ecologically Sensitive Design (ESD) and have been adopted from the Biodiversity Connectivity Strategy in consultation with DPI. The design principles and management measures include:

- During construction, clearance of riparian vegetation would be minimised to the least possible extent, and post-construction targeted rehabilitation would be undertaken in accordance with MCoA B13
- Permanent waterway crossings would be designed to ensure no physical, hydraulic and behavioural barriers to aquatic fauna movements, in accordance with SPIR condition MCoA B22, ensuring that:
 - Creek crossing structures designed to maximise light penetration
 - Natural stream flow and velocity be maintained as closely as possible
 - Surface level of causeway be the same or lower than the natural level of the stream bed to reduce interference with flow
 - Habitat within a culvert be as natural as possible (example allow rock and bed material to infill culvert base). To achieve this, the culverts will be designed to encourage the deposition of sediment, creating similar bed substrate to adjacent creek and the planting of specific plant species
 - Fauna and fish passage standards are maintained, as detailed in the Connectivity Strategy, including minimum design widths, including for natural banks, while also providing for scour protection and cut and fill batters
 - Bridges will be designed and sized to ensure peak flood velocities are not increased by more than one metre per second than the existing flood event, where Oxleyan Pygmy Perch have been confirmed.
- Bridge structures would be designed to minimise impacts to flow regimes and fish passage in light of the following principles, in accordance with MCoA B23:
 - Bridges are to be single span bridges with piers to be located outside the main channel
 - Bridge structures to be designed to prevent an increase of backup of water during times of flood, which may enable Eastern Gambusia to access waterbodies where they are currently not found (e.g., Broadwater National Park)
 - Construction would not alter or reduce flow where there are existing or potential Oxleyan Pygmy Perch populations (primarily within Sections 7, 8 and 9).
- As per MCoA B40, all crossings of Class 1 watercourses in known Oxleyan Pygmy Perch habitat shall be designed and constructed with a bridge or arch structure and, where feasible and reasonable, no supporting structures shall be installed within affected waterways.
- Where an Oxleyan Pygmy Perch habitat waterway is realigned or its stream profile is changed, or an in-stream structure is installed in the waterway (both permanent and temporary construction structures), the final design of that waterway will not result in water velocities exceeding 0.4 metres per second under normal flow conditions as per MCoA 41.
- As per MCoA B42, design and rehabilitation considerations will ensure that afflux of waterways with known Oxleyan Pygmy Perch habitat will not increase by more than the relevant flood management objective in the documents referred to in condition A2 for flood events up to the 1 in 100 year event
- Where there are known populations of Oxleyan Pygmy Perch construction would not alter or reduce flow. Waterway crossings in areas of Oxleyan Pygmy Perch habitat will be designed such that water velocities through structures do not inhibit Oxleyan Pygmy Perch passage under normal

flow conditions. This will be achieved by maintaining the existing substrate and vegetative habitat as controls hydraulic diversity and maintaining the pre-disturbance cross-sectional area of the waterway

- Standard operational spill basins be installed at key locations and other key drainage lines that lead directly into Oxleyan Pygmy Perch habitat. As such, all road surface runoff that have drainage lines leading directly into Oxleyan Pygmy Perch habitat will be directed into operational spill basins
- Implementation of erosion and sediment control and pollution control measures to avoid impacts to aquatic ecosystems and water quality, in accordance with MCoA B34, and as detailed in **Section 6.3.9**
- Bridge construction would consider the impact of high pH runoff on Oxleyan Pygmy Perch habitats as a result of concreting activities. There is a potential risk that runoff could increase pH of the receiving waterway if discharged from concreting sites. To reduce this risk to low, the following mitigation measures are proposed and further discussed in the Water Quality Paper:
 - Using pre-formed concrete piles and girder elements to minimise the need for concrete pouring in floodways
 - Reinforced form work incorporating water tight seals at all joints
 - A shroud suspended under the bridge deck to intercept any spills that might occur in the event of any form work seepage
 - Timely off-site disposal of any seepage caught in the shroud by the on-site supervision team
 - Covering recently poured bridge decks with impermeable and durable plastic to prevent alkaline run-off entering waterways
- No water resulting from construction will be released directly into Oxleyan Pygmy Perch habitat. The release of water would only occur under the following conditions:
 - Release of stored water into areas where Oxleyan Pygmy Perch are known or have potential to occur would only be undertaken as a last resort
 - Released water would be a pH level that matches the mean pre-construction pH determined during baseline monitoring of the waterway, to within 1 pH unit
 - Chemical treatments used prior to the release of water from sediment basins would not persist in the environment or negatively impact upon the environment after release
 - Potential pre-release water treatments and/or their derivatives would be included as parameters in baseline water quality monitoring
- After construction, river banks would be restored to protect them against erosion. This will include the revegetation with local riparian species, the instillation of scour protection and a slope that is no steeper than the natural river bank that they replaced as outlined in **Section 6.3.10**.

6.3.6 Timing requirements

The following provides construction timing requirements for Oxleyan Pygmy Perch in accordance with MCoA B7:

- High-risk construction activities in known Oxleyan Pygmy perch habitat shall not be undertaken in the Oxleyan Pygmy Perch spawning period as defined in the MCoA (October to April)
- High-risk construction activities in known Oxleyan Pygmy Perch habitat shall not be undertaken on days when the relevant Bureau of Meteorology site predicts a 90% chance of 10 mm of rain or more, unless otherwise agreed with DPI (Fisheries)
- Prior to commencement of any in-stream works DPI (Fisheries) will be consulted regarding timing of such activities.

6.3.7 Temporary watercourse crossings

Temporary watercourse crossings will be required during construction to facilitate equipment and personnel access to the construction works. Wherever possible, existing crossings will be used, however where this is not feasible, the construction and operation of temporary watercourse crossings will be designed to minimise impacts to the existing aquatic ecology and water quality values and to ensure that connectivity is maintained during construction. During detailed design, locations for temporary watercourse crossings, the type of crossing, the duration each crossing will be established for the management and mitigation measures specified for each crossing location.

Temporary watercourse crossings may include bridges, arches, multi-celled culverts, box culverts and pipe culverts. Where temporary access tracks occur over drainage lines with no flow, fords may be installed. The potential impacts of these temporary watercourse crossings on aquatic ecology values depends upon the type of waterway crossing, the duration that the crossing is in place and the type and volume of traffic that would use the waterway crossing. The type of temporary watercourse crossing used have been determined in consultation DPI (Fisheries). General temporary watercourse crossing and access track mitigation, as well as specific mitigation in accordance with MCoA conditions, include:

- Temporary bridge or arch structures in known Oxleyan Pygmy Perch habitat shall be used if the crossing is intended to be in place for more than three months (MCoA B8)
- Temporary culvert crossings would be constructed from clean fill using pipe or box culvert cells to carry flows. Where the watercourse is a known Oxleyan Pygmy Perch habitat, temporary crossings will be installed so as to not directly impact the watercourse bed, or impact water flow or fish passage
- Where temporary crossings in known Oxleyan Pygmy Perch habitat are proposed using with culverts, the Applicant shall, in consultation with DPI (Fisheries):
 - Determine the size of the culvert or pipes to facilitate fish passage; and
 - Identify the minimum size of clean rock to be used to ensure that rock material will not wash into the waterway in periods of high flows (MCoA B9)
- Where short duration crossing are proposed using culverts or pipes, these will be of adequate size to minimise flow velocity while maintaining light penetration to facilitate fish passage. The requirements will be determined in consultation with DPI (Fisheries)
- Installation and subsequent decommissioning of temporary waterway crossings would be undertaken outside of the peak Oxleyan Pygmy Perch spawning season as defined in the MCoA (October to April) in known Oxleyan Pygmy Perch habitat (MCoA B9)
- All temporary water crossings and culverts will be constructed in accordance with *Guidelines for Controlled Activities Watercourse Crossings* (DPI 2008) and, *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (Fairful and Witheridge 2003) and with consultation of OEH, DPI (Fisheries), DoE and Roads and Maritime such that there are no barriers or impedances to instream fish movement (MCoA B38)
- All temporary works (e.g. crossings, flow diversion barriers) would be removed as soon as practicable and in a way that does not promote future channel erosion
- Where necessary waterways may need to be temporarily diverted to allow structures to be placed in order to minimise impacts to water quality
- The preferred temporary structure for crossing waterways would be consistent with Witheridge (2002) where the use of bridges is the preferred structure for Class 1 (major fish habitat waterways) (MCoA B40)
- Scour protection on both sides of the waterway at temporary crossing structures within 50 m of Class 1 waterways or within the range of the Oxleyan Pygmy Perch
- All temporary waterway crossings will be well maintained, free of fine material and capable of withstanding inundation in high flows
- At the completion of construction, the temporary crossings would be removed and rehabilitated.

6.3.8 Translocation

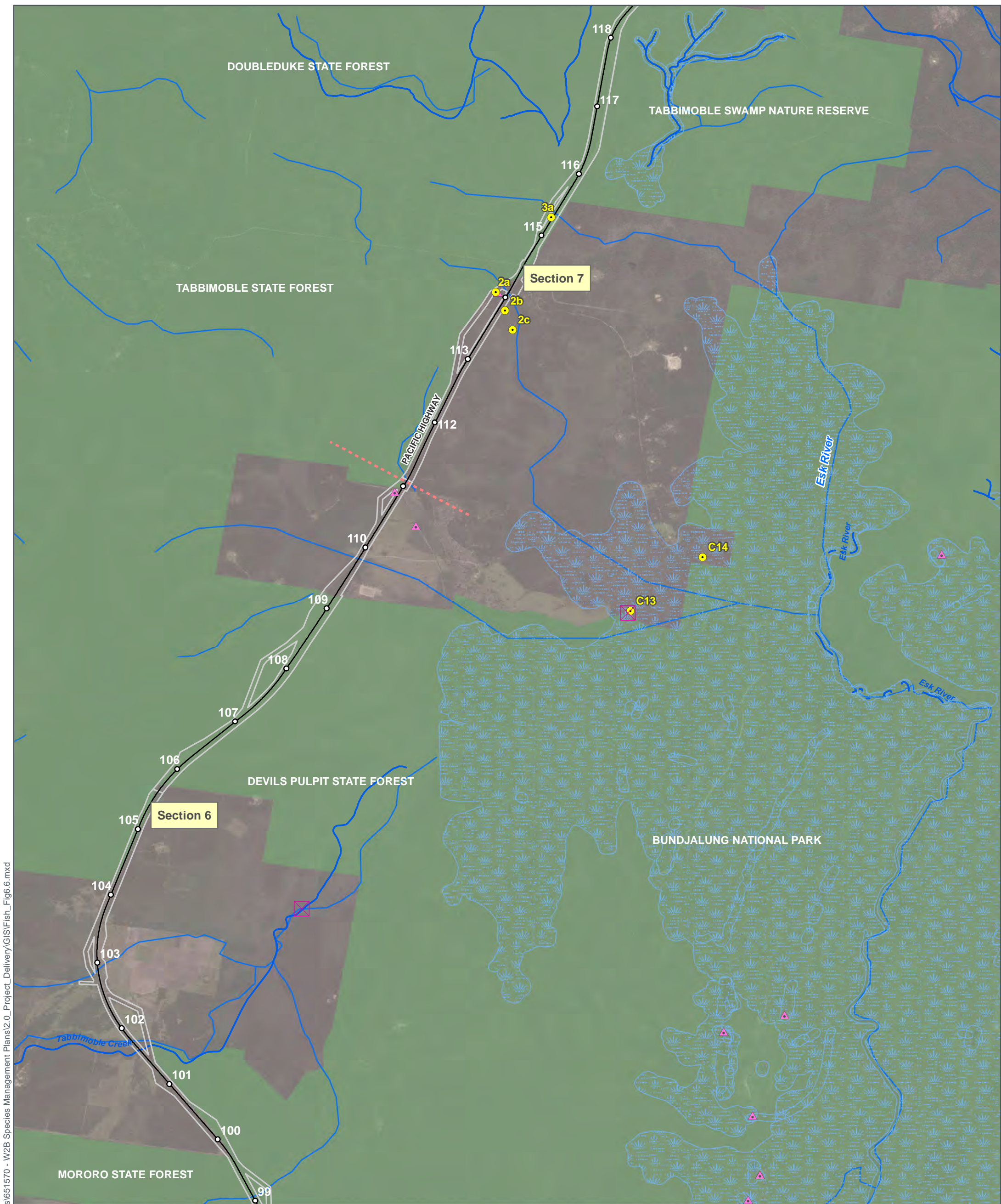
An Oxleyan Pygmy Perch Translocation Protocol has been prepared (GeoLINK 2015) in consultation with DPI (Fisheries) and is attached as a part of **Appendix E (f)**. It is noted that a permit is required to capture and hold threatened species, and there are biosecurity issues to be addressed with respect to fish proposed to be held in captivity and subsequently released. However, the following section provides the basis for the proposed translocation protocol.

Every effort will be made to avoid any disturbance to the stream channel and in-stream habitat during construction; however, some level of disturbance will be unavoidable at certain sites. At any site where instream disturbance (i.e., dewatering, creek diversion) is likely to occur, an experienced fish ecologist will be engaged to determine whether translocations will be necessary.

Oxleyan Pygmy Perch have been successfully maintained in aquaria (McDowall 1996) and therefore it would be feasible that these species could be cleared from the immediate impact area and held in aquaria for the duration of the proposed construction activities. However, the preferred strategy is for any individual cleared from the proposed construction area to be translocated to nearby suitable habitat that is unlikely to be affected by the construction activities. The suitability of these sites will be determined based on water quality and habitat availability, permanency and connectivity, as well as potential impact from construction activities.

There are many sites adjacent to the project where Oxleyan Pygmy Perch have previously been observed (GeoLINK 2012, 2013, 2014). The pre-construction surveys identified a large amount of variation in the distribution and abundance of Oxleyan Pygmy Perch. As Oxleyan Pygmy Perch use flood conditions to opportunistically recruit to new areas (Knight and Arthington 2008), it is possible that they might be caught outside of known locations during routine fish salvage operations along the project alignment. The likelihood of this occurring increases with increasing proximity to watercourses where Oxleyan Pygmy Perch have previously been observed. Conversely, not all sites where Oxleyan Pygmy Perch have previously been observed may be suitable for translocation due to the potential of site drying out at times of low rainfall. For this reason, priority release sites have been proposed for Oxleyan Pygmy Perch by translocation management area.

The preliminary priority Oxleyan Pygmy Perch translocation sites were chosen in consultation with DPI (Fisheries) and are provided in **Table 6.1** and displayed in **Figure 6-6** and **Figure 6-7**. All sites represent secure habitat for Oxleyan Pygmy Perch during periods of dry, have suitable habitat and water quality conditions and are in proximity to areas where Oxleyan Pygmy Perch have previously been observed. In most cases they are downstream of areas where Oxleyan Pygmy Perch are likely to be captured during translocation operations. Standard procedure is to relocate aquatic fauna downstream of the capture site to avoid the potential for moving pathogens or weeds upstream. The opposite is suggested for Oxleyan Pygmy Perch in order to increase the potential for migration back into affected areas (GeoLINK 2015). Therefore, translocation sites have been generally selected upstream but in situations where upstream environments are not suitable, downstream sites are provided. Where possible two priority translocation sites have been proposed in case large numbers are captured, or a site is deemed inappropriate at the time of translocation.



Path: W:\PROJECTS\Roads & Maritime Services\651570 - W2B Species Management Plans\2.0_Project_Delivery\GIS\Fish_Fig6.6.mxd

ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans LEGEND LOCATION DIAGRAM

Figure 6.6 Proposed Oxleyan Pygmy Perch Translocation Sites

WORK REQUEST NUMBER: RMS

DATA SOURCES:
Topographic Vector Series 3 © Commonwealth of Australia (Geoscience Australia) 2006

○ Chainage (kilometres)	● Oxleyan Pygmy Perch monitoring record (W2B)
— Alignment	▲ Oxleyan Pygmy Perch historic record
- - - Section change	⊠ Translocation site
▭ Project boundary	— Key fish channels
	▭ Oxleyan Pygmy Perch habitat

ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
15/05/2015	JH	CC	BE	0	Issued for Use
24/03/2015	JH	MD	BE	A	Issued for Review

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Table 6-1 Preliminary priority Oxleyan Pygmy Perch translocation sites

Project Section	Chainage Area	Oxleyan Pygmy Perch Survey Site	Priority translocation sites		Notes*
			Easting	Northing	
6	101000 – 109000	N/A	56J 0523168	UTM 6760125	Oxleyan Pygmy Perch have not previously been captured from this chainage area. The most suitable translocation site is F4 from the Biodiversity Offset Study, which is located on private land approximately 2.5 km downstream of the project area.
6 - 7	109000 - 118000	2b, 3a	56J 0535020	UTM 6764444	Release at Site 4 from Devils Pulpit Upgrade Project, post-construction monitoring. Located on private land approximately 2.5 km downstream of project area.
			56J 0527280	UTM 6764362	Release at Site C13 from pre-construction surveys. Located in National Park approximately 3.5 km downstream of the project area.
7 – 8	118000 – 132000	N/A	As above or below	As above or below	There are no suitable translocation sites in the immediate area. Oxleyan Pygmy perch have not previously been captured in this chainage area. If Oxleyan Pygmy Perch are captured during dewatering, translocate to the priority sites listed for Sections 6 -7, or 8.
8	132000 – 136000	10b, 11d	56J 0538410	UTM6783404	Release near Site C7 from pre-construction surveys. Located in Broadwater National park approximately 1.5 km upstream of the project area.
8 – 9	136000 – 138000	12a	56J 0538541	UTM 6786519	Release at Site 22c from pre-construction surveys. Located on private property approximately 0.8 km downstream of the project area.
			56J 0539183	UTM 6787174	Release at Site C1 from pre-construction surveys. Located in Broadwater National Park approximately 1.5 km downstream of the project area.
9	138000 – 140000	16b	56J 0539475	UTM 6787861	Release at Site 27e from pre-construction surveys. Located in Broadwater National Park approximately 0.4 km upstream of the project area.
9	140000 – 143000	13e, 13c	56J 0541890	UTM 6788671	Release site is a large farm dam on private property approximately 0.7 km upstream of the project area.
			56J 0541028	UTM6788743	Release at Site 26d from pre-construction surveys. Located on private property approximately 0.4 km upstream of the project area.
9	143000 – 160000	N/A	As above	As above	There are no suitable translocation sites in the immediate area. Oxleyan Pygmy perch have not previously been captured in this chainage area. If Oxleyan Pygmy Perch are captured during dewatering, translocate to the priority sites listed for Sections 9.

*Release site on private property are subject to access arrangements.

While the priority translocation sites were identified based on known Oxleyan Pygmy Perch locations, as having suitable habitat conditions and retain water in dry periods, the suitability of translocation sites should be re-confirmed at the time of release.

Should translocations be required, the following procedures will be employed to minimise the risk of mortality to individuals during the process:

- For all known Oxleyan Pygmy Perch habitat, capture methods should be limited to bait traps, dip nets and backpack electro-fishing as per the methods described in *Surveying Australia's Threatened Fish* (DSEWPaC 2011)
- Fine mesh nets spanning the width of the watercourse would be placed upstream and downstream of the dewatering area
- Large numbers of unbaited box traps should be deployed immediately prior to commencing dewatering and during the early stages of pumping to maximise the capture of Oxleyan Pygmy Perch in the least disruptive fashion
- A backpack electro-fisher and dip nets would be the most effective capture method as water levels recede
- An experienced aquatic ecologist should remain on site for the duration of the dewatering process to ensure no Oxleyan Pygmy Perch are stranded
- Oxleyan Pygmy Perch should be transported to translocation sites in separate containers to minimise potential for negative interactions with other species
- Suitable habitat and water quality conditions should be confirmed at the release site immediately prior to capture effort
- No more than 30 Oxleyan Pygmy Perch are to be held in captivity at one time
- Oxleyan Pygmy Perch are to be held in captivity for no longer than one hour prior to release
- Oxleyan Pygmy Perch being held in captivity in preparation for translocation are to be isolated from other species
- Any invasive aquatic species (Eg. Eastern gambusia) captured during this process will be humanely destroyed
- Any Oxleyan Pygmy Perch found dead during activities should be retained and provided to scientific institutions for aging and genetic studies
- Equipment should be cleaned/sterilised before use at each site
- Individual fish should be visually inspected for health condition. Introduction of *Lernaea* or other pathogens into populations that do not have it would be a concern
- Fish must be identified to species level by a trained person to help prevent mis-identification and translocation of pest species
- Fish should not be caught when air or water temperatures are extreme – e.g. midday, mid-summer. Be aware that small holding containers are subject to rapid temperature changes
- Aerators should be used during transit.

6.3.9 Earthworks and sediment control

Detailed site-specific erosion and sediment control plans will be prepared as part of the CEMP. Experiences and findings from Devils Pulpit will be used to inform the plan for the project. Initial monitoring for Devils Pulpit has demonstrated no notable change in water quality during construction and operation. Generally, runoff from identified sites would be treated using a sedimentation basin.

The required water quality parameters for the basins discharging into this area have been identified in the CEMP based on pre-construction water quality and pre-construction threatened fish species monitoring programs and will most likely be subject to an Environment Protection Licence (EPL). During construction, discharge to waterways of water from sediment basins that does not meet the water quality requirements for Oxleyan Pygmy Perch habitat would not be permitted, but rather this water would be used for beneficial purposes (i.e., sprayed into adjacent open grass areas or used for construction purposes such as dust suppression). Discharge by diffuse method of land irrigation would be allowed only if a minimum of 50 m from a waterway, within the project boundary, and subject to negotiations with the landholder. If diffuse discharge is not feasible then water would be pumped to a proposed storage facility.

Appropriate sediment fences would be erected around any threatened fish habitat where works are on or adjacent to waterways to prevent run-off directly entering local waterways. Geofabric, would also be used where river banks are disturbed during the construction of bridges and other waterway crossings. These details would be further designed on a site-specific basis as part of the CEMP, following the outcomes of the pre-construction surveys.

All erosion and sediment control measures must be best-practice based on industry guidelines and must be certified in consultation with DPI (Fisheries). These measures include:

- The timing requirements as discussed in **Section 6.3.6** would be implemented for earthworks and sediment control
- Instream works are defined in the NSW Office of Water State Guidelines for Controlled Activities and the *Water Management Act 2000*. They include works within a watercourse or waterfront land. The definition of waterfront land includes the bed and bank of any river, lake or estuary and all land within 40 m of the highest bank of the river, lake or estuary. A **rainfall event is defined as greater than 15 mm in a 24 hour period**. It has been assumed that waterfront land refers to land on the floodplain and not land on the raised existing road level
- If required, clearing of riparian vegetation will be minimised as far as practicable, with any disturbed areas subject to rehabilitation post-construction to restore in-stream riparian habitat to at least pre-construction condition
- There would be no stockpiling of material for bridgeworks within 50 m of known areas of Oxleyan Pygmy Perch habitat
- Chemicals and fuels to be stored and bunded so that the floor of the bund is above the 1 in 20 year flood event and the top of the bund above the 1 in 100 year flood event
- Batch plants would be located greater than 300 m from Oxleyan Pygmy Perch habitat due to the risk of high alkaline runoff occurring (through spilling/overtopping). Additionally, all batch plants would have measures to capture, re-use and treat alkaline runoff
- Disturbed acid sulfate soils should be isolated from areas which could runoff towards any waterway or could flood until such time that they are properly treated
- Measures to be implemented for events such as rainfall events (more than 15 mm in 24 hours) and fuel and chemical spills
- Measures to be implemented to monitor, review and update the effectiveness of the sediment and erosion control measures implemented.

6.3.10 Habitat restoration

Post-construction, the key priority will be habitat restoration. Initially, temporary erosion control measures will be used to prevent damage to recently disturbed banks. However, where possible, native riparian vegetation (using suitable native species from the local area) within the road reserve will be planted and managed over time to consolidate the banks and provide more natural erosion control. Where revegetation would not be possible (e.g. immediately under bridge due to permanent shading) rocks and other items may be used to protect disturbed banks and reduce flow. Any disturbed river banks would be restored to their natural gradient or have a lower gradient so as not to increase hydraulic shear during high flows prior to the spawning season.

Any woody debris or rocks that are removed from the river channel during construction are to be returned to the river after construction has been completed.

Inspection, monitoring and maintenance of restored habitat areas are documented in the monitoring program in **Section 8**.

6.4 Mitigation goals and corrective actions

Mitigation goals and corrective actions for Oxleyan Pygmy Perch to be undertaken during construction are summarised in **Table 6-2**.

Table 6-2 Mitigation goals and corrective actions - Construction

Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions	Responsible party for corrective action implementation
Minimise change to in stream habitat i.e. macrophyte, woody snag cover, benthic material and riparian habitat during construction.	Management of riparian and aquatic habitats Development of construction methodologies to reduce disturbance to riparian and instream habitats Management of instream woody debris Rehabilitation of riparian and aquatic habitats near construction zones.	Monthly inspection of disturbed areas in OPP waterways	Any change to in stream habitat that is identified as being significant by the project aquatic ecologist i.e. macrophyte and woody snag cover from baseline conditions.	On guidance from the project aquatic ecologist, implement appropriate rehabilitation and reconstruction strategies as soon as practical.	Project Contractor Project Ecologist
No deterioration in water quality in the vicinity or downstream of the construction works.	Implementation of water quality control measures. Management of sedimentation and erosion.	Weekly water quality monitoring during construction and after Event (more than 15 mm in 24 hours)	Any deviation from the baseline water quality values identified for each site in Table 4-1 .	Assess the source of the issue immediately after negative water quality variation is identified. Undertake actions to control (and where necessary remediate) any impacts arising as a result of construction activities within one month of recognition.	Project Contractor Project Ecologist Project Environmental Advisor
No change in natural stream flow, turbidity and velocity.	Design to prevent and/or minimise in-stream barriers, including appropriate design of bridges and culverts to ensure no physical, hydraulic and behavioural barriers to aquatic fauna movements. Avoid the need for scour protection on the flow of waterways. For small waterways with known Oxleyan Pygmy Perch commit to keeping piers out of the main channel.	Weekly water quality monitoring during construction and after Event (more than 15mm in 24 hours) Fish survey to monitor the abundance of all species biannually.	Changes to natural stream flow or velocity result in isolation of pools containing threatened fish, making them susceptible to evaporative drying or poor water quality.	Monitoring of these isolated pools by the project ecologist to be increased until flow is restored. If the habitat native fish are deemed to be at risk, these fish will be translocated using procedures described in the Translocation Protocols (GeoLink 2015).	Project Contractor Project Ecologist Project Environmental Advisor
No new occurrences of Eastern Gambusia in waterways where they were previously not recorded.	Management of riparian and aquatic habitats. Ensure pest fish species are not moved by translocation activities for OPP. Development of construction methodologies to reduce disturbance to instream habitats. Rehabilitation of aquatic habitats near construction zones.	Survey to monitor the abundance of all fish species biannually.	Any Eastern Gambusia recorded in a waterway during ongoing aquatic monitoring where they have previously not been recorded.	Immediately following discovery, conduct further surveys to estimate abundance of Eastern Gambusia and waterway conditions. Review possible causes and consult with DPI (Fisheries) for appropriate actions.	Project Contractor Project Ecologist

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Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions	Responsible party for corrective action implementation
Minimal disturbance of riparian habitat in the vicinity or downstream of the construction works.	Management of riparian and aquatic habitats Development of construction methodologies to reduce disturbance to riparian and instream habitats. Rehabilitation of riparian and aquatic habitats near construction zones.	Monthly inspections of disturbed areas in OPP waterways Stabilisation of any exposed banks. Rehabilitation to occur as soon as practicable (within 1 month of completion of construction) and, where possible, be completed in Oxleyan Pygmy Perch habitat prior to spawning season each year.	Unnecessary residual decline in riparian vegetation in the immediate vicinity or downstream of work after construction around waterway crossings is completed.	Rehabilitation and reconstruction strategies have not been commenced within one month of the completion of waterway crossing construction.	Project Contractor Project Ecologist Project Environmental Advisor
Promote threatened fish awareness among construction staff, contractors and the general community.	Preparation of construction work method statements for specific activities. Induction training for all staff and contractors working in known and potential habitat for Oxleyan Pygmy Perch.	Each time a new staff member or contractor will be working in areas of known or potential habitat.	Induction and awareness training for personnel working near known or potential habitat not completed prior to construction. No adherence to protocols outlined in this plan.	Stop works until all personnel have completed awareness training and inductions. Re-iterate key training messages to any personnel observed in breach of this plan.	Project Contractor Project Ecologist Project Environmental Advisor
Successful translocation of threatened fish species.	Implementation of this TFMP requirements for translocation and the Translocation Strategy and monitoring of the plan to identify success or otherwise.	Monitoring of survival of translocated populations. Fish survey biannually.	No translocated threatened fish species observed in translocation sites during post-translocation monitoring.	Increase targeted monitoring in translocation sites immediately to confirm the population decline. Review suitability of translocation sites if increased monitoring confirms population decline. Review translocation strategy (GeoLink 2015) in consultation with DPI (Fisheries) within one month of confirmation of population decline.	Project Contractor Project Ecologist

7 Operational management measures

7.1 Potential impacts during operational phase

Potential impacts to Oxleyan Pygmy Perch during the operational phase of the project include:

- Disturbance and degradation to in-stream habitat
- Contamination or other reduction in water quality
- Changes in hydrological conditions
- Loss of connectivity/barriers to movement
- Creation of suitable habitat for noxious aquatic flora and fauna, especially Eastern Gambusia.

7.2 Management objectives

The performance criteria of the management strategy during operation of the project include:

- No negative impact on threatened species
- To maintain water quality within the thresholds established during the pre-construction monitoring
- To maintain critical habitat condition during operation at known and potential habitat locations for threatened fish species
- To maintain natural stream flow and velocity and connectivity for threatened fish.

7.3 Management measures

7.3.1 Water Quality

Oxleyan Pygmy Perch have a narrow set of habitat requirements and are therefore sensitive to changes in water quality conditions (**Section 3.2.3; Table 3.1**). Increased pollutant load in road runoff is the main impact to water quality associated with the operation of the project. Petrochemical runoff from the road when operational may have a toxic effect on Oxleyan Pygmy Perch in receiving waters.

To minimise the impact of runoff during the operation, runoff from the project will be directed to detention basins before being discharged to drains and then local waterways. Basins will also be located adjacent to wetlands and watercourses to protect waterways from unexpected spills. Operational spill basins will be installed at key locations and other key drainage lines that lead directly into Oxleyan Pygmy Perch habitat.

Poor water quality is known to occur throughout sections of the project. Therefore continued water quality monitoring would be important to identify baseline conditions and ensure that the project does not exacerbate existing poor water quality during the operation of the project.

The details of the monitoring program are provided in **Section 8**.

7.3.2 Maintaining flow

Water crossing structures from the concept design have been designed to minimise the impacts of altering the natural flow regimes of these waterways as a priority. The design took into consideration the class of waterways, in particular Class 1 waterways, as potential habitat for threatened fish. Detailed design of bridges and culverts will ensure that barriers to fish are not created, including the design of bridges to avoid where possible the placement of piers in the waterways.

Inspection and maintenance and cleaning of culvert structures will be done in accordance with Management Activities detailed in the Oxleyan Pygmy Perch Recovery Plan (NSW DPI 2005). Maintenance and cleaning will be undertaken by Roads and Maritime as part of regular highway maintenance in proximity and in response to an identified issue to prevent blockages in connectivity between potential habitat sites of threatened fish.

7.3.3 Maintenance of restored habitat

At the completion of construction, the bed and banks will be reinstated to a condition similar to or better than the original condition ensuring that there are no adverse impacts on the aquatic values (different measures may be required for each crossing). Banks would be graded to a slope that is no steeper than existing site conditions. These restoration areas of riparian vegetation and creek banks will be maintained as part of implementing the project's Urban Design and Landscape Plan (UDLP) requirements.

Inspection, monitoring and maintenance is specified within the Roads and Maritime specifications including R178 and R179. An increased level of maintenance and monitoring will be completed in the first twelve month period (as described in **Table 7-2**) and then tapers off as the revegetation becomes self-sustaining (as described in **Table 7-1**), but will be subject to performance measures being met. Monitoring of revegetation will continue for at least three years to ensure the successful establishment of propagules and beyond that until the health of the revegetated areas are demonstrated for three consecutive monitoring periods.

Table 7-1 Recommended monitoring and maintenance schedule (Year 1)

Monitoring	Timing	Maintenance
Site preparation	Commencement	Where weed infestations occur, spray the area for weeds prior to planting using appropriate herbicides or pesticides and to the manufacturer's specifications. Experienced weed management professionals using best practice methods will be employed near waterways to ensure no impacts to the waterways occur. Where weed infestations occur within 50 m of known threatened fish habitat, alternative methods such as hand weeding or mechanical control will be primarily used. The areas employing chemical control methods are to be left for at least two weeks prior to planting.
Watering	First month	Immediately post planting undertake watering in accordance with Specification R179. Undertake watering at 2 day intervals for four weeks after planting.
Watering	2-6 months	Watering will continue at weekly intervals gradually decreasing over time. The amount of watering will be in accordance with Specification R179.
Plant health	Monthly for 12 months	Carry out maintenance inspections of plantings at intervals not exceeding one month. Weeds not smothering plants, plants healthy with active growth, replanting required if plant survival not at required percentage. A written report to be submitted to Roads and Maritime by contractor after each maintenance inspection.
Weed control	Monthly	Keep all planting areas free of weeds. Weed removal to be undertaken at intervals not more than four weeks and ensure weeds do not flower to form seed heads. For noxious weeds take action as required by that local government authority. Dispose of weeds off site.
Plant replacement	Monthly for 12 months	The contractor will be responsible to replace missing or dead plants within fourteen days of detection. They must be of similar size and quality and identical species to that lost. Replacement plantings are to be watered for the first 12 weeks.
Stakes and tree guards	Monthly for 12 months	Repair any tree ties or tree guards that have broken or are missing. Replace as soon as practicable after being identified.

Table 7-2 Recommended monitoring and maintenance schedule (Year 2 and Year 3)

Monitoring	Timing	Maintenance
Mulch/weed suppression. Plant nutrient deficiency.	Every 6 months in Year 2 and 3.	Addition of mulch where required. Addition of fertiliser/nutrients where required. Weeds controlled within 2 m of planting locations, blanket treatment of weed areas if appropriate or targeted treatment of weed outbreaks.
Weed and plant health	Every 6 months in Year 2 and 3.	Weeds not smothering plants, healthy active plant growth, replanting required if the target percentage survival rate not achieved.

Details of monitoring methods for aquatic and riparian habitats are provided in **Section 8**.

7.3.4 Monitoring

Monitoring during the operation of the project would include fish surveys, water quality monitoring and habitat monitoring. Monitoring sites and timing for Oxleyan Pygmy Perch have been established based on the results of the pre-construction surveys and in consultation with DPI (Fisheries). Monitoring will occur bi-annually (anticipated to be in May – June and then another in August – September). This timing is specifically selected to be outside of the known spawning season of the Oxleyan Pygmy Perch. Monitoring sites are shown in **Figure 8-1**, **Figure 8-2** and **Figure 8-3**.

Where these species were absent during pre-construction surveys, no additional surveys will be undertaken, instead water quality and habitat monitoring, including monitoring of revegetated areas will be used to determine the effectiveness of mitigation measures.

Inspection, monitoring and maintenance of restored habitat areas are documented in the monitoring program in **Section 8**.

7.4 Mitigation goals and corrective actions

The mitigation goals and corrective actions for Oxleyan Pygmy Perch during operation are summarised in **Table 7-3**.

Table 7-3 Mitigation goals and corrective actions - Operations

Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Triggers for corrective actions	Corrective actions	Responsible party for corrective action implementation
To maintain critical water quality condition during operation at known habitat locations for the Oxleyan Pygmy Perch.	Implementation of water quality control measures, including detention basins and operational spill basins at identified Oxleyan Pygmy Perch and habitat locations. Water quality monitoring.	Water quality monitoring will be quarterly during operation. At least three events (in excess of 15 mm of rain over 24 hours) would be monitored during the construction period and at least three events will be monitored after the road is operational over a period of at least six months. Water quality monitoring will continue for at least 3 years after road is operational to determine whether run-off has had an adverse effect on the stream environment.	Any deviation from the baseline water quality values identified for each site in Table 4-1 .	Immediate investigation into the specific cause. Appropriate remedial action to be undertaken immediately if required in consultation with DPI (Fisheries).	Project Contractor Project Ecologist Project Environmental Advisor
To maintain natural stream flow, velocity and connectivity for threatened fish.	Inspection, maintenance and cleaning of culvert structures to prevent blockages and restricted fauna movements. Rehabilitation and restoration of disturbed areas to similar or better than original condition. Maintenance of connectivity for threatened fish.	Biannual surveys as part of the monitoring program outlined in Section 8 . A regular schedule of maintenance would be implemented by Roads and Maritime as part of regular maintenance along the highway and in response to an identified issue. Surveys as part of the monitoring program outlined in Section 8 .	Any change in habitat structure downstream of the construction area/ that are not also evident immediately upstream. Fish found to be trapped or not using crossing structures.	Immediate investigation into the specific cause so that appropriate remedial action can be taken. Review and modify monitoring program. Make physical changes to the structure or floor as appropriate.	Project Contractor Project Ecologist Project Environmental Advisor
No occurrence of Eastern Gambusia in waterways where they have not previously been recorded.	Management of riparian and aquatic habitats. Development of construction methodologies to reduce disturbance to instream habitats. Rehabilitation of aquatic habitats near construction zones.	Biannual fish monitoring to establish abundance/relative abundance of species.	Any Eastern Gambusia in OPP waterways affected by the project where they have previously not been recorded.	Immediately following discovery, conduct further surveys to estimate abundance of Eastern Gambusia and waterway conditions. Review possible causes and consult with DPI (Fisheries) for appropriate actions.	Project Contractor Project Ecologist
No observed reduction in abundance of any	Management of riparian and aquatic habitats. Development of construction	Biannual fish monitoring to establish abundance/relative abundance of species. This timing has been	Any reduction in the abundance of a known Oxleyan Pygmy Perch	Immediate investigations into cause of population reduction. Review of mitigation measures to	Project Contractor Project Ecologist Project Environmental Advisor

Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Triggers for corrective actions	Corrective actions	Responsible party for corrective action implementation
know Oxleyan Pygmy Perch population deemed to be in excess of natural fluctuations.	methodologies to reduce disturbance to instream habitats. Rehabilitation of aquatic habitats near construction zones.	specifically selected so as to not affect the spawning of the species.	population deemed to be in excess of natural fluctuations.	improve OPP habitat/water quality within the specific area of habitat where population decline noted.	
To restore riparian and instream habitat at known and potential habitat locations for the Oxleyan Pygmy Perch.	This will be addressed in more detail in the Project Habitat Rehabilitation Plan. Bed and banks will be reinstated to a condition similar to or better than the original condition.	For the first twelve months monitoring of revegetation will be monthly. It will then go to every 6 months for years two and three. Monitoring will occur in Spring/Summer to evaluate the success of revegetation against performance objectives.	Monitoring and maintenance activities not being undertaken. More than 10% of plants have died after year one, and more than 20% have died after three years. Bed and banks not reinstated to a condition similar to or better than their original condition.	Review maintenance schedule for revegetated areas within one month of trigger being identified and plant more feed and habitat trees as required. Immediate investigation into the specific cause of decline in condition of the bed and banks so that appropriate remedial action can be taken.	Project Contractor Project Ecologist Project Environmental Advisor

8 Monitoring program

Monitoring will be undertaken to determine the effectiveness of mitigation measures and will specifically be focused at the Oxleyan Pygmy Perch monitoring sites identified during the pre-construction surveys. The monitoring program described below may need to be refined if new locations of Oxleyan Pygmy Perch or other threatened fish species are found.

8.1 Objectives

Monitoring will be conducted during construction and operation where known Oxleyan Pygmy Perch populations may be impacted, and for a period until such time as the mitigation measures have been proven to be effective over three consecutive monitoring periods.

Monitoring will provide information such that sound conclusions can be drawn in relation to management of threatened species. The overall monitoring objectives include:

- Evaluate the success of mitigation measures (including erosion and sediment control and pollution control measures)
- Determine the extent of secondary impacts of the project on Oxleyan Pygmy Perch populations and identify any additional mitigation measures that may minimise these impacts such as connectivity, stream mitigation, water quality and restoration of habitat
- Determine the effectiveness of bridge design and bank rehabilitation in the management of Oxleyan Pygmy Perch.

The monitoring can be refined, subject to progress against the above matters. In order to fulfil these objectives a number of ecological variables will be monitored, with each variable discussed below.

The monitoring sites will be those used during pre-construction surveys for Sections 6 to 9 where known populations of Oxleyan Pygmy Perch have been recorded and where suitable habitat exists for Oxleyan Pygmy Perch. Monitoring sites are illustrated in **Figure 8-1**, **Figure 8-2**, and **Figure 8-3**. The need for ongoing monitoring in these project sections would be confirmed at the end of the targeted surveys and depend on the presence of known and potential habitat for threatened species.

8.2 Fish surveys

8.2.1 Methods, timing, intensity and duration

Impact and control site selection

Bi-annual targeted threatened fish monitoring is estimated to occur in May/June and August/September and align with the methods undertaken for pre-construction surveys to date (GeoLINK 2013, 2014). The timing of these surveys have been designed so as to have no effect on the spawning of the Oxleyan Pygmy Perch. Surveys will be conducted until performance objectives and mitigation measures are shown to be met for three consecutive monitoring periods.

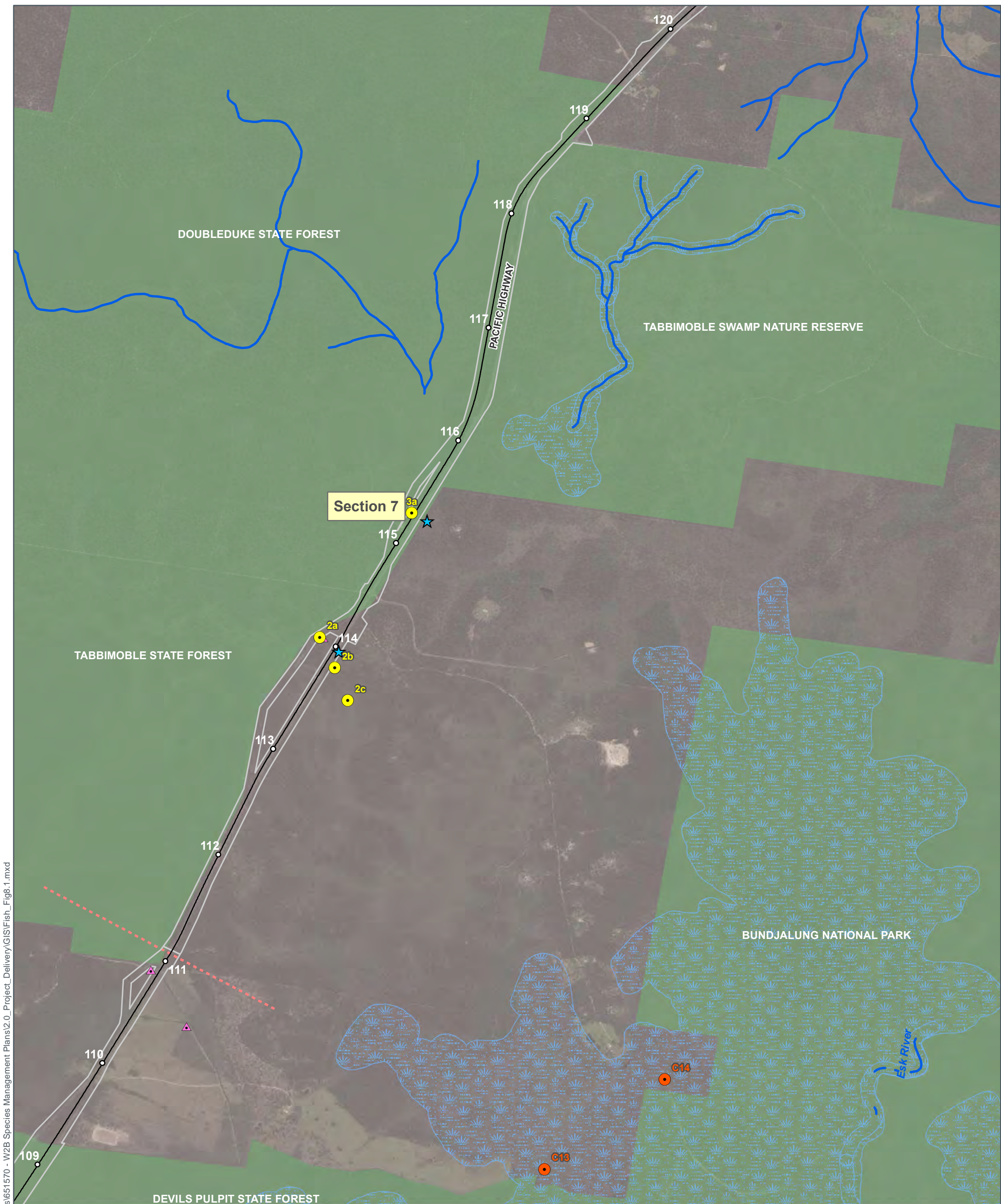
Initial surveys identified a number of potential monitoring locations, within which several sites were surveyed. Monitoring locations were refined during pre-clearance aquatic ecology surveys based on the presence of suitable habitat (**Section 3.1.3**) for threatened fish species, particularly Oxleyan Pygmy Perch. A total of 18 impact sites and 9 control sites were finalised during this process, all of which have had Oxleyan Pygmy Perch confirmed at the sites with the exception of five control sites. Waterways included back-waters on flood-prone land, ephemeral swamps, farm drainage lines, natural creeks, dams, excavations and flood control infrastructure. At each location, surveys were undertaken at up to three sites selected based on instream habitat characteristics and land access requirements. Where possible, survey sites were selected upstream and downstream of the construction area. Due to the potential for construction impacts to extend along waterways, as well as the location of suitable habitat for target species, some sites were located outside the alignment corridor; however, not more than 200 m from that corridor.

At sites where Oxleyan Pygmy Perch were recorded, an additional control site was selected and sampled. Control sites were mostly located at larger distance from the alignment corridor to provide greater certainty that control sites will not be impacted by construction activities. The protocol for selecting control sites used a hierarchy of principles; however, due to site constraints it was not always possible to apply this. The hierarchy followed was the selection of control sites located:

- 1) >2 km upstream of the impact area
- 2) >1 km upstream of the impact area
- 3) >2km downstream of the impact area
- 4) In a different drainage and .2 km upstream of any impact area.

Control sites were not always feasible in upstream areas and some were known sites in conservation reserves (e.g. Broadwater National Park). The control sites will be included in ongoing monitoring so that any changes in abundance at or near the construction area can be compared against control sites. We note that upstream sites would not be truly independent control sites because they would still be within the same stream as potential impact sites and therefore there would be potential for changes at impact sites to affect populations at the control sites. However, due to the extent of the project, it would not be possible to select a truly independent upstream control site.

Only sites where Oxleyan Pygmy Perch have been recorded during pre-construction surveys will be carried forward for ongoing monitoring. Monitoring sites are presented in **Figure 8-1**, **Figure 8-2**, and **Figure 8-3**. Site descriptions are provided in the targeted survey reports (GeoLINK 2013, 2014).



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ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans LEGEND LOCATION DIAGRAM

Figure 8.1 Threatened Fish Monitoring Sites – Section 7

WORK REQUEST NUMBER: RMS

DATA SOURCES:
Topographic Vector Series 3 © Commonwealth of Australia (Geoscience Australia) 2006

○ Chainage (kilometres)	★ Surface water monitoring site
— Alignment	▲ Oxleyan Pygmy Perch historic record
- - - Section change	● Oxleyan Pygmy Perch monitoring sites
▭ Project boundary	● Control sites
	— Key fish channels
	▨ Oxleyan Pygmy Perch habitat

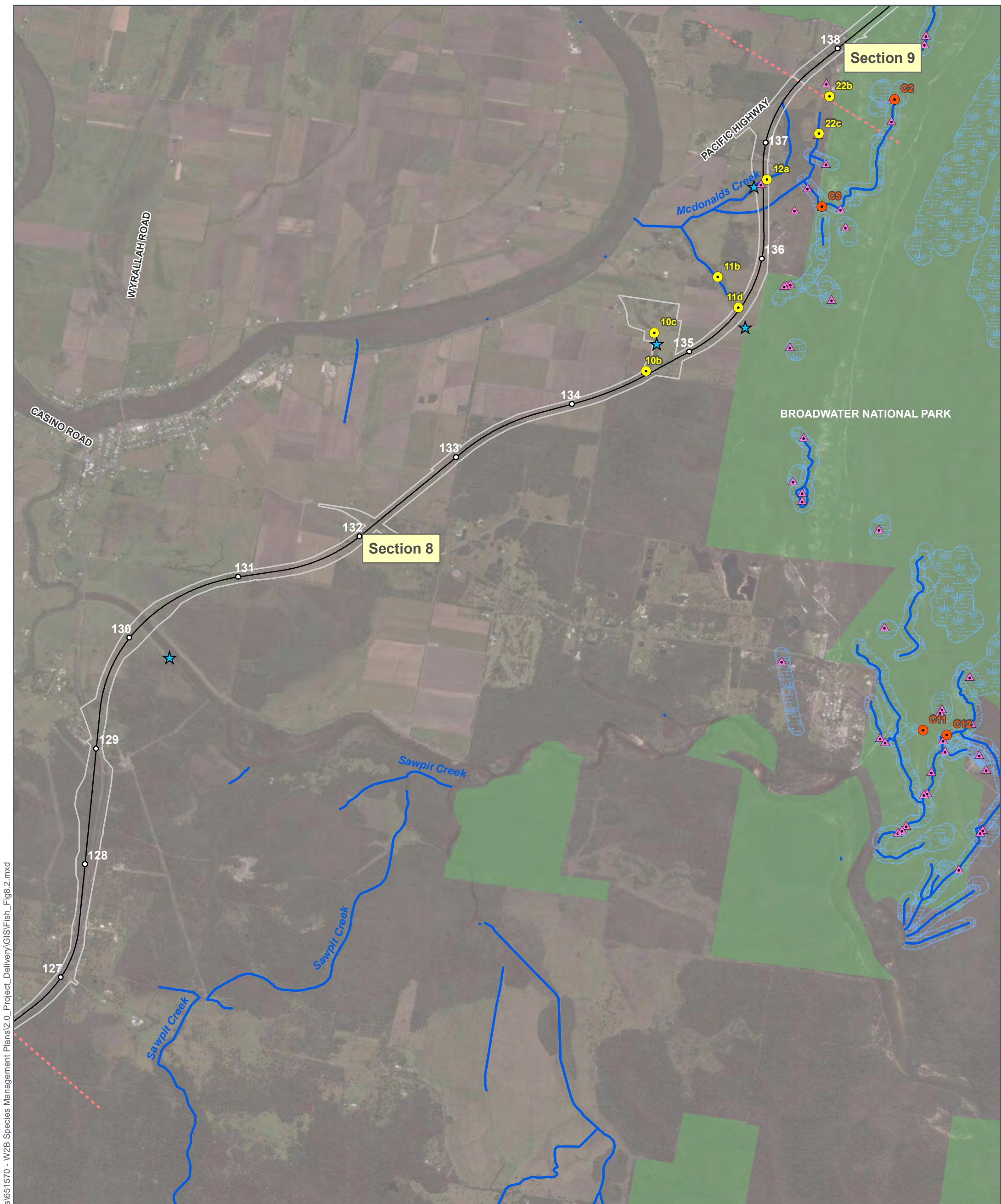
ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
12/05/2015	JH	CC	BE	0	Issued for Use
24/03/2015	JH	MD	BE	A	Issued for Review

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ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans LEGEND LOCATION DIAGRAM

Figure 8.2 Threatened Fish Monitoring Sites – Section 8

WORK REQUEST NUMBER: RMS

DATA SOURCES:
Topographic Vector Series 3 © Commonwealth of Australia
(Geoscience Australia) 2006

○ Chainage (kilometres)	★ Surface water monitoring site
— Alignment	▲ Oxleyan Pygmy Perch historic record
- - - Section change	● Oxleyan Pygmy Perch monitoring sites
□ Project boundary	● Control sites
	— Key fish channels
	▭ Oxleyan Pygmy Perch habitat

ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
12/05/2015	JH	CC	BE	0	Issued for Use
24/03/2015	JH	MD	BE	A	Issued for Review

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The Broadwater

Coffs Harbour

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8.2.2 Fish sampling methods

Fish sampling would be undertaken in accordance with the *Survey Guidelines for Australia's Threatened Fish* (DSEWPaC 2011), and Knight et al. (2007), including at each site:

- The deployment of 10 unbaited standard collapsible bait traps for 30 minutes. Where no threatened species were recorded during the initial 30 minutes, traps would be deployed for an additional 30 minutes. Unbaited traps would be used as baiting does not increase the probability of attracting fish (Knight et al. 2007). Unbaited bait traps would be placed 1.5 to 2 m apart amongst or near submerged or emergent vegetation
- Undertaking back-pack electro-fishing, where safe to do so, generally restricted to shallow areas (e.g., <1 m depth) due to safety concerns operating in deeper water, targeting still or flowing habitats with submerged or emergent aquatic vegetation and submerged rocks and logs. Voltage, current and pulse settings would be adjusted according to local conductivity recordings to ensure fish were only stunned temporarily. Sampling would be undertaken for a maximum of 600 second pulse time or two passes of available habitat, with any stunned fish collected using a 5 mm dip net (knotless mesh)
- Use of dip nets where sample techniques listed above are unable to be used effectively (e.g. in water too shallow to deploy traps).

Captured fish would be retained in storage buckets until the completion of fishing at each site to avoid recapture. Storage buckets would be filled with water from the site being surveyed and kept in the shade. Captured fish would be identified, counted and measured prior to release to determine relative abundance and size class distributions. Abnormalities including wounds or deformities would also be recorded. Any exotic fish species captured would be euthanised in accordance with approved animal ethics procedures (Barker et al. 2009). Fish would be handled with wet hands at all times, with handling kept to a minimum to limit stress or injury.

All surveys would be undertaken by experienced aquatic ecologists, who are able to identify fish species in the field, and who hold the relevant permits and training for fish surveys in NSW. Only senior electro-fishing operators would use electro-fishing equipment and would comply with the Australian Code of Electro-fishing Practice (SSCFA 1997) at all times.

Although abundance of threatened fish is most likely to be highest near the end of their spawning season, surveys would not be conducted during the spawning season (October to April) as per the survey guidelines (DSEWPaC 2011). To maximise the effectiveness of monitoring surveys, sufficient water needs to be present at monitoring sites; however, surveys would target stable, low-flow conditions.

Arthington (1996) noted that more Oxleyan Pygmy Perch were captured during surveys conducted after 4pm; therefore, where practicable, surveys would be undertaken in the mid to late afternoon. However, where not practicable, sampling time for control and impact sites, and for sites immediately upstream and downstream of the construction area would be varied to ensure that predictable differences in sampling times do not bias results.

8.2.3 Performance Indicators and corrective actions

The objectives of the mitigation measures include:

- No negative impact on Oxleyan Pygmy Perch
- To minimise the impacts of habitat loss, fragmentation and barriers to movement that have been created by the project
- To maintain the long-term viability of the Oxleyan Pygmy Perch in the project area.

The status of threatened fish species abundance would be measured against the performance indicators detailed in **Table 8-1**.

Table 8-1 Performance indicators and corrective actions for fish survey

Trigger for corrective action	Timing and corrective actions	Responsible party for corrective action implementation
Relative abundance of Oxleyan Pygmy Perch in impact site has reduced significantly when compared to control sites over three consecutive monitoring periods.	<p>If significant discrepancies between the abundance of fish at construction sites and downstream of construction sites compared to historical trends with respect to the sites immediately upstream of the construction sites and control sites further upstream have been identified, then further investigation may be needed to determine the potential cause. Such measures would be determined in consultation with DPI (Fisheries). Investigate instream habitat and consider improving habitat condition and connectivity.</p> <p>If a temporary crossing has been used, ensure design is in accordance with DPI (Fisheries) guidelines and requirements.</p> <p>Additional water quality monitoring to ensure that it would not result in adverse effects.</p>	Project Contractor Project Ecologist
Occurrence of Eastern Gambusia in waterways where they have not previously been recorded.	<p>Monthly inspection through construction to ensure no weed incursion. Fish survey biannually.</p> <p>Rehabilitate area and structure habitat, improve drainage so that conditions are not conducive to pest species.</p> <p>Ensure translocation activities of OPP do not move pest fish species. Manage aquatic weeds and pests.</p> <p>Immediately following discovery, conduct further surveys to estimate abundance of Eastern Gambusia and waterway conditions.</p> <p>Review possible causes and consult with DPI (Fisheries) for appropriate actions.</p>	Project Contractor Project Ecologist

8.3 Water quality monitoring

8.3.1 Methods, timing, intensity and duration

Impacts to water quality represent a significant threat to Oxleyan Pygmy Perch during the construction phase of the project. Species will have specific tolerance ranges for the parameters listed below, therefore changes in these parameters beyond natural or baseline seasonal variation can impact aquatic habitats, biological and chemical processes, and flora and fauna within.

To define baseline characteristics, physico-chemical water quality parameters were assessed at each of the fish survey sites during the larger pre-construction water quality surveys. Water quality monitoring will continue to be undertaken at all fish survey impact and control monitoring sites, as well as immediately upstream, immediately downstream, and at all waterway crossing construction areas. The monitoring program during construction would comprise of the existing measured parameters (temperature, pH, electrical conductivity (EC), dissolved oxygen and turbidity).

During operation when water quality monitoring will be done quarterly, as a minimum of one wet (after rainfall event) and one dry sample within the quarter, additional values will be recorded such as:

- Nutrients – total nitrogen, oxides of nitrogen, ammonia, total phosphorus and orthophosphates
- Dissolved and total metals – aluminium (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), magnesium (Mg), manganese (Mn) and zinc (Zn).

At any sites where any water from construction areas is discharged, or may runoff directly into known Oxleyan Pygmy Perch habitat, the following parameters will be assessed in addition to those listed above:

- Velocity
- Any other parameters associated with pre-release water treatment, or construction activities that could impact water quality.

Monitoring would continue on a weekly basis throughout construction to assess impacts associated with the project. Monitoring would also continue to be undertaken on a quarterly basis (with two samples each quarter, of one rainfall event and dry event) through the operation phase of the project.

Acute pollution would most likely occur during rain events, therefore monitoring would also be undertaken during or immediately after a rainfall event (an Event) in excess of 15 mm over 24 hours. Rainfall event-based monitoring would be undertaken upstream and downstream of construction areas and all sites and waterway crossings. At least three events over a period of six months (to be extended in the event of unusual dry spell) would be monitored during construction and operation to determine whether runoff is having an adverse impact on water quality, and assess the effectiveness of control and mitigation measures.

8.3.2 Performance indicators and corrective actions

The water quality monitoring data would be analysed as a time-series that compares each downstream site with its paired upstream site to determine any substantial changes between sites that may be a result of construction of the project. The data would also be compared against ANZECC/ARMCANZ (2000) default trigger values and the known tolerances of Oxleyan Pygmy Perch to identify if any observed changes are likely to be ecologically significant.

Based on baseline water quality data (Golder 2014), aquatic ecological monitoring data (GeoLink 2013, 2014) and the Oxleyan Pygmy Perch flood refuge assessment (GeoLink 2014a) ANZECC/ARMCANZ (2000) has recommend the development of site specific trigger values that represent the 'current status' of ambient water quality at the sites. These 'current status' trigger values can be compared with monitoring data during construction and operation to assess for stable, improving or deteriorating water quality status at each site. This information may be further refined during the establishment of the Woolgoolga to Ballina Water Quality Management Program (WQMP), required under MCoA D12. It should be noted control sites were not established when Golders were undertaking water quality monitoring therefore there are no results for those sites.

Event-based monitoring would be likely to give much more variable results than the routine monitoring program, therefore each event would be analysed separately. For each event, water quality downstream of the construction area would be compared against water quality immediately upstream of the construction area. Differences between upstream and downstream sites would trigger further investigation to determine the cause, source of particular pollutants, and appropriate actions would be taken to address any identified problems.

The main performance indicators and corrective actions have been outlined in **Table 8-2**.

Table 8-2 Performance indicators and corrective actions for water quality monitoring

Trigger for corrective action	Timing and corrective actions	Responsible party for corrective action implementation
Any change in water quality from baseline conditions in the vicinity of, or downstream of the construction works. Any evidence of sediment or erosion being caused by the project. Any weed incursion into OPP waterways observed.	Timing: Weekly monitoring, or following an event of more than 15 mm over 24hours, during construction and annual reporting. Quarterly and event monitoring during operation. Corrective actions: Identify cause for likely water quality deterioration. Implement appropriate rehabilitation and reconstruction strategies. Rehabilitate area, structure habitat and improve drainage so that conditions are not conducive to pest species.	Project Contractor Project Ecologist Project Environmental Advisor

<p>Disparity in water quality between downstream and upstream monitoring sites observed during operation of the project.</p>	<p>Immediate investigation into the specific cause so that appropriate remedial action can be taken. Review and modify monitoring program to assist in the identification of the source. Make physical changes to the structure or floor as appropriate.</p>	<p>Project Contractor Project Ecologist Project Environmental Advisor</p>
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8.4 Aquatic habitat monitoring

8.4.1 Methods, timing, intensity and duration

Quantitative habitat surveys are to be undertaken at each of the threatened fish monitoring sites bi-annually as per the pre-construction surveys (GeoLINK 2012, 2013, 2014), which are based on the methods described in Pusey *et al.* (2004).

Three transects are to be established perpendicular to the channel at each site. The location of these transects are to be identified by dividing the site into three even segments and then randomly selecting a point in each segment. Wetted width and average water depth will be measured along each transect.

Four 0.5 m² quadrats are to be randomly positioned along each transect. Fewer quadrats may be used in channels that have a wetted width of less than 2.5 m. Substrate composition, woody debris cover and vegetation cover will be estimated within each transect to give a total of up to 12 quadrats for each site. Aquatic plants in each quadrat will also be identified and recorded.

Four transects are also to be randomly positioned along each stream bank to estimate the amount of root masses, undercut bank, vegetation overhang and riparian vegetation cover at each site. The total length of the four transects equal approximately 20 per cent of the wetted perimeter at each site.

Photo points are to be established at each site with a GPS and repeat photographs would be taken from the same location on each survey. Quarterly surveys will be undertaken until such time as it can be established that the habitat has been restored effectively.

Habitat surveys will be conducted at the same time as the fish surveys and will continue until mitigation methods have proven effective over three consecutive operational monitoring periods.

8.4.2 Performance indicators and corrective actions

Any habitat changes that have been identified at construction sites or downstream of the construction area that was not also evident at sites immediately upstream of the project would be attributed to the construction or operation of the project. Such results would trigger immediate investigation into the specific cause so that appropriate remedial action can be taken such as replanting, replacing lost trees, weeding and physical modification.

The main performance indicators and corrective actions have been outlined in **Table 8-3**.

Table 8-3 Performance indicators and corrective actions for aquatic habitat monitoring

Triggers for corrective actions	Timing and corrective actions	Responsible party for corrective action implementation
Survey of Class 1 and 2 waterways with known or potential OPP habitat identifies additional populations of Oxleyan Pygmy Perch or Purple Spotted Gudgeon.	Corrective action: If surveys identify presence of additional populations of Oxleyan Pygmy Perch or Purple Spotted Gudgeon then additional control sites would be selected and sampled. These control sites would be added to ongoing monitoring program.	Project Contractor Project Ecologist
<p>Any change in habitat structure downstream of construction area, i.e. Macrophyte and woody snag cover.</p> <p>Any change in natural stream flow and velocity resulting in threatened fish being trapped in isolated pools.</p> <p>Occurrence of Eastern Gambusia in waterways where they have not previously been recorded.</p> <p>Any weed incursion into OPP waterways.</p> <p>No threatened fish species observed in ponds where fish have been translocated to.</p>	<p>Timing: Aquatic habitat will be monitored during fish surveys.</p> <p>Corrective actions: Immediately implement appropriate rehabilitation and reconstruction strategies.</p> <p>Undertake actions to control (and where necessary remediate) any impacts to natural stream flow arising as a result of construction activities.</p> <p>Monitor isolated pools closely. Relocate native fish if isolated pools are deemed to be at risk of drying by project ecologist, or if water quality in these pools declines.</p> <p>Rehabilitate area and structure habitat, improve drainage so that conditions are not conducive to pest species.</p> <p>Increase monitoring of translocation sites to confirm the absence of threatened fish species. If population declines in translocation sites are confirmed, review translocation locations and the translocation strategy (GeoLink 2015) in conjunction with the DPI (Fisheries) to identify why translocations have been unsuccessful.</p>	Project Contractor Project Ecologist Project Environmental Advisor

8.5 Translocation

As per the Translocation Strategy (GeoLink 2015), translocation of Oxleyan Pygmy Perch required to be undertaken during construction will require monitoring to determine effectiveness. Trapping will be undertaken in translocation locations to assess the presence or absence of translocated species. Details of the capture and relocation are to be reported in the aquatic monitoring program and include fish species, number and health of species captured, location of recipient site. The recipient sites are to be added to the ongoing aquatic monitoring program.

8.6 Evaluation, project review and reporting

Reports would include:

- Annual reports including the provision and analysis of all monitoring data, data interpretation and presentation, discussion, any change to performance indicators (including, where appropriate, an assessment of the statistical power of the data to be able to detect the specified levels of unacceptable change), and how these were addressed (i.e., actions implemented).

8.6.1 Responsibility

The aquatic ecologist employed to undertake the threatened fish species monitoring for each relevant project section would be responsible for the evaluation of the monitoring information collected. The definition of suitably qualified ecologist requires “a person with a tertiary degree in a related field (e.g., environmental science, ecology) with a minimum five years of experience conducting targeted fish surveys for projects of a similar scale and complexity as the W2B project.”

8.6.2 Timing

A brief annual report would be prepared by the contractor for distribution to the Roads and Maritime and other relevant government agencies (DPI Fisheries, OEH, DP&E and DoE) regarding the annual surveys and monitoring results.

A final report would be prepared at the conclusion of the monitoring period. This report would incorporate all the results of the monitoring and recommend any additional measures (if deemed necessary) to facilitate the long term survival of Oxleyan Pygmy Perch populations in the locality.

9 Summary table and implementation schedule

A summary of the actions proposed within this plan is provided in **Table 9.1**. This table also identifies the person responsible for each action and the estimated timing of the project.

Table 9-1 Summary table and implementation schedule of management plan

No.	Task	Responsibility	Pre-construction	Construction	Post-construction (Year and Season)																				
					Year 1				Year 2				Year 3				Year 4				Year 5				
					Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	
1. Pre-construction management																									
1.1	Pre-construction monitoring and surveying to confirm monitoring sites.	Roads and Maritime	X																						
1.2	Add/update as required (e.g. if OPP or PSG recorded)	Roads and Maritime	X																						
2. Construction management																									
2.1	Contractor induction and training	Contractor		X																					
2.2	Work Method Statement (WMS)	Contractor		X																					
2.3	Implementation of erosion and sediment control and pollution control measures	Contractor		X																					
2.4	Location of temporary water crossings	Contractor		X																					
2.6	Translocation (if needed)	Contractor		X																					
2.7	Habitat restoration plan	Roads and Maritime/ Contractor		X																					
2.8	Construction monitoring and surveys	Contractor		X																					
2.9	Water Quality Monitoring	Contractor		Weekly																					
3. Operational management																									
3.1	Inspection, maintenance and cleaning of culvert structures	Contractor		Annually																					
3.2	Maintenance of restored habitat	Contractor		Monthly (first year) Every 6 months (Year 2 and 3)																					
4. Operational monitoring																									
4.1	Fish surveys#	Roads and Maritime, Contractor				X		X		X		X		X		X		X		X		X		X	
4.2	Water quality monitoring#	Roads and Maritime, Contractor			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4.3	Aquatic habitat monitoring#	Roads and Maritime, Contractor			X		X		X		X		X		X		X		X		X		X		X
4.4	Habitat restoration# (until mitigation measures proven effective)	Contractor			X		X		X		X		X		X		X		X		X		X		X

No.	Task	Responsibility	Pre-construction	Construction	Post-construction (Year and Season)																			
					Year 1				Year 2				Year 3				Year 4				Year 5			
					Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring
4.5	Flow - inspection, maintenance and cleaning of culvert structures	Roads and Maritime				X		X		X		X		X		X		X		X		X		
5. Evaluation and reporting																								
5.1	Evaluation	Roads and Maritime	X	X			X			X			X			X			X			X		
5.2	Reporting	Ecologist	X	X			X			X			X			X			X			X		

as per MCOA condition D8(k), ongoing monitoring during operation of the SSI (for operation/ongoing impacts) is to be undertaken until such time as the use and effectiveness of mitigation measures can be demonstrated to have been achieved over a minimum of three successive monitoring periods (years).

10 References

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Appendix A – M. Birch Curriculum Vitae

Appendix B – M. Birch review

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AQUATIC SCIENCE AND MANAGEMENT

Attention: Kim Collings
Senior Environmental Scientist
Sinclair Knight Merz.

9th September 2013

RE: W2B THREATENED SPECIES MANAGEMENT PLAN - REVIEW

Dear Kim,

Thank you for the invitation to contribute to a review of the Threatened Species Management Plan (TSMP) for Oxleyan Pygmy Perch (OPP) and Purple-Spotted Gudgeon (PSG) along the Pacific Highway upgrade between Woolgoolga and Ballina. Having reviewed the TSMP, background information relating to the project including the Biodiversity and Water Quality Working Papers and relevant sections of the Environmental Impact Study (EIS) in addition to a variety of articles relating to the species in question, I am submitting this letter by way of a response to the TSMP.

Background

The EIS for the Woolgoolga to Ballina section of the Pacific Highway upgrade has been on exhibition. Following review, various state government agencies have requested that TSMPs to be implemented during highway construction are prepared and accepted as a condition of approval of the EIS.

Among the threatened species identified as actually or potentially found along the upgrade corridor are the Oxleyan Pygmy Perch (*Nannoperca oxleyana*, OPP) and the Purple-spotted Gudgeon (*Mogurnda adspersa*, PSG). A draft TSMP has been prepared for OPP and PSG and comments from various state and federal government agencies have been incorporated. Roads and Maritime have requested that subject experts also review the draft plans prior to their acceptance.

Methods

In reviewing the TSMP for OPP and PSG, there were 5 specific tasks completed. They are as follows:

- 1 Review background information to the project, including the Environmental Impact Assessment and associated Biodiversity Working Paper.
- 2 Consider feedback provided from DSEWPac, DP&I, EPA and DPI on the relevant draft Management Plan.
- 3 Provide a desktop review of the revised Management Plan from a scientific perspective of the relevant species addressed by the Management Plan.
- 4 Attend a teleconference debriefing to provide feedback on the Management Plan to Roads and Maritime and the authors.
- 5 Prepare a written review statement on the Management Plan on letter headed paper. This review should, as a minimum, provide feedback on the following key questions:
 - a. Is the design of the monitoring project appropriate for the species?

- b. Is the frequency and timing of monitoring adequate?
- c. Is the Management Plan clear on what basis the monitoring locations would be selected?
- d. Are appropriate goals being set?
- e. Are the mitigation and management actions sufficiently targeted for the species?
- f. Are the objectives, performance measures, corrective actions and triggers for corrective actions in accordance with SMART principles?
- g. Do the management measure objectives, performance indicators, triggers and corrective actions link sufficiently to allow effective implementation?
- h. Has the Management Plan provided sufficient evidence where the proposed mitigation has previously been effective?
- i. Does the Management Plan describe and discuss contingencies, should the proposed measures be ineffective?
- j. If we can't demonstrate mitigation proposed will be effective, can we demonstrate that corrective actions will be effective?
- k. Where there is no known research / evidence of the effectiveness of the specific measure proposed – have relevant alternative contingencies been committed to?
- l. Have indirect impacts been addressed in the Management Plan, as relevant?

Review Statement

In general, the draft (version 0.4, August 2013) Threatened Species Management Plan prepared for OPP and PSG is comprehensive and well structured. It includes goals, mitigation measures performance indicators and contingencies for each of the three phases of the project that comply with SMART principles, link together appropriately and are targeted to the species in question. The TSMP has been prepared in a way that demonstrates a clear understanding of the conservation and ecology of OPP and PSG. The recommendations of this review are mostly of a minor nature, as all of the key points are addressed in the TSMP. The draft TSMP does, however, contain sufficient spelling and grammatical errors to impede the clarity of some sections. A spelling and grammar review prior to finalisation of the document will improve its readability.

a. Is the design of the monitoring project appropriate for the species?

The monitoring program described in Section 8 of the TSMP includes a fish survey, water quality monitoring, aquatic habitat monitoring and translocation monitoring.

The methods described in the fish survey design of the monitoring program adhere to the accepted best practices for monitoring OPP as described by DSEWPac (2011) and Knight *et al.* (2007b). The report includes recommended settings for backpack electrofishing with the important inclusion of adjusting voltage, current and pulse frequency to ensure animals are not harmed. The methods described adequately balance capture of both OPP and PSG and management of their wellbeing during the survey.

The methods described in the Water Quality Monitoring include monthly and event monitoring of basic physico-chemical parameters and total suspended solids. These are appropriate parameters to gain an understanding of water quality impacts upon OPP as the tolerance ranges to physico-chemical parameters are reasonably well described (Knight & Arthington 2008, Pusey *et al.* 2004) and the potential impacts of suspended solids on reproductive and feeding success are well described in Section 2.3.2 of the TSMP. However, nutrient enrichment and contamination with toxic substances can also have impacts upon OPP (DPI 2007), and it is a recommendation of this report that analyses of nutrients (total nitrogen, oxides of nitrogen, ammonia, total phosphorus, orthophosphates) and a series of dissolved and total trace metals (particularly those that become more toxic at low pH, e.g. aluminium) be included in water quality monitoring. Furthermore, to account for potential impacts of tannin leachates and the treatment of stored water it is a recommendation of this review that dissolved inorganic carbon and lime pollution are also monitored. Any additional pre-release water treatment measures with the potential to impact upon water quality with respect to OPP should also be included in the suite of water quality parameters monitored.

The methods described in the Aquatic Habitat Monitoring are clearly outlined in **Section 8.4.1** of the TSMP. The methods are appropriate for describing the habitats in the types of waterways frequented by PSG and OPP and also for capturing natural habitat variability in such waterways.

b. Is the frequency and timing of monitoring adequate?

The TSMP is not entirely clear on the frequency of monitoring of OPP and PSG. Monitoring is referred to as biannual in **Table 6-1** but annual in **Table 5-1** (preconstruction). In all cases it is scheduled to be undertaken in May/June. The TSMP proposes that no monitoring is to be undertaken during the breeding season which can begin in October and last through to May (Knight *et al.* 2012). Realistically, this leaves the opportunity for a maximum of two surveys per year, one in late May - early June and one in Late August early September. If only one survey is to be undertaken annually it should be scheduled for late May, early June, following the breeding season and prior to the (typically) dry winter season when the potential range for OPP contracts.

Water quality monitoring is proposed to be undertaken on a monthly basis prior to and during construction and quarterly basis during the operational phase. Additional event based samples are also proposed, although this section of the TSMP does not include a definition for heavy rainfall (i.e. how many mm/24hr period at which weather stations). Monthly monitoring backed up by event based monitoring should be adequate to form a useful baseline and to assess the impacts of construction on water quality. It is a recommendation of this review that the definition of a heavy rainfall event (with respect to triggering extra water quality monitoring) is included in the TSMP.

Aquatic habitat surveys are proposed to be undertaken at the same time as fish surveys. Timing the surveys in this way will minimise the impact of survey work on fish and their habitat.

Changes to natural stream flow and velocity have been identified as key threats to OPP (DPI 2005). The TSMP suggests that stream velocity would be measured during fish and habitat monitoring. However, fish and habitat monitoring are currently not proposed to be undertaken at sufficient frequencies adequately sample the range of flow and velocity conditions during the pre-construction, construction and operational phases. It is a recommendation of this review that monitoring of stream velocity should be undertaken at the same frequency as water quality monitoring (ie, monthly and following rainfall events). This may require amending the current water quality monitoring programs for the various Woolgoolga to Ballina highway upgrade sections. In order to assess the goal of no change in hydrological conditions an adequate baseline of water velocity conditions need to be collected.

c. Is the Management Plan clear on what basis the monitoring locations would be selected?

The TSMP describes the selection of impact and control sites for fish monitoring under **Section 8.2.1**.

The methods for selecting impact fish and habitat monitoring sites are clearly outlined in the TSMP. Impact fish and habitat monitoring sites are to be selected following the outcomes of the targeted surveys. The sites will be selected based upon the location of known or potential habitat for OPP and PSG. It is important that both known and potential habitat are monitored, as OPP are thought to have extensive dispersal abilities and habitat fragmentation is one of the key threats implicated in the decline of OPP (Knight *et al.* 2009, Knight *et al.* 2012). Continued monitoring at sites with *potential* habitat for PSG and OPP will also allow performance indicators to be assessed. Although OPP are regarded as habitat specialists, applying the known range of water quality values and habitat types of OPP to a survey of *potential* habitats for OPP will result in a large number of potential sites. In order to contain the number of survey sites to a realistic figure it is suggested that a ranking system be developed to utilise water quality and habitat information generated during the targeted surveys. For example, each site could be scored and ranked on its:

- Distance (along stream) from known OPP populations;
- pH at the time of the survey;
- ratio of sand/mud in benthic material;
- presence/absence of undercut banks and root mass along banks;
- proportion of emergent rushes and submerged vegetation;
- observed proportion and abundance of *Gambusia holbrooki*.

It is anticipated that this measure would result in a smaller number of total sites for monitoring and therefore more efficient use of resources.

The basis given in the TSMP for selecting control fishing and habitat monitoring sites is clear. According to the TSMP a control site is to be selected for every site with a confirmed population as determined by the targeted surveys (which are being undertaken in order to inform the detailed design phase). At present the TSMP suggests that control sites should be located upstream of the upgrade corridor but may need to be located downstream due to a lack of suitable habitat upstream. A figure of 2km is given as a minimum distance upstream for the suitable location of the control site. No equivalent downstream distance is provided. There is potential for some difficulty finding suitable control sites using this protocol. In some cases there may be difficulty finding appropriate control sites without access constraints within the same drainage area (upstream or downstream), subcatchment or catchment. Setting one monitoring control site for each population located within the construction corridor is suitable. However, it is a recommendation of this review that the protocol for selecting control sites be reviewed and that it include a hierarchy of principles. A suggested hierarchy would be:

1. Control site located >2km upstream of impact site;
2. Control site located >1km upstream of impact site;
3. Control site located >2km downstream of impact site;
4. Control site located in different drainage, >2km upstream of any other impact site;

Water quality monitoring sites are to be located immediately upstream and immediately downstream of the proposed crossings at known and potential OPP and PSG sites.

d. Are appropriate goals being set?

The goals for management have been presented for the pre-construction (**Section 5.2** and **Table 5-1**), construction (**Section 6.2** and **Table 6-1**) and operational phases of the project (**Section 7.2** and **Table 7-1**).

The goals for the pre-construction phase are to re-confirm the presence or absence of threatened fish species and to identify the final set of monitoring locations. These are appropriate goals for the species and realisation of these goals will assist species management and monitoring in the construction and operational phases of the project. However, it is a recommendation of this review that presence absence of potential habitat and potential corridors between existing populations and/or areas of known habitat should be identified at this stage also and should be added to the list of goals under **Section 5.2**. A further recommendation is that the identification of baseline water quality and habitat conditions is also added to the list of pre-construction goals listed in **Section 5.2** (the text under **Section 5.3.1** indicates that this is planned).

The listed goals for the construction phase of the project are:

- no negative changes in in stream habitat;
- no deterioration of water quality;
- no hydrological changes;
- no increased in abundance of *Gambusia holbrooki*; and
- successful translocation of fish species.

These goals are appropriate for the species and their realisation will ensure that impacts from the construction phase of the project are minimised. Habitat loss and fragmentation, sedimentation and pollution of water, changes to hydrology and increasing abundance of the *G. holbrooki* have been identified as key threats to OPP (Knight *et al.* 2012, DPI 2005) and PSG (DPI 2013). Direct impacts of construction work may need to be avoided by translocation. Other relevant threats that have been identified include lack of community awareness (DPI 2005) and changes to riparian habitats (Knight *et al.* 2012). It is a recommendation that minimal change to riparian habitats be included as a goal under **Section 6.2** along with promoting awareness among the construction staff, all contactors and the general community (riparian habitat restoration is addressed under **Section 6.3.7** and management measures addressing awareness are already in place under **Section 6.3.2**). A further recommendation of this review is that design parameters of crossings should be used to maintain existing water velocity/flow by utilising existing cross sectional areas, substrate and in-stream habitats in areas of known and potential OPP habitat. Where existing water velocities are not adequately described a maximum water velocity of 0.3m/s should be included as a design goal for water crossings over known and potential OPP habitat. Where translocations are required they should be over as small a distance as feasible and translocations between catchments should be avoided (Knight *et al.* 2009)

The listed goals for the operational phase of the project are to maintain water quality and hydrological conditions. These goals are appropriate for both OPP and PSG and along with the goals for the pre-construction and construction phases should ensure minimal impact upon both species.

The OPP Recovery Plan (DPI 2005) includes increasing habitat connectivity as a goal. It is a recommendation of this review that the TSMP adopt the goal of an increase in habitat connectivity via rehabilitation of vegetative habitat in degraded drains and waterways forming potential corridors on Roads and Maritime acquired land. For example, degraded agricultural drains through Roads and Maritime acquired land could be revegetated to increase available habitat for OPP and improve connectivity. The TSMP could include a list of aquatic plants that OPP are commonly associated with, to be updated following the targeted survey. The list (following DPI 2005) would include emergent rushes (eg. *Lepironia articulata*, *Schoenus brevifolius*, *Restio (Baloskion) pallens*, *Eleocharis* spp., *Gahnia* sp., *Juncus* sp.), water lilies (*Nymphaea* sp.), bladderworts (*Utricularia* sp.) and mosses (e.g. *Sphagnum falciculatum*). OPP are also found among leaf litter, root masses and occasionally woody debris (DPI 2005). A densely covered riparian zone, of typical *Banksia* and *Melaleuca* spp., is therefore also desirable. There is a well-documented history of rehabilitating and managing waterways in the Evans Head area to improve habitat for OPP (DECC 2009).

e. Are the mitigation and management actions sufficiently targeted for the species?

Mitigation and management measures are listed for the pre-construction (**Section 5.3, Table 5-1**) construction (**Section 6.3, Table 6-1**) and operational (**Section 7.3, Table 7-1**) phases of the project.

The pre-construction management and mitigation measures include a targeted fish and habitat survey, and baseline water quality survey. The methods and timing of the fish and habitat survey described in the TSMP conform to the accepted best practice for OPP and PSG (DSEWPac 2011, although seine netting for PSG cannot be implemented due to restrictions for OPP). The water quality monitoring parameters described are targeted for the species as pH and suspended solids have been identified as having particular relevance to OPP and the tolerance ranges for both OPP and PSG are relatively well described (see Pusey *et al.* 2004). However, it is a recommendation of this review that some other parameters should be included (see question a, above).

The construction phase mitigation and management measures include:

- the preparation of construction work method statements (CWMS) for specific activities to address the management requirements for construction;
- induction and training activities for contractors and staff working in the areas of known and potential OPP and PSG habitat;
- design measures and timing restraints for construction around known and potential OPP and PSG habitat;
- design and construction measures for temporary watercourse crossings;
- fish translocation procedures;
- earthworks and sediment control; and
- habitat management and restoration.

The details of the proposed mitigation and management measures are extensive. In general the proposed mitigation and management are well targeted to the species as they address the relevant key threats to OPP and PSG, which are habitat fragmentation and loss, water pollution, changes to the hydrological regime, sedimentation and an increased abundance of *G. holbrooki* (Knight *et al.* 2012, DPI 2007, DPI 2013). In addition, the proposed timing restrictions will further minimise disturbances during the spawning season. However, the timing requirements in the TSMP list the OPP spawning season as October to December (p24), when the peak periods are reported to be October-December and February-April (Knight *et al.* 2012, updated from Knight *et al.* 2007a). It is a recommendation of this report that the reasons for this anomaly are clarified in the TSMP. It is understood that the Devils Pulpit Pacific Highway upgrade is being undertaken with the greatest levels of controls at OPP sites between October and December. It is also understood that similar approvals will be sought for the other OPP sites along the greater Woolgoolga to Ballina Pacific Highway upgrade. The proposed mitigation and management measures for the construction phase do not include pre-release water treatments. It is understood that this is because at this stage there is no planned release of stored water into waterways in OPP habitat. Instead, stored water is to be released via irrigation at a set distance from OPP habitat. It is a recommendation of this review that if no release of water into OPP habitat is planned then it should be made clear in the TSMP. If release of water into OPP habitat is to occur then it is important to ensure that:

- release of stored water into OPP habitat is undertaken only as a last resort;
- water released into OPP habitat is at a pH that matches the mean pre-construction pH of the waterway (as established during baseline water quality monitoring) to within 1 pH point;
- any chemical treatments used prior to the release of water stored in sediment basins will not persist in the environment or negatively impact upon the environment after release.
- potential treatments and/or their derivatives are included as parameters in baseline water quality monitoring.

The known water quality tolerances of OPP in NSW are presented in **Table 1.1**.

Table 1.1 Summary of water quality information from NSW sites where OPP have been collected.

<i>Measure</i>	<i>Range</i>	<i>Mean ± SE</i>
Temperature (°C)	10.9 – 28.3	16.1 ± 0.34
Dissolved Oxygen (mg/L)	2.15 – 10.02	6.42 ± 0.189
pH	3.32 – 6.9	4.47 ± 0.087
Conductivity (µS/cm)	68 - 2148	186 ± 22.7
Turbidity (NTU)	0 – 80	14 ± 3.6

From *Knight & Arthington (2008)*

In addition, the habitat preferences of the species are well described in the literature down to the aquatic plants that are most often found at known OPP locations (Knight *et al.* 2009). This provides an opportunity along with information collected during the targeted surveys, to include a list of preferred aquatic plant species to utilise in any habitat restoration works (see **Question d**, above).

The management and mitigation measures proposed for the operational phase of the project include measures to protect water quality, maintain natural flow regimes and maintain restored habitat. These measures are also suitably targeted for the species, as they address the relevant potential threats posed by the highway upgrade; being water pollution, hydrological changes and habitat loss and fragmentation.

f. Are the objectives, performance measures, corrective actions and triggers for corrective actions in accordance with SMART principles?

The objectives, performance indicators and corrective actions are in accordance with SMART principles.

The objectives, performance indicators and corrective actions are specific in that they relate specifically to the threatened species in question and the current understanding of their conservation biology. They are also specific in that some of the objectives and measures are proposed in a flexible fashion so that they can be adjusted for individual water crossings along the upgrade alignment. They are mostly specific in the sense that they set clear goals but there are some exceptions to this. The exceptions include:

- No change in stream habitat (p 28) should include benthic material and riparian condition as measures in addition to woody debris and macrophytes;
- All of the goals set for the construction and operational phases could include reference to the triggers for corrective actions set during pre-construction monitoring.

Measurable performance indicators have been proposed for each of the individual goals and associated mitigation/management measures. In addition, for each of the triggers for corrective action that will rely on comparative information for their measurement, suitable data gathering has been proposed as part of the pre-construction surveys or comparisons will be made between upstream and downstream pairs of samples. For example, pre-construction surveys of water quality and in stream habitat will inform performance measurements for habitat management, habitat restoration, water quality control and sediment and erosion measures.

The majority of the proposed objectives, performance indicators and corrective actions are achievable. Many of the construction phase measures are currently being successfully implemented on the Devils Pulpit Highway upgrade. Some of the measures, such as targeted pre-construction surveys have been already been arranged. The only two mitigation goals that may be difficult to achieve are 'No increase in the abundance of Eastern Gambusia' and 'No notable change in stream habitat 100m above and below construction works'. Populations of Eastern Gambusia are likely to fluctuate in response to forces not under the control of the highway construction team and the rapid increases that are possible may not be captured in pre-construction surveys. In addition, at the immediate site of waterway crossings changes to the in-stream habitat are very likely, particularly with respect to submerged and emergent vegetation, and this should be acknowledged in the TSMP.

The objectives, performance measures and corrective actions and thresholds are focussed on results that reflect an understanding of the conservation biology of the species in question. For example, OPP are a habitat specialist with extensive dispersal capabilities and an opportunistic life-cycle strategy. This means that habitat connectivity and availability is of utmost importance and that disturbances during years where conditions are favourable could have long lasting negative consequences. The objectives, mitigation measures and performance thresholds all address the importance of these principles.

The majority of the objectives, performance measures and corrective actions and thresholds are not time time-based. For the pre-construction and construction phases of the project this is not possible as the construction starting dates and the length of the construction period are not known at this point in time. However, it is a recommendation of this review that: (if adherence to SMART principles is a goal for the TSMP)

- where possible the corrective actions should be given time frames for their implementation;
- post-construction objectives, measures, thresholds and corrective actions should be given time frames;
- water quality and flow/velocity objectives for the post construction phase should also be measured over a set number of rainfall events.

g. Do the management measure objectives, performance indicators, thresholds and corrective actions link sufficiently to allow effective implementation?

The objectives, monitoring, performance thresholds and corrective actions all link very well in the document. The tabular presentation of these aspects of the report (Tables 5-1, 6-1 and 7-1) demonstrates this neatly. Each objective has been listed along with the measures to achieve it, performance thresholds for its effectiveness and any related corrective actions.

h. Has the Management Plan provided sufficient evidence where the proposed mitigation has previously been effective?

An evaluation of the proposed mitigation measures is presented in **Table 4-1** of the TSMP. The TSMP outlines the successes of many of the proposed measures at the Devils Pulpit upgrade. The evidence provided is sufficient, and where measures relate specifically to OPP the evidence from Devils Pulpit may be the only evidence available. The approach of monitoring outcomes at Devils Pulpit for success and adapting the TSMP accordingly is adequate. Where measures relate to general environmental management, such as bed and bank restoration, habitat restoration, sediment and erosion control and implementation of detention basins and operational spill basins more specific evidence could be provided.

i. Does the Management Plan describe and discuss contingencies, should the proposed measures be ineffective?

The TSMP describes corrective actions for all of the proposed mitigation measures, should they not meet the performance thresholds defined in the document. It is important to note that any new measures added as a result of this, or other reviews, should be incorporated into the TSMP with the relevant contingencies.

j. If we can't demonstrate mitigation proposed will be effective, can we demonstrate that corrective actions will be effective?

The proposed mitigation methods can be demonstrated to have been effective in comparable applications. However, in the case that one of or some of the performance thresholds are not met during the implementation of the plan, many of the corrective actions are non-specific and their effectiveness will be difficult to measure.

k. Where there is no known research/evidence of the effectiveness of the specific measure proposed – have relevant alternative contingencies been committed to?

All of the specific measures proposed have been demonstrated to be effective in previous applications.

l. Have indirect impacts been addressed in the Management Plan, as relevant?

Many indirect impacts of construction and operation have been explored and addressed within the TSMP. For example, the potential proliferations of aquatic weeds and invasive fish species due to habitat disturbances and changes to hydrology and water quality have been addressed. However, there are some indirect impacts of the construction period upon OPP that have not been considered. Indirect impacts upon existing populations of OPP outside of the immediate construction corridor have not been addressed in the plan. Although, habitat for OPP mapped by DPI (Fisheries) has been identified the fact that populations of OPP have been observed in the majority of these waterways has not been adequately explored in the background documents. This is of particular relevance in the cases where populations exist on both sides of the existing highway (for example between the two intersections with Rileys Hill Rd) and construction has the potential to increase the pressures causing habitat fragmentation and hydrological changes – both of which have been identified as key threatening processes (Knight *et al* 2012, DPI 2005). Indirect impacts upon OPP and PSG due to potential disturbance of acid sulphate soils, particularly in sections 8 and 9, have not been considered. It is a recommendation of this review that indirect impacts upon OPP populations outside of the construction corridor be considered and that the potential impacts of acid sulphate soil disturbance on OPP be considered in the TSMP.

m. Are qualifications and experience of authors in subject field relevant?

The authors are well qualified to prepare the Threatened Species Management Plan for OPP and PSG. All four of the authors have relevant graduate and postgraduate qualifications. Collectively the authors have practical experience in the design and delivery of fish surveys, water quality monitoring, environmental management of infrastructure projects, threatened species legislation, threatened species management and natural resource management generally.

n. Any other matters.

Along with the above suggestions, the following general issues were identified in the report:

- Under **Section 7.3.2**, 'Maintaining Flow', maintenance and cleaning of culvert structures should be done in accordance with principles set out in **MA10** of the OPP Recovery Plan (DPI 2005). These
- Under **Section 6.3.3**, 'Design Principles', the third dot point should include substrate and vegetative habitat as controls for velocity;
- Under **Section 6.3.6**, 'Earthworks and Sediment Control' the fourth dot point should be updated to include waterways that are relevant to the TSMP; and
- Under **Section 6.2**, Eastern Gambusia and Plague Minnow are referred to as separate species. These are two common names for the same fish (*Gambusia holbrooki*), not separate species.

Conclusions

The TSMP is thorough and well organised. It is based on sound information contained in the working papers for biodiversity and water quality and the Environmental Impact Study. It focusses on managing the potential threats that have been identified in the literature as being most significant to OPP and PSG, being habitat loss and fragmentation, water pollution, hydrological changes and an increase in the abundance of *Gambusia holbrooki*. The TSMP describes a variety of management objectives and links them to actions, measurable thresholds and corrective actions in a way that should facilitate the implementation of the plan in its entirety and across the pre-construction, construction and operational phases. However, there are a number of minor recommendations arising from this review. They are presented in Table 1.2.

Table 1.2 Summary of recommendations arising from this review

Section	Recommendation
8.3	Analyses of nutrients (total nitrogen, oxides of nitrogen, ammonia, total phosphorus, orthophosphates) and a series of dissolved and total trace metals (particularly those that become more toxic at low pH, e.g. aluminium) should be included in water quality monitoring. All of these parameters, with the exception of oxides of nitrogen, are included in the draft Devils Pulpit to Ballina monitoring protocol for locations that are considered potential habitats for threatened fish. The TSMP should be updated to reflect this.
8.3	Where captured water is to be released directly into known or potential OPP habitat, dissolved inorganic carbon and lime pollution should also be monitored. In addition, any pre-release water treatment measures with the potential to impact upon water quality with respect to OPP should also be included in the suite of water quality parameters monitored at these sites;
8.3.1	The definition of a heavy rainfall event is included in the TSMP with respect to water quality monitoring. The draft Devils Pulpit to Ballina monitoring protocol utilises a figure of 15mm over a 24hr period to define a wet weather sample. The TSMP should be updated to reflect this;
8.2/8.3	Monitoring of stream flow and velocity should be undertaken under the same time frame as water quality monitoring at sites with known or potential habitat for OPP. The water quality monitoring plans for these sites should be amended to reflect this
8.2.1	The protocol for selecting control sites should be reviewed and should include a hierarchy of principles. A suggested hierarchy would be: <ol style="list-style-type: none"> 1. Control site located >2km upstream of impact site; 2. Control site located >1km upstream of impact site; 3. Control site located >2km downstream of impact site; or 4. Control site located in a different drainage, >2km upstream of any other impact or control site.
5.2	The identification of presence or absence of suitable habitat and potential corridors between existing populations and/or areas of high quality habitat should be identified at this stage also and should be added to the list of goals under Section 5.2 . Although it is clear in Section 5.3.1 , the identification of baseline water quality and habitat conditions should also be added to the list of pre-construction goals listed in Section 5.2 . It is understood that baseline water quality and habitat conditions are already being assessed.
6.2	Minimal change to riparian habitats should be included as a goal under Section 6.2 along with promoting awareness among the construction staff, all contactors and the general community.

Section	Recommendation
6.3.3	The reasons for listing the OPP spawning season as October to December (p24), when the peak periods are reported to be October-December and February-April (Knight <i>et al.</i> 2012, updated from Knight <i>et al.</i> 2007a), should be clarified in the TSMP.
6.2	Benthic material and riparian condition in the measures for no change in habitat, as they are important features of habitat for OPP.
6 and 7	The TSMP should include reference to the thresholds identified during pre-construction monitoring in the goals set for construction and operational phases.
6.3	<p>It is a recommendation of this review that if no release of water into OPP habitat is planned then it should be made clear in the TSMP. If release of water into OPP habitat is to occur then it is important to ensure that:</p> <ul style="list-style-type: none"> ▪ release of stored water into OPP habitat is undertaken only as a last resort; ▪ water released into OPP habitat is at a pH that matches the mean pre-construction pH of the waterway (as established during baseline water quality monitoring) to within 1 pH point; ▪ any chemical treatments used prior to the release of water stored in sediment basins will not persist in the environment or negatively impact upon the environment after release. ▪ potential pre-release water treatments and/or their derivatives are included as parameters in baseline water quality monitoring.
6.2	The TSMP should acknowledge that populations of <i>Gambusia holbrooki</i> are likely to fluctuate in response to stochastic factors and that changes to the in-stream habitat at crossing sites are very likely, particularly with respect to submerged and emergent vegetation.
Tables 5-1, 6-1 and 7-1	Where possible the stated corrective actions should be given time frames for their implementation. Post construction objectives, measures and thresholds should also be given time frames for their implementation.
Table 7-1	Water quality and flow/velocity objectives for the post construction phase should also be measured over a set number of rainfall events;
7	Indirect impacts upon known OPP populations outside of the construction corridor should be considered in addition to the potential impacts of acid sulphate soil disturbance on OPP.

In addition to the above recommendations, there are a number of suggestions arising from this review. These are presented in **Table 1.3**.

Table 1.3 Summary of suggestions arising from this review

Section	Recommendation
8.2	A ranking system could be developed to utilise water quality and habitat information generated during the targeted surveys to prioritise sites with potential habitat for continued monitoring.

Section	Recommendation
7.2	The TSMP could adopt the goal of an increase in habitat connectivity via rehabilitation of vegetative habitat in degraded drains and waterways forming potential corridors for threatened fish on Roads and Maritime acquired land.

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Sincerely,

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Appendix C – Response to expert review

ID No	Section	Recommendation	Recommendation has been addressed (Version 1)	How Recommendation has been addressed (Version 2)
TFiMP01	8.3	Analyses of nutrients (total nitrogen, oxides of nitrogen, ammonia, total phosphorus, orthophosphates) and a series of dissolved and total trace metals (particularly those that become more toxic at low pH, e.g. aluminium) should be included in water quality monitoring. All of these parameters, with the exception of oxides of nitrogen, are included in the draft Devils Pulpit to Ballina monitoring protocol for locations that are considered potential habitats for threatened fish. The TSMP should be updated to reflect this.	Adopted- plan updated	These parameters are discussed in Section 8.3 .
TFiMP02	8.3	Where captured water is to be released directly into known or potential OPP habitat, dissolved inorganic carbon and lime pollution should also be monitored. In addition, any pre-release water treatment measures with the potential to impact upon water quality with respect to OPP should also be included in the suite of water quality parameters monitored at these sites.	Adopted – plan updated	<p>Management of water quality during construction is addressed in Section 6. No water resulting from construction will be released directly into Oxleyan Pygmy Perch habitat. The release of water would only occur under the following conditions:</p> <ul style="list-style-type: none"> ○ Release of stored water into areas where Oxleyan Pygmy Perch are known or have potential to occur would only be undertaken as a last resort. A last resort may consist of excessive flooding in the area. ○ Released water would be a pH level that matches the mean pre-construction pH determined during baseline monitoring of the waterway, to within 1 pH unit ○ Chemical treatments used prior to the release of water from sediment basins would not persist in the environment or negatively impact upon the environment after release ○ Potential pre-release water treatments and/or their derivatives would be included as parameters in baseline water quality

ID No	Section	Recommendation	Recommendation has been addressed (Version 1)	How Recommendation has been addressed (Version 2)
				<p>monitoring.</p> <p>Water quality monitoring will also be conducted during construction and operation of the project.</p> <p>Parameters to be measured during operation on a quarterly basis include:</p> <ul style="list-style-type: none"> • Nutrients – total nitrogen, oxides of nitrogen, ammonia, total phosphorus and orthophosphates • Dissolved and total metals – aluminium (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), magnesium (Mg), manganese (Mn) and zinc (Zn).
TFiMP03	8.3.1	The definition of a heavy rainfall event is included in the TSMP with respect to water quality monitoring. The draft Devils Pulpit to Ballina monitoring protocol utilises a figure of 15mm over a 24hr period to define a wet weather sample. The TSMP should be updated to reflect this.	Adopted- plan updated	Heavy rainfall event is defined in Section 8.3.1.
TFiMP04	8.2/8.3	Monitoring of stream flow and velocity should be undertaken under the same time frame as water quality monitoring at sites with known or potential habitat for OPP. The water quality monitoring plans for these sites should be amended to reflect this	Adopted- plan updated	Proposed changes were made to include monitoring of flow and velocity in Version 1.
TFiMP05	8.2.1	The protocol for selecting control sites should be reviewed and should include a hierarchy of principles. A suggested hierarchy would be: <ol style="list-style-type: none"> 1. Control site located >2 km upstream of impact site; 2. Control site located >1 km upstream of impact site; 3. Control site located >2 km downstream of impact site; or 4. Control site located in a different drainage, >2 km upstream of any other impact or control site. 	To be reviewed prior to implementation	The suggested hierarchy has been added to the monitoring section.
TFiMP06	5.2	The identification of presence or absence of suitable habitat and potential corridors between existing populations and/or areas of high quality habitat should be identified at this stage also and should be added to the list of goals under Section 5.2. Although it is clear in Section 5.3.1, the identification of baseline water quality and habitat conditions should also be added to the list of pre- construction goals listed in Section 5.2. It is understood that baseline water quality and	To be reviewed prior to implementation	Adopted. Proposed changes have been made.

ID No	Section	Recommendation	Recommendation has been addressed (Version 1)	How Recommendation has been addressed (Version 2)
		habitat conditions are already being assessed.		
TfIMP07	6.2	Minimal change to riparian habitats should be included as a goal under Section 6.2 along with promoting awareness among the construction staff, all contactors and the general community.	Adopted- plan updated	Proposed changes have been adequately been made in Version 1.
TFIMP08	6.3.3	The reasons for listing the OPP spawning season as October to December (p24), when the peak periods are reported to be October-December and February-April (Knight et al. 2012, updated from Knight et al. 2007a), should be clarified in the TSMP.	Adopted- plan updated	Proposed changes have been adequately been made in Version 1.
TFIMP09	6.2	Benthic material and riparian condition in the measures for no change in habitat, as they are important features of habitat for OPP.	Adopted- plan updated	Proposed changes have been adequately been made in Version 1.
TFIMP10	6 & 7	The TSMP should include reference to the thresholds identified during pre-construction monitoring in the goals set for construction and operational phases.	Adopted- plan updated	Proposed changes have been adequately been made in Version 1.
TFIMP11	6.3	<p>It is a recommendation of this review that if no release of water into OPP habitat is planned then it should be made clear in the TSMP. If release of water into OPP habitat is to occur then it is important to ensure that:</p> <ul style="list-style-type: none"> • release of stored water into OPP habitat is undertaken only as a last resort; • water released into OPP habitat is at a pH that matches the mean pre-construction pH of the waterway (as established during baseline water quality monitoring) to within 1 pH point; • any chemical treatments used prior to the release of water stored in sediment basins will not persist in the environment or negatively impact upon the environment after release. • potential pre-release water treatments and/or their derivatives are included as parameters in baseline water quality monitoring. 	Adopted- plan updated	Proposed changes have been adequately been made in Version 1.
TFIMP12	6.2	The TSMP should acknowledge that populations of <i>Gambusia holbrooki</i> are likely to fluctuate in response to stochastic factors and that changes to the in-stream habitat at crossing sites are very likely, particularly with respect to submerged and emergent vegetation.	Adopted – plan updated	Proposed changes have been adequately been made in Version 1.
TFIMP13	Table 5.1, 6.1, 7.1	Tables 5-1, 6-1 and 7-1. Where possible the stated corrective actions should be given time frames for their implementation. Post construction objectives, measures and thresholds should also be given time frames for their implementation.	To be reviewed prior to implementation	Timeframes for corrective actions have been included where appropriate.

ID No	Section	Recommendation	Recommendation has been addressed (Version 1)	How Recommendation has been addressed (Version 2)
TFiMP14	Table 7.1	Water quality and flow/velocity objectives for the post construction phase should also be measured over a set number of rainfall events;	To be reviewed prior to implementation	Mitigation goals regarding water quality and flow velocity have been included in Table 7.3 and appropriate monitoring and corrective actions.
TFiMP15	6	Indirect impacts upon known OPP populations outside of the construction corridor should be considered in addition to the potential impacts of acid sulphate soil disturbance on OPP.	Adopted – plan updated	Proposed changes have been adequately been made in Version 1.

Appendix D – Agency Consultation and Responses

ID No	Section	Recommendation	Recommendation has been addressed (Version 1)	How Recommendation has been addressed (Version 2)
DPI (Fisheries)				
DPI 1	General	The Threatened Fish Management Plan detailed in Appendix K while generally satisfactory has still some outstanding issues to be resolved. The plan in its current form requires improvement in both grammar and spelling to ensure that its intent is clear. Specific issues NSW DPI Fisheries would like addressed or clarified in the plan are detailed below.	To be reviewed prior to implementation	Further work has been made to the plan to improve grammar and clarity.
DPI 2	Table 4.1	Table 4.1 combines mitigation/control measures for threatened fish with non-threatened fish. NSW DPI Fisheries would like to see this table revised to have a clear focus on threatened species measures.	To be reviewed prior to implementation	The table now focusses on threatened fish species found within the project area during targeted surveys being Oxleyan Pygmy Perch.
DPI 3	6.2	Main goals for Management should include no negative impact on threatened species.	To be reviewed prior to implementation	This management goal has now been included throughout relevant sections.
DPI 4	6.3.3	Underboring of creeks is included as both a high risk and low risk activity. NSW DPI Fisheries consider underboring of waterways to be a high risk activity.	To be reviewed prior to implementation	Underboring has been removed from the list of low risk activities.
DPI 5	6.3.4	The installation and decommissioning of temporary waterway crossings where threatened species are present should not be conducted during both the October to December spawning period and the February to April spawning period. A commitment to minimising the time temporary crossings are in waterways should be made.	To be reviewed prior to implementation	Adopted- plan updated
DPI 6	6.3.5	This (translocation) strategy needs a lot more work and should be further developed in consultation with NSW DPI Fisheries. NSW DPI Fisheries recommends that suitable sites for relocating OPP should be identified during future aquatic surveying. Identifying suitable sites will allow the development of a translocation plan.	To be reviewed prior to implementation	Suitable translocation sites have been added, following advice from subsequent surveys (GeoLINK 2014). An Oxleyan Pygmy Perch Translocation Protocols report has been prepared and DPI (Fisheries) consulted in its development. Translocation of OPP is discussed in Section 6.3.8 of this plan.
DPI 7	6.3.6	This section needs to be rewritten to clearly address the Woolgoolga to Ballina project as it	To be reviewed prior to	Adopted – plan updated, now references Devils

ID No	Section	Recommendation	Recommendation has been addressed (Version 1)	How Recommendation has been addressed (Version 2)
DPI (Fisheries)				
		has sections directly taken from the Devils Pulpit Upgrade plan.	implementation	Pulpit Upgrade Plan.
DPI 8	Table 6.1	Table 6.1 makes a commitment to no change in instream habitat. This commitment is unrealistic as some changes are inevitable due to the installation of a structure and associated scour protection. NSW DPI Fisheries would like a commitment to minimise riparian vegetation clearing during construction and a targeted rehabilitation program post construction to restore as much as possible the instream and riparian habitat.	To be reviewed prior to implementation	Adopted – plan updated, now specifies minimal disturbance to instream habitat
DPI 9	2.2	The Oxleyan Pygmy Perch breeding period extends from September – May with spawning occurring from September until April (not only October – Dec as stated). Knight et al. 2007 also found evidence of two peak spawning periods – one between September and December and the other between February and April, with reduced spawning in January.	To be reviewed prior to implementation	Spawning period for Oxleyan Pygmy Perch has been updated throughout the TFMP to reflect the definition provided in the MCoA – October to April.
DPI 10	4.3.2	All Class 1 waterways should be bridged in accordance with NSW DPI Policy & Guidelines. NSW DPI requests a firm commitment to this. Culverts are unacceptable for waterways with OPP due to velocity issues and the difficulty in managing construction issues such as alkaline run off from blinding slab and sediment & ASS issues from constructing a clean water diversion. Bridge works should be scheduled so that high risk construction activities (concrete pours, piling etc) are undertaken outside the spawning season of OPP. The water management and sediment erosion control should be conducted as has been done at Devils Pulpit Upgrade rather than employing a traditional sediment basin management regime. This involves a floodplain capture system that encourages infiltration and natural treatment of runoff, pumping excess water from the floodplain to turkeys nest storage for reuse or irrigation to land, stabilisation of works within 50 metres of the waterway prior to the spawning season, capture of alkaline runoff from bridge decks and parapet works. High risk works should not be undertaken when rain is forecast or when creeks are flowing.	To be reviewed prior to implementation	Adopted – plan updated, where relevant mitigation measures now state permanent crossings of all Class 1 waterways will be bridged unless agreed with DPI Fisheries.
DPI 11	4.4.4	See comment in 2.2. above (TFiMP24). The draft report states the peak spawning season occurs from Oct – Mar which is inconsistent with the information presented in 2.2 (October – December). The peak spawning period occurs from September – April and the report should be amended accordingly. Wherever possible a temporary bridge should be employed particularly if the crossing is intended to be in place for any significant period of time. Where short duration crossings are proposed using culverts or pipes, adequate size pipes should be	To be reviewed prior to implementation	Spawning period for Oxleyan Pygmy Perch has been updated throughout the TFMP to reflect the definition provided in the MCoA – October to April.

ID No	Section	Recommendation	Recommendation has been addressed (Version 1)	How Recommendation has been addressed (Version 2)
DPI (Fisheries)				
		used for minimising velocity and to allow light to facilitate fish passage. Clean rock should be used of a minimum size that will not wash into the creek in high flows. Temporary crossings should be instream for the minimum amount of time possible and not in place during the spawning season. They should be well maintained, free of fine material and be capable of withstanding inundation in high flows with a low point and wrapped in geofabric.		
DPI 12	4.4.5	A permit is required to capture and hold Threatened species. There also biosecurity issues would need to be addressed with respect to any fish that are proposed to be held in captivity and subsequently released. In addition, there are limited care in captivity guidelines in respect of water quality, feeding etc and this information would need to be provided. Also creates issues with holding large numbers of fish for indeterminate times, and associated potential for mortality and/or reproduction in captivity.	To be reviewed prior to implementation	Adopted – plan updated, now states that the translocation strategy will be developed in consultation with NSW DPI, and that if adopted, a permit will be required.
DPI 13	4.4.6	NSW DPI are not supportive of a traditional basin management approach in identified sensitive areas such as waterways with OPP and the surrounding floodplain of these waterways. The soil and water management approach at Devils Pulpit Upgrade has been proven to capture events exceeding the 90th percentile and has demonstrated excellent performance in maintaining water quality and protection of OPP. NSW DPI are not supportive of reducing pH in basins using acid and then release of water from these basins into sensitive OPP waterways as the threshold of aluminium toxicity is close at the pH levels suggested in the Management Plan.	Adopted – plan updated	Plan now references relevant aspects of the Devils Pulpit Upgrade Plan. Water quality management during construction is detailed in Section 6.3.
DPI 14	5.2.2	NSW DPI is not supportive of capturing OPP and dye marking them to use in field trials to ascertain if fish passage is being achieved. Such an approach is likely to result in mortalities and would be difficult to achieve under field conditions.	Adopted – plan updated	Dye tracing removed from monitoring
DPI 15	5.3.1	NSW DPI recommends increasing the frequency of water quality monitoring in OPP waterways to weekly during construction as this monitoring is the best indicator of any construction impacts occurring and allows for remedial action to be implemented in a more timely manner.	Adopted – plan updated	Adopted – plan updated. Water quality monitoring frequency is now weekly during construction.
DPI 16	Table 5.1	Should be Table 6.1. The table is incomplete	Adopted – plan updated	Adopted – plan updated. Table has been completed.

ID No	Section	Recommendation	Recommendation has been addressed (Version 1)	How Recommendation has been addressed (Version 2)
DPI (Fisheries)				
DPI 17	5.5.2	NSW DPI should also receive this report	To be reviewed prior to implementation	Adopted – plan updated to reference that the report will be distributed to NSW DPI.
DPI 18	5.6	Contingency measures to be adopted for a change in OPP population numbers should include consultation with NSW DPI	To be reviewed prior to implementation	Adopted – plan updated to reference consultation with NSW DPI should there be a change in OPP population numbers.
DPI 19	General	Other issues which have not been addressed include the impact of culvert construction on waterways upstream of OPP habitat and how mitigation of issues such as alkaline runoff from blinding slabs, ASS from diversion channels and sediment from these works will be achieved.	To be reviewed prior to implementation	Adopted – plan updated.
DPI 20	General	NSW DPI is happy to have Purple Spotted Gudgeons (PSG's) removed from the Threatened Fish Management Plan for the Woolgoolga to Ballina Pacific Highway Upgrade as they have not been detected during a number of targeted aquatic surveys. The proposed mitigation measures for Oxleyan Pygmy Perch in the plan will also cater for the needs of PSG's should any be found in any future aquatic surveys during or prior to construction.	To be reviewed prior to implementation	Adopted – plan updated. Purple Spotted Gudgeon removed from the plan. A reference has been made to say that mitigation measures for OPP will also benefit the PSG.
DPI 21	General	NSW DPI is satisfied with the proposal to extend culverts at Chainage 114000 due to the advice provided by Matt Birch that there is no significant OPP habitat upstream of the current culvert arrangement and therefore connectivity is not required.	To be reviewed prior to implementation	Noted

ID No	Section	Recommendation	How Recommendation has been addressed (Version 3)
DPI (Fisheries)			
DPI 22	Page 14 Figure 1.3	Flow chart has “implement Invertebrates management plan” at the construction stage-it should be “implement Fish Management Plan”	Flowchart amended.
DPI 23	Page 53	Recommended additions to the dot points are:	These additional points have been included in Section 6.3.8

ID No	Section	Recommendation	How Recommendation has been addressed (Version 3)
DPI (Fisheries)			
	Section 6.3.8	<ul style="list-style-type: none"> No more than 30 OPP to be held in captivity at any one time OPP are to be held for no longer than one hour prior to release OPP are held separately from other aquatic fauna Increasing the size of holding gear to allow for separate holding of OPP <p>Retaining any dead OPP for potential scientific information such as aging or genetics.</p>	
DPI 24	OPP Translocation Strategy - page 6 Section 2.3	<p>Recommended additions to the dot points are:</p> <ul style="list-style-type: none"> No more than 30 OPP to be held in captivity at any one time OPP are to be held for no longer than one hour prior to release OPP are held separately from other aquatic fauna Increasing the size of holding gear to allow for separate holding of OPP <p>Retaining any dead OPP for potential scientific information such as aging or genetics.</p>	The Translocation Strategy is superseded by this TFMP. The Translocation Strategy will be included in Appendix E(f) of this plan and therefore both documents will inform measures to be implemented. However the TFMP will take precedence. These requested additions are specified in Section 6.3.8 of the TFMP and will be implemented.

ID No	Section	Recommendation	How Recommendation has been addressed (Version 3)
DPE			
DPE 1	Table of Contents	The OPP Translocation Protocol should be appended to the Plan.	Acknowledged. The Translocation Protocol will be included as suggested. It is Appendix E (f).
DPE 2	Chapter 1.3.2 and Figure 1-3	The Plan only addresses updating up to the commencement of construction. The Plan shall be amended to include details on the process for monitoring, reviewing and amending the Plan during construction and operation of the project, including the responsibilities for updating and approving the revised plan, the proposed timeframe for review (e.g. annually) and any factors which may trigger a review. Triggers for review should include where threatened species observed during construction or future surveys in waterways where the fish were not observed during the targeted surveys. In such instances, an assessment of the Plan should be undertaken and measures implemented, as required.	<p>Flowchart has been amended to reference steps that will be undertaken during operation.</p> <p>Wording has been included in Section 1.3.2 regarding triggers for future review and update of this document.</p>
DPE 3	Figure 1-3	Under the row titled construction, the figure refers to the Threatened Invertebrates MP.	Flowchart has been amended.

ID No	Section	Recommendation	How Recommendation has been addressed (Version 3)
DPE			
DPE 4	Chapter 2	<p>This chapter states targeted surveys for threatened fish was completed between 2012 and 2015. However Chapter 2.2.2 (Survey Results) only mentions surveys in sections 1-2 in 2012 and 2013, and in sections 6-9 in 2013 and 2014. Were further targeted surveys carried out in 2015?</p> <p>Will further fish surveys/monitoring be carried out in sections 1 and 2?</p> <p>Are there existing records of PSG in the waterways surveyed in sections 1, 2, 6-9 and 11? These records should be listed in the Plan and shown in the figures.</p>	<p>Targeted surveys for threatened fish were undertaken from 2012 to 2014. Wording has been updated in Section 2. Sections 1 and 2 had two targeted surveys completed and Sections 6-9 had two rounds of targeted surveys.</p> <p>No further surveys are to be carried out in Sections 1 and 2 as recommended by the expert and agreed upon by DPI Fisheries.</p> <p>As is stated in comment DPI 20, DPI have agreed to remove the PSG from this management plan. If the PSG is found during future monitoring or survey efforts, the plan will be reviewed and updated as per the unexpected finds procedure.</p>
DPE 5	Chapter 5.2	<p>One of the management objectives includes the identification of high quality habitat. The term high quality habitat is used in various chapters in the Plan, however, there is no definition of high quality. The Plan must describe what a high quality habitat comprises and how such a habitat is monitored in terms of the features that define it as high quality.</p>	<p>High quality habitat was referenced from a previous round of comments. It has no bearing on the information in the report and it is considered that contextually, the use of term "known habitat" will be more effective. Only the term "Known Habitat" or "OPP Habitat" are now used.</p>
DPE 6	Table 5-1	<p>One of the mitigation goals is to re-assess the likelihood of threatened fish to provide input into the detailed design of crossing structures. Two targeted surveys in the period June to September would be conducted pre-construction. Are additional targeted surveys in sections 6-9 to be carried out pre-construction? See comment 4.</p> <p>Identification of high quality habitat – see comment 5. Provide details of triggers for corrective actions and corrective actions should monitoring show/indicate degradation in the quality of the habitat.</p>	<p>Two rounds of surveys have been undertaken prior to construction, the first round of surveys in 2013 and the second in 2014 for Sections 6-11.</p> <p>Table 5.1 is regarding pre-construction phase of project. Therefore degradation of habitat will not be as a result of the project and corrective actions not applicable at this stage. Corrective actions will start to apply in the construction phase should OPP habitat show signs of degradation from baseline information as outlined in Section 6.4.</p>
DPE 7	Chapter 6.1	<p>6th dot point – what are littoral weeds? Please provide details of such weeds and context in terms of threatened fish habitat.</p>	<p>Littoral weeds are weed species with a preference for littoral rainforest habitat. Clarifications have been added.</p>
DPE 8	Chapter 6.3.4	<p>Oxleyan Pygmy Perch Management Areas are presented in Figures 6-3 to 6-5 and these are based on proximity to high risk activities. The Plan does not provide details of the purpose of these areas and the controls and/or management measures that are relevant to activities carried out in these areas. How were the management areas defined/determined? The Plan should provide more details on these management areas.</p>	<p>Oxleyan Pygmy Perch Management Areas are areas in which high risk activities are not to be conducted during high risk times. This includes OPP spawning or high rainfall. This is clarified in Section 6.3.4. High risk activities and high risk times are consistent with the definitions in Condition B7 of the approval.</p>

ID No	Section	Recommendation	How Recommendation has been addressed (Version 3)
DPE			
DPE 9	Chapter 6.3.5	<p>6th dot point - missing words "not increase"?</p> <p>8th dot point – operational spill basins be installed at key locations and other key drainage lines that lead directly into OPP habitat – is this correct. Are these standard spill basins or will they contain other features/controls/80th or 90th percentile to minimise water quality impacts on the waterways?</p> <p>12th dot point – river banks would be restored to protect them from erosion. A key design principle should be the revegetation of disturbed river banks with riparian vegetation, including banks with scour protection.</p>	<p>Wording has been updated.</p> <p>Operational spill basins will be standard. Wording has been clarified in Section 6.3.5. They will be designed to contain any spills from the road and prevent them entering OPP waterways.</p> <p>Wording regarding restoration of river banks as recommended has been included.</p>
DPE 10	Chapter 6.3.6	<p>Consultation with DPI-Fisheries should include management measures for in-stream works as well as timing.</p>	<p>Wording has been included.</p>
DPE 11	Chapter 6.3.8	<p>Cross reference should be made to the Translocation Protocol.</p> <p>In what circumstances will the translocation of threatened fish be required? What is the maximum duration between capture and release? Will Eastern Gambusia be released if captured?</p> <p>The translocation sites should be determined with DPI-Fisheries.</p>	<p>References and additional wording has been included in Section 6.3.8 regarding consultation with DPI.</p>
DPE 12	Chapter 6.3.9	<p>Change environmental to environment protection licence.</p>	<p>Wording has been modified as instructed.</p>
DPE 13	Chapter 6.3.9	<p>Is spraying of weeds with herbicides or pesticides appropriate for riparian restoration areas or areas within 50 metres of threatened fish habitat? Alternative means of weed removal should be considered given the sensitive environment.</p>	<p>Alternate means of weed control such a mechanical or hand removal methods will be assessed near OPP habitat. Only experienced professionals will be used during weed control activities, and these professionals will be briefed accordingly reducing the risk of pollution. Table 7-1 now reflects this.</p>
DPE 14	Chapter 4	<p>Aquatic Monitoring W2G – Stage 1 (GeoLink 2012): The Geolink report on sections 1 and 2 of the project made four recommendations. Please advise the status of recommendations 2 to 4 and whether they have/will be adopted/ implemented.</p>	<p>The recommendations from the GeoLink (2012) report address:</p> <ul style="list-style-type: none"> • Minimising habitat disturbance; • Aquatic monitoring; and • Accounting for natural variation.

ID No	Section	Recommendation	How Recommendation has been addressed (Version 3)
DPE			
DPE 15	Chapter 5	Aquatic Monitoring W2G – Stage 2 (GeoLink 2013): The report makes a number of recommendations - please advise the status of the recommendations and whether they have/will be adopted/ implemented.	<p>These factors have all been addressed in various sections of this report.</p> <p>This report makes a number of recommendations regarding:</p> <ul style="list-style-type: none"> • No OPP or PSG being likely in Sections 1 and 2. • Maintaining habitat integrity. • Aquatic monitoring and background variation. <p>These factors have been addressed, where applicable, throughout this report.</p>
DPE 16	Chapter 4	Aquatic Monitoring W2B – Stage 1 (GeoLink 2013): What is the status of recommendation 5 in relation to the crossing structure at location 2, section 7?	Wording included - Section 7: Unnamed waterway south of Serendipity Rd (chainage 114.000) (DPI Fisheries is satisfied with the proposal of a culvert extension due to the advice provided by Matt Birch that there is no significant OPP habitat upstream).
DPE 17	Chapter 4	Aquatic Monitoring W2B – Stage 2 (GeoLink 2015): The report makes a number of recommendations - please advise the status of the recommendations and whether they have/will be adopted/ implemented.	<p>The recommendations from the GeoLink (2015) report address:</p> <ul style="list-style-type: none"> • Timing of surveys after flood events; • Water quality monitoring; • Habitat quality monitoring; and • Accounting for natural variation. <p>These factors have all been addressed in various sections of this report.</p>
DPE 18	Chapter 4	What is the status of the conclusions of the report, in particular the last two dot points.	This report has been reviewed and all of the conclusions regarding management and monitoring of OPP refuge have been addressed. They have been referenced as necessary in the report.
DPE 19	Chapter 2.3	<p>The Protocol should include details of:</p> <ul style="list-style-type: none"> • Who will undertake the capture of fish; • Maximum duration between capture and release that fish are kept in containers; • Storage of containers from time of capture to release – ensure water temperature within range of OPP; and 	The Translocation Strategy is superseded by this TFMP. The Translocation Strategy will be included in Appendix E(f) of this plan and therefore both documents will inform measures to be implemented. However the TFMP will take precedence. These matters are addressed in Section 6.3.8 of the TFMP.

ID No	Section	Recommendation	How Recommendation has been addressed (Version 3)
DPE			
		<ul style="list-style-type: none"> Monitoring of fish at release sites. 	

ID No	Section	Recommendation	How Recommendation has been addressed (Version 3)
DoE			
DoE 1	Figures 6.1, 6.2, 6.3, 6.4, 6.5 Appendices	Pygmy is misspelt as "Pigmy" References provided to appendices in the Plan need to be reviewed. Suggest separating technical reports at Appendix E and include reference to each appendix within the relevant section of the Plan (currently all appendices are titled Appendix E).	Amended. Appendix E has been broken up accordingly.
DoE 2	This Plan	This Plan has been prepared to address all relevant NSW approval conditions relating to Oxleyan Pygmy Perch (OPP).	Acknowledged.
DoE 3	6.3.4	Have been identified as per advice from NSW DPI Fisheries	Acknowledged.
DoE 4	6.3.5	Figures 6.1 and 6.2 identify the locations of crossing structures within sections 6, 7, 8 and 9. The reason for selecting a culvert (and not a bridge or an arch structure) near location 113 within section 7 is unclear given the location of OPP habitat and OPP recordings at this site. Please explain why this has been identified as a temporary crossing (as per B9) if this is the case and/or if installation of a culvert has been discussed and approved by NSW DPI Fisheries.	Acknowledged. This has been addressed as per the comment in Section 6.3.5: "DPI Fisheries is satisfied with the proposal of a culvert extension due to the advice provided by Matt Birch that there is no significant OPP habitat upstream". Therefore the culvert crossing structure has been endorsed by DPI Fisheries as adequate.
DoE 5	Figure 6.2	Figure 6.2 does not indicate any connectivity structure between location 137 and 141 although numerous OPP are known to occur in this area. Please explain.	This appears to be due to the fact that the habitat does not cross the road in this area. A review of connectivity structures was undertaken with DPI Fisheries and they are satisfied with those proposed.
DoE 6	6.3.7	Outcomes of discussions with NSW DPI Fisheries have not been included in the Plan in relation to approval condition requirements.	All OPP considerations, including those related to design, have been addressed in consultation with DPI Fisheries. Workshop was held between Roads and Maritime and DPI Fisheries in February 2015. Meeting

ID No	Section	Recommendation	How Recommendation has been addressed (Version 3)
DoE			
			minutes provided in Attachment F .
DoE 7		Condition B10: This has not been addressed in the Plan	Condition B10 has now been addressed in Table 1-1.
DoE 8	Condition B11 and B12	The applicability or otherwise of these two conditions in relation to Oxleyan pygmy perch has not been addressed.	These conditions have been reviewed. B12 is now included however B11 has been deemed irrelevant.
DoE 9	Figure 4.1 and section 6.3.10 Table 6.2	Whilst figure 4.1 refers to a habitat restoration plan, a detailed plan has not be provided. The information provided in relation to rehabilitation does not appear to satisfactorily address B13 requirements., Table 7.3 Table 6.2, column 2 does not provide a timeframe for commencement of rehabilitation Information provided under column 5 should be linked to identification of non-compliance trigger rather than one month of completion of waterway crossing construction	The project rehabilitation plan is responsible for addressing this in full. Wording has been updated to clarify. Wording in Table 7.3 and Table 6.2 has been updated.
DoE 10	6.3.8	Please provide the Appendix reference to the Translocation Protocol under this section. Table 2.1 of the Translocation protocol refers to a site number 25. Such a site number could not be found in any of the Figures in the Plan.	Translocation strategy has been appropriately referenced. Translocation sites are mapped in this TFMP.
DoE 11	Section 2 , 2.1 and 2.2.2.	Where are the results of 2015 targeted surveys?	Surveys were undertaken in 2014, however the report for these surveys was released in 2015 (GeoLink 2015). This is supplied as Appendix E (b).
DoE 12	Figure 4.1	Suggest inclusion of relevant sections/appendices within each box identifying management measures.	This diagram was intended to be simple and just summarise key management measures for each stage. Each stage has its own section which provides further detail. No change has been made.
DoE 13	Table 5-1	Does the information in Table 5.1 indicate that further monitoring/re-assessment of fish species will be undertaken prior to commencement of construction? This table should provide specific information based on surveys undertaken to date for crossing designs, suitable habitat, high quality habitat, potential corridors etc .	This refers to pre-clearance surveys and these have been completed as a part of the 2014 period (GeoLink 2015). Clarifications have been made.
DoE 14	Table 6.2	It is unclear why water quality monitoring is limited to following a rainfall event. Does this mean if there is no rainfall event during construction period there will be no water quality monitoring? How does water quality monitoring after a rainfall event provide a	Water monitoring is stated as occurring weekly during construction as well as after a rainfall event.

ID No	Section	Recommendation	How Recommendation has been addressed (Version 3)
DoE			
		representative water quality of the OPP habitat and any deviation from baseline water quality levels?	Runoff will become a particular issue after a rain event when water flows into habitat areas making this a high risk.
DoE 15	Table 6.2	Please specify the species for fish surveys under Monitoring timing/frequency column Eg OPP, Gambusia).	These surveys will be general surveys capturing and recording all species. This will facilitate the monitoring of the abundance of individual species and the relative abundance of all species.
DoE 16	Table 7.3	What are key OPP and habitat locations? Doe this include all known OPP habitat locations? Please specify.	Wording has been modified in Table 7.3 for clarity.
DoE 17		What is meant by three events for monitoring? A monitoring period of 6 months for water quality during operation (how long after construction completed?) of the project is not considered adequate.	Events (as defined in table 6.2) are rainfall events. This ensures that no residual pollutants are being washed into OPP habitat by these events.
DoE 18		There is no monitoring of OPP proposed during operations.	An additional row has been added to Table 7.3 regarding direct OPP monitoring.
DoE 19	Translocation protocol	This does not provide water quality data at proposed translocation sites. The following information has not been included in the translocation protocol: <ul style="list-style-type: none"> • Equipment should be cleaned/sterilised before use at each site . • Individual fish should be visually inspected for health condition. Introduction of Lernaea or other pathogens into populations that do not have it would be a concern. • Fish must be identified to species level by a trained person to help prevent mis-identification and translocation of pest species • Fish should not be caught when air or water temperatures are extreme – e.g. midday, mid-summer. Be aware that small holding containers are subject to rapid temperature changes. • Aerators should be used during transit. 	These additional measures have been added to Section 8.5 of this TFMP and will be implemented. The Translocation Strategy is superseded by this TFMP. The Translocation Strategy will be included in Appendix E(f) of this plan and therefore both documents will inform measures to be implemented. However the TFMP will take precedence.
DoE 20	Birch Review	This review relates to the original management plan in 2013 and does not directly reflect the adequacy of the current management plan.	This table has a Version 1 and Version 2 column, this addresses any relevant changes in either version.

ID No	Section	Recommendation	How Recommendation has been addressed (Version 3)
DoE			
		A table illustrating how the review comments have been addressed in the current plan would have been more appropriate.	
DoE 21		See comment under B 8 above. Also please confirm compliance with condition B40 in relation to proposed crossing structures.	As per condition B40, all crossings have been designed in consultation with DPI (Fisheries).
DoE 22		This Plan does not address compliance with B 41 and B42 requirements.	Section 6.3.5 addresses both of these conditions.

ID No	Section	Recommendation	How Recommendation has been addressed (Version 3)
EPA			
EPA 1	General	Generally sound MP. All previous agency and, most importantly, expert commentary has been incorporated into this plan	Acknowledged
EPA 2	Page 47 Section 6.3.9 2nd series of dot points	Release of stored water to OPP areas as a last resort. What constitutes a last resort? Haven't there been placed enough measures to ensure this doesn't get considered as an option?	Excessive flooding may initiate a required release of stored water. Where this event is predicted Roads and Maritime will notify and consult with relevant agencies.
EPA 3	6.3.4	Have high risk/low risk activities been categorised in consultation with expert or DPI fisheries	Yes.

Appendix E – Technical reports

Appendix E (a) – Woolgoolga to Glenugie Aquatic Monitoring Sections 1 and 2 – Stage 1 (GeoLink 2012)

Appendix E (b) – Woolgoolga to Glenugie Aquatic Monitoring Sections 1 and 2 – Stage 2 (GeoLink 2013)

Appendix E (c) – Woolgoolga to Ballina Aquatic Monitoring Sections 6 to 11 – Stage 1 (GeoLink 2013)

Appendix E (d) – Woolgoolga to Ballina Aquatic Monitoring Sections 6 to 9 – Stage 2 (GeoLink 2015)

Appendix E (e) – Oxleyan Pygmy Perch Drought Refuge Assessment (GeoLink 2014)

Appendix E (f) – Oxleyan Pygmy Perch Translocation Protocols (GeoLink 2015)

Appendix F - DPI Fisheries Meeting Minutes (2015)