TILLEGRA DAM - HUNTER ESTUARY RAMSAR WETLAND IMPACTS

Independent Review

For:

DEPARTMENT OF PLANNING

October 2010

Final Report

Cumberland Ecology
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Report No. 10071RP1

The preparation of this report has been in accordance with the brief provided by the Client and has relied upon the data and results collected at or under the times and conditions specified in the report. All findings, conclusions or recommendations contained within the report are based only on the aforementioned circumstances. The report has been prepared for use by the Client and no responsibility for its use by other parties is accepted by Cumberland Ecology.

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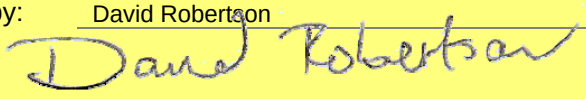
Signed:	
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Introduction

1.1 Purpose

Cumberland Ecology was commissioned by the Department of Planning (DoP) to conduct an independent review of a report entitled "Hunter Estuary Ramsar Wetland Impact Assessment" prepared by EcoLogical. The report – referred to hereafter as the "Wetland Impact Assessment or WIA Report" - assesses the impacts of the proposed Tillegra dam upon the Hunter Ramsar wetlands, which are listed as wetlands of international importance and matters of national environmental significance by the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

The WIA Report relies on materials from other related studies and so this independent review extended to cover other relevant reports, particularly studies on Estuarine Impacts of the Proposed Tillegra Dam and Ecological Character Descriptions of the Kooragang Island Component and the Shortland Wetland component of the Hunter Wetlands. A list of the documents prepared on behalf of the proponent that were reviewed is listed below:

- Biosis (2005) Ecological Character of Shortland Wetlands Private Ramsar site in NSW Draft Final Report.
- BMT WBM (2010) Estuarine impacts of the proposed Tillegra Dam: A collated assessment.
- Brereton, R., and Taylor-Wood, E., (2010), Ecological Character Description of the Kooragang Component of the Hunter Estuary Wetlands Ramsar Site. Report to the Department of the Environment, Water, Heritage and the Arts, Canberra.
- DECCW (2010). Ecological Character of Shortland Wetlands private Ramsar site in NSW. Dubbo NSW.
- DEWHA (2002). Information Sheet on Ramsar Wetlands (RIS).
- EcoLogical Australia (2009). Tillegra Dam Ramsar WIA Report Prepared for Hunter Water Corporation.
- EcoLogical Australia (2010). Tillegra Dam Ramsar WIA Report Independent Review Prepared for Hunter Water Corporation.

- Peirson, WL., Bishop, K., Van Senden, D., Horton, PR. and Adamantidis, CA., *Environmental Water Requirements to Maintain Estuarine Processes* (2002), Environmental Flows Initiative Technical Report Number 3, Commonwealth of Australia, Canberra.

- Peirson, WL (2010). Second Independent Review - Tillegra Dam: Hydrological and Water quality impacts on Hunter Estuary

Richard Kingsford and Chelsea Hankin of the Australian Wetlands and Rivers Centre prepared an alternate assessment of the ecological impacts of the Tillegra Dam that raised issues with the WIA Report. That report was considered in this peer review. Its title is as follows:

- Richard T. Kingsford and Chelsea J. Hankin (2010) The impact of the proposed Tillegra Dam on the Hunter River Estuary, its Ramsar wetland and migratory shorebirds. shorebirds. Australian Wetlands and Rivers Centre. The University of New South Wales.

EcoLogical responded to the Kingsford and Hankin Report and to other submissions in a response document (the Proponents Response). This independent review considered both the Kingsford and Hankin report and the Proponent's Response.

The purpose of this report is to independently assess the WIA Report and affiliated literature based on the 14 Terms of Reference provided to Cumberland Ecology in a letter from the Department of Planning (DoP) dated 2 September 2010. The letter states that it is understood that the review to be undertaken by Cumberland Ecology is based on the assumption that the Proponent's assessment of hydrological and water quality changes to the Hunter Estuary as a result of the project is correct. However, Cumberland Ecology has broadened this scope where appropriate and reviewed additional information relating to the Tillegra Dam project. The information within this broader material provides independent reviews of different aspects of the project based on the Environmental Assessment provided by the Proponent. This broader material has been referenced in this report where appropriate.

The review of these 14 terms of reference are provided in Chapter 2 of this report while a short conclusion summarising the results of the review is provided in Chapter 3. The remainder of this chapter provides a brief introduction to the history of the project.

1.2 Background to the Project

Hunter Water Corporation is seeking approval to construct a 450 gigalitre dam at Tillegra, near Dungog in the Upper Williams River catchment. Tillegra Dam is proposed to be located on the Upper Williams River, within the localities of Tillegra and Munni. The proposed dam would inundate an area of approximately 2,100 hectares at Full Supply Level. The project is within the Dungog Local Government Area, within the Hunter region of NSW, approximately 70km north of Newcastle.

The proposal is to be assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* and consequently, the Minister for Planning is the approval authority for the project. On 13 May 2009, the Minister for Planning formed an Opinion under section 75C of the Environmental Planning and Assessment Act 1979 that the project is essential for the State for economic and social reasons and therefore declared it to be a critical infrastructure project.

The Environmental Assessment for the proposal was exhibited from 10 September 2009 until 13 November 2009 and 2,659 public submissions were received and a further ten from government agencies. The project was also declared a controlled action on 23 January 2009 under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), for downstream impacts to Ramsar wetlands, in the Hunter Estuary. The Commonwealth approval process will be assessed in accordance with clause 13.2 of the Bilateral Agreement between NSW and the Commonwealth, made under the EPBC Act, relating to environmental impact assessment.

DoP has also commissioned four other independent reviews related to the Tillegra Dam project; two of which are relevant to this peer review: a hydrology review of the Williams River and a review of the hydrology and water quality modelling of the Hunter Estuary. These documents form part of the scope of review for this report.

1.3 Methods

The two authors of this peer review, Dr David Robertson and Mr Nathan Campbell, each reviewed all of the aforementioned literature. Both authors are familiar with the Hunter River Estuary and with the flora and fauna that occur within them and have worked on other estuary sites with similar ecology.

The reports of the proponent were examined to consider their purpose and objectives, and how those were addressed by various technical work in subsequent sections of each report. Where recent reports and peer reviews were published after the main WIA report, Cumberland Ecology has considered whether the later reports potentially change the conclusions of the WIA report.

Cumberland Ecology has taken a conservative approach to the peer review. Where gaps in the assessment were perceived by the reviewers, even if ostensibly small, the gaps have been discussed and highlighted in the peer review.

Chapter 2

Results of Peer Review

Within this chapter, the DoP terms of reference for the peer review are provided under relevant headings within italics, followed by the review comment in plain text. The actual DoP issue number from the brief is provided in parenthesis at the end of each italicised section.

2.1 Proponent's Ecological Character Description

The accuracy of the Proponent's 1 Ecological Character Description (ECD) of the Hunter Estuary Ramsar wetland (refer to Appendix 6 -Chapter 3 of Document 1), with reference to the Department of Environment, Climate Change and Water (DECCW) ECD (DoP Brief Issue 1);

The Proponent's Ecological Character Description (ECD) is generally accurate, but lacks some details about existing cumulative impacts on the criteria for which the Ramsar wetlands were gazetted, as explained below.

At the time of preparation of this independent review, two Ecological Character Description (ECD) reports are available for the Hunter Ramsar Wetlands. One, on the Shortland Wetlands by Department of Environment and Conservation (now DECCW), was prepared in 2006 and has been reviewed and summarised within the WIA Report. The other, on the ECD of the Kooragang Component of the Hunter Ramsar Wetlands has only recently been completed in June 2010 by Brereton and Taylor-Wood, (2010). It post dated the WIA Report and has not been considered.

The proponents Ecological Character Description (ECD) of the Hunter Estuary Ramsar Wetland is generally well researched and accurate when considering the information available at the time of publication.

The WIA Report acknowledges that the Hunter Estuary is one of Australia's most significant migratory seabird sites and notes that the Ramsar wetlands have two separate components, the Shortland Wetlands and the Kooragang Nature Reserve.

The Shortland Wetlands was designated as a Ramsar site on the basis of the following criteria:

Criterion 1: Shortland Wetland is unique in that it has a combination of high conservation value near-natural wetlands and high conservation artificial value wetlands. It is the only complex of this type found within the Sydney Basin biogeographic region.

Criterion 4: Shortland Wetlands supports a large number of species, some in very large numbers, at a critical seasonal stage of their breeding cycle and as a refuge during adverse conditions. Twenty-eight bird species have been recorded as breeding at the site and it provides drought refuge for a number of species during critical inland drought episodes. The site is also important during dry periods for resident ducks, herons and other water birds.

The Kooragang Nature Reserve component of the Hunter Estuary Wetlands was designated as a wetland site on the basis of the following criteria:

Criterion 3: Kooragang Nature Reserve is ecologically diverse and represents a significant genetic pool for wetland species in the Sydney Basin biogeographic region. The mangrove and salt marsh areas are particularly good examples of these plant communities. The wetlands are also important for maintaining high diversity of birds within the biogeographic region, with over 250 species recorded.

Criterion 4: Kooragang Nature Reserve is widely recognised for its importance in the conservation of migratory birds, with at least 38 species of migratory birds recorded. The Reserve regularly supports 15 species of migratory shorebird, and also supports a large number of species at a critical seasonal stage of their breeding cycle with 24 breeding species recorded. In 2000, 4800 migratory shorebirds were recorded in the Estuary.

Criterion 6: Kooragang Nature Reserve regularly supports between 2% and 5% of the East-Asian-Australasian Flyway population of Eastern Curlew, with counts from 1989-2000 ranging from 320-9000 birds.

Of the two wetland components that could theoretically be impacted by the proposed Tillegra Dam, the Kooragang Nature Reserve is the most likely to be impacted because it is physically linked to the Hunter River North Arm. Given the ecological significance of that wetland, the diversity of water birds and wetlands that it supports, the latest information in the ECD report by Brereton and Taylor-Wood (2010) should be considered. In particular, the most recent ECD report clearly states that key aspects of the wetlands are under threat and have diminished, including salt marsh wetlands and water bird populations. There have been substantial declines in both, exceeding what has been termed the “limits of acceptable change” or LAC. Moreover, the mechanisms for decline are not well known or understood.

The ECD report on Kooragang Island Nature Reserve also states that the major threats identified that may lead to significant changes in the ecological character of the Hunter Estuary Wetland Ramsar site include sea level rise, changes in freshwater/saltwater balance due to changes in land drainage and exclusion of tidal waters leading to salt marsh decline.

The information within the WIA Report is broadly consistent with the most recent information available about wetland character by Brereton and Taylor-Wood (2010), which was commissioned by DEWHA. The information within the WIA report appears to be based upon an earlier DEWHA Information Sheet on Ramsar Wetlands (October 2002) (as is stated within the Tillegra Dam Ramsar WIA Report). However, the report by Brereton and Taylor-Wood (2010) contains more detailed ecological information than the WIA report, particularly with regard to risk factors affecting wetland condition. The WIA report should be updated to take such additional detail into consideration.

The Kooragang Nature Reserve is one of the most important wetland sites in Australia and is listed as a Ramsar wetland due to wetland vegetation and water birds, which have been declining to a significant degree. The WIA Report and/or the Proponent's Response should have provided more detail on the known cumulative changes that have occurred on the ecological characteristics of the wetland in the previous few decades as discussed by Brereton and Taylor-Wood (2010). Such cumulative impacts to wetlands and water birds should be acknowledged as part of the context within which any potential impacts of Tillegra Dam are evaluated.

2.2 Proponent's Identification of Threats and Limits of Acceptable Change

The accuracy of the Proponent's identification of threats and Limits of Acceptable Change for the Hunter Estuary Ramsar Wetlands as a result of the project (refer to Appendix 6 - Chapter 3 of Document 1), with reference to the DECCW ECD (DoP Brief Issue 2);

The proponent has prepared a list of potential threats and acceptable changes for the Hunter Estuary as a result of proposed construction of Tillegra Dam and this is shown in section 3.11.4, particularly Table 5 of the WIA Report.

2.2.1 Threats

The analysis in the WIA Report indicates that climate change (and sea level rise) constitutes an extreme risk to the Ramsar wetlands, which is appropriate. Relatively small changes in sea level would have major impacts across the Ramsar wetlands that are likely to dwarf potential impacts from the Tillegra Dam project in the medium to long term. Cumberland Ecology has been supplied with modelling approximate inundation extents of mean high water for a 0.4m sea level rise scenario. A copy of this map is appended to this report. The map clearly shows that under a 0.4m sea level rise almost the entire Kooragang Island would be inundated – representing a far bigger threat to the wetlands. The predicted 0.4m rise in sea level is predicted to occur within decades and within the operational phase of the dam.

Other threats assessed within Table 5 of the WIA Report include:

- Changed hydrological regime;

- Biochemical changes;
- Urban/industrial development;
- Floods and storms; and
- Offsite threats to biodiversity (including impacts that occur in other countries to migratory species).

The risk assessment then concluded that there are two main perceived threats on the Hunter Estuary Wetlands from the proposed Tillegra project, those being hydrological and biochemical changes.

Potential threats discussed and considered by the Proponent are generally adequate as they have considered the potential impacts of the dam including change in hydrological regime and saltwater balance have been identified as threats in the Wetlands at Kooragang within the WIA Report and as two of the major threats to the Hunter Estuary Ramsar Wetlands as defined by the Ecological Character Description for Kooragang Wetland (DECCW, 2010).

The Proponent's identification of risks to the wetlands is generally accurate, with one qualification. The wetland flora and migratory seabirds have been in decline for decades. Substantial declines have been recorded and these declines have exceeded limits of acceptable change within Kooragang and Shortland Wetlands. The precise reasons for declines are not absolutely known. The lack of certainty should be acknowledged within the risk assessment.

2.2.2 Limits of Acceptable Change

Limits of acceptable change (LAC) are discussed based on the Shortland Wetland ECD because at the time of preparation, none had been devised for Kooragang Island. This is now not the case and the WIA Report should be updated to take into consideration the LAC for Kooragang Island provided in the report by Brereton and Taylor-Wood (2010)

Table 6 in the WIA report summarises the proposed LAC, with details for the two separate wetlands. Of these, some are provided in quantifiable form (e.g. 5% changes in the number of water bird populations over a 10 year period). However, many of the other suggested limits talk about qualitative things such as "significant loss of, modification to, hydrological and biochemical changes to salt marsh communities would be unacceptable". The term "significant" is not quantified. There should be numeric LAC values provided for all variables.

The limits of change for the Shortland Wetland contain a moderate proportion of changes that are actually qualitative changes as a large amount of ongoing research has been conducted within the wetland as report by Biosis (2005). The proponent's ecological report table actually provides acceptable limits of change for the Shortland Wetland referenced as being the acceptable limits of change within the Biosis report. These

quantitative acceptable limits of change are considered acceptable as they are akin to the typical acceptable percentage change that is considered appropriate for other scientific studies of 5%.

It is understood that there has been no detailed monitoring of the ecological characters of Kooragang Wetland and as such it is difficult to create quantitative acceptable limits of change for the for any impacts that may occur on this wetland. The acceptable limits of change in the report are typically recorded in reference to 'significant changes' where significant has been defined as "a change or impact that is important, notable or of consequence, having regard to its context or intensity" (EcoLogical, 2009). For one of Australia's most important Ramsar wetlands that has seen significant decline in bird numbers since the 1970's such qualitative limits of change are not considered appropriate.

Brereton and Taylor-Wood (2010) have produced quantitative limits of change for Kooragang Wetland based on a detailed field study and literature review. These limits of change are more detailed than those prepared by the WIA Report. The WIA Report should be updated to reflect the LAC for Kooragang Island presented in Brereton and Taylor-Wood (2010).

2.3 Proponent's Methodology

The appropriateness of the Proponent's methodology for determining impacts to the ecological character of the Hunter Estuary Ramsar wetlands (DoP Brief Issue 3);

As stated above, the WIA Report determined that there are two main perceived threats on the Hunter Estuary Wetlands from the proposed Tillegra project, those being hydrological and biochemical changes. The impact assessment methodology is therefore based almost entirely upon very detailed modelling to examine hydrological and salinity changes that could occur under different scenarios.

2.3.1 Modelling of Hydrology and Salinity

Provided that the modelling is correct and accurate, and provided that all important scenarios are modelled, this approach is appropriate. To a large extent, the modelling indicates that the impacts of the project are likely to be small and insignificant, particularly when the relative impacts of the project are compared with those likely from sea level rise. Cumberland Ecology has been supplied with modelling approximate inundation extents of mean high water for a 0.4m sea level rise scenario. A copy of this map is appended to this report. The map clearly shows that under a 0.4m sea level rise almost the entire Kooragang Island would be inundated – representing a far bigger threat to the wetlands. The predicted 0.4m rise in sea level is predicted to occur within decades and within the operational phase of the dam.

The modelling work in the WIA Report has been criticised by Kingsford and Hankin (2010) as being oversimplified and unlikely to fully address the potential impacts upon water birds, which have declined significantly over recent decades.

The second independent review of the hydrological and water quality impacts on the Hunter Estuary by Peirson (September 2010) concludes that there remain weaknesses in the hydrological report. One such weakness is that the conclusions are descriptive, not quantitative. Notwithstanding that, Peirson (2010) stated that there are two conclusions of primary interest for impact assessment:

1. With respect to flood inundation within Ramsar site boundaries an area in the west may be most significantly impacted – perhaps a hectare in size.

2. Based on the ELCOM modelling assessment, for most of the time, salinity structure is estimated to shift slightly seaward due to increased flows over Seaham Weir. As flows increase and the mean saline structure is shifted towards the sea, there will be some reduction in this shift due to the more modest flow increases at Seaham Weir. The predicted changes are small – less than two hundred metres under conditions of low flow.

These impacts predicted by Peirson (2010) are quite small in nature and area but have potential to have impacts upon some shorebird feeding areas (e.g. intertidal macroinvertebrates on which they feed) and possibly upon some estuarine plants, particularly salt marsh. Neither the WIA report nor the Response report considers such impacts on individual species of plants or water birds. However, for the purposes of due diligence, given the importance of the Hunter Wetlands, this should be done.

Peirson (2010) also notes that there has not been an assessment of the period of filling of the dam, although it is referred to during the report.

The Proponent's Response report (EcoLogical, 2010) has addressed many of the concerns about the modelling and impact assessment methodology, such as those by Kingsford and Hankin (2010). The additional data and additional modelling conducted in the later report are adequate in addressing the issues raised by the methodology as indicated by Peirson (2010), however Peirson (2010) reports that there may be a problem with the flood calibration of the Hunter Estuary used in the modelling that needs to be solved prior to being sure of all modelling reported. Other criticisms of the methodology are adequately discussed by the inclusion of a literature review in the latter reports submitted to DoP (EcoLogical 2010, BMT WBM 2010).

As mentioned above, significant questions were raised by the peer reviews that have followed submission of the Environmental Assessment Report for the Tillegra Dam Project. Kingsford and Hankin (2010) provided strong evidence that the modelling of the EcoLogical report is potentially flawed due to its simplicity of modelling through not incorporating the potential impacts to the Hunter Estuary Ramsar Wetlands from predicted changes of the project on an annual, seasonal, monthly and daily basis as well as under drought conditions. EcoLogical responded by running a more complex modelling scenario

by spelling out all of the different time scale and extreme weather condition scenarios. Conclusions drawn from this remodelling differed from that of Kingsford and Hankin (2010) who determined that the results of the modelling proved that significant impacts could occur as a result of the construction of the dam. The Proponent's consultant concluded that any changes to inflows to the Hunter Estuary Ramsar Wetland would not cause a significant impact with potential flow on effects.

The WIA Report concluded that there would be minimal impact to the Hunter River Estuary because of the barrier effect of Seaham Weir and the importance of inflows from the Hunter and the Paterson-Allyn Rivers. Kingsford and Hankin (2010) argued that predicted changes in flow modelling may result in sizable reductions to in flows into the estuary, affecting the Ramsar site and migratory shorebirds and their habitats. The predicted impacts of Kingsford and Hankin (2010) are discussed in detail in Section 2.4 but include flow on effects of changes in salinity and water levels to such a point that they may begin to impact on threatened vegetation communities, migratory shore birds and their habitat.

2.3.2 Ecological Analysis

There is no detailed ecological impact assessment for individual species or for important habitats such as salt marsh, and this is a major weakness in the WIA Report and the later Proponents Response Report.

The WIA Report has mentioned threatened and migratory species of birds and other biota that occur in the Ramsar wetlands. However, there is no detailed analysis of the use of the wetlands by different species. Migratory waders and other water birds do not make uniform use of the wetlands. Many are highly specialised in the way that they feed and move within the wetland areas. Moreover, not all populations are likely to have declined to the same degree.

There is no acknowledgement in the WIA Report that water bird populations and salt marsh areas have declined significantly. There is no detailed analysis of the different ways that various species use the wetlands spatially and temporally and consequently there has been no attempt at a species-specific impact assessment.

2.4 Accuracy of the Proponent's Assessment

The accuracy of the Proponent's assessment considering relevant guidelines and the accuracy of the Proponent's assessment in quantifying and determining the level of impact (DoP Brief Issue 4);

2.4.1 Assessment according to relevant guidelines

The proponent has considered guidelines in assessing the impacts of the EPBC Act listed Ramsar wetlands being the *Matters of National Environmental Significance – Significant*

Impact Guidelines 1.1. The assessments conducted under these guidelines are appropriate when making a referral, given the results of the modelling and that no significant impacts are predicted. However the discussions only briefly mention the wetland vegetation and the migratory wading birds. These are the very reason that the wetlands are listed as Ramsar wetlands and it is considered that these should be discussed in far more detail.

No guidelines exist for quantifying the impacts of a dam project upon estuaries and estuarine biota. However, the wetlands under consideration are of international importance and so potential impacts to species and communities should be considered specifically and in detail. An attempt to quantify impacts and to focus on the species most at risk from any impacts, no matter how small, should be made. The WIA report has not done this.

The Proponent has also appropriately assessed the impacts of the proposed development of Tillegra Dam according to Table 2 of the Peirson *et al* (2002) document which provides a checklist method of assessment for changes in predicted environmental flows. This has been reported within the BMT WBM (2010) report.

2.4.2 Accuracy of assessment

In general the proponent's assessment of impacts is considered adequate, particularly when considering the conclusion that the impact of the changes in flow regime will not be significant. However there remain a small number of criticisms regarding the proposal that should be explored prior to considering that the impacts of the project are insignificant. These criticisms are detailed below;

- The modelling of the proponent in the recent WBM BMT (2010) report has carefully considered the previous criticisms of the project and has resulted in a thorough assessment of the project from a hydrological perspective. The proponent has indicated that Post Tillegra there will be a small drop in flood inundation water levels. This has been considered as a post filled Tillegra Dam scenario only, it has not considered the process during the actual filling of Tillegra Dam where water losses are considered by Cumberland Ecology to be greater than during the period the dam is full. The proponent needs to model these scenarios to determine the likely impacts of lower flood levels on sensitive wetland communities such as Salt marsh and migratory waders. Without the modelling scenario of filling period of the dam it is considered unlikely that the assessment of Tillegra Dam is appropriate.

- The proponent has concluded that the modelling post Tillegra Dam will result in some small areas of the dam not being inundated during flooding events, due to lower flood inputs, but has not indicated what the potential impacts of flooding level changes will have upon the migratory birds that use the wetland nor the vegetation communities within the wetland area. These small changes in flood inundation heights may result in the reduction of a considerable area

of flooded habitat on the very flat flood plains and could have significant ramifications for the development of some of the wetland vegetation communities and result in the loss of areas of habitat for vegetation communities and subsequently wetland birds;

- The impact of these changes, particularly during the filling of Tillegra Dam should be considered for any potential impacts on macroinvertebrate species and the potential impacts that changes in marcoinvertebrate assemblages could have on the migratory wetland birds and their feeding patterns;

- Cumulative impacts of the project, discussed within Section 5.4 of the Proponent's Report, is too brief and does not consider the long term future of the water usages of the Hunter Valley. Considerations should include the potential ongoing and long term impacts that may arise from additional mines, agriculture and residential development within the Hunter Valley, however these considerations seem to be absent within the Proponent's discussion.

2.5 Suggested Improvements

Suggested improvements if any flaws are identified in the Proponent's assessment methodology of presentation of information (DoP Brief Issue 5);

A small number of improvements recommended by Cumberland Ecology that are not considered within the WIA Report are discussed below;

- The Proponent needs to quantitatively define and map the area of potentially impacted wetlands under the different filling and flooding scenarios (identified in the second peer review by Peirson 2010). Only then can determination of the significance of impact of the project on vegetation communities such as salt marsh and migratory birds be determined.

- Maps of various flooding scenarios were provided separately to Cumberland Ecology and these show some indication of the areas where flooding may change. However, the mapping of different flooding scenarios are based on existing modelling that does not take into account criticisms of modelling by other peer reviewers, particularly Peirson 2010);

- A more detailed discussion should be made of the potential impacts of the proposed construction of Tillegra Dam upon the sensitive vegetation communities within the wetlands. Salt marsh is a very sensitive community that forms along a fringe of estuarine wetlands. Kooragang Nature reserve within the Hunter Estuary Wetlands forms a very large stand of this community due to topographic elevation, tidal influence and salinity levels. Potential changes that could occur on the wetland include the transition of the community from salt marsh to a mangrove community. Any of these changes

could have important ramifications for the wetland bids which use the salt marsh as habitat.

- It is also considered that the impacts of the changes in hydrological inputs should have been discussed in more detail for their potential impacts upon migratory waders. Some waders have a preference for feeding across wetlands at certain depths. A small vertical change in hydrological input and sedimentation load resulting in a small vertical change in topography and water level could be compounded across the gradual slope of the wetlands, such a change could result in the potentially significant area of habitat for certain migratory wading bird species that have selective preferences for feeding within certain areas of the wetland under certain tidal regimes. The numbers of wading species have declined dramatically within the Hunter Estuary Wetland since the 1970's which may be a result of the changes in hydrological and sedimentary inputs as a result of the removal of water upstream.

- Impacts of changes in salinity on invertebrates within the wetland have not been addressed in detail. The changed hydrological regime of the project during the filling period and post filling period could be significant for the macroinvertebrates that use the wetland. The feeding preferences for many wading bird species are most likely not known. If such changes impact on any particular invertebrate species, that is a preferred food source for any specific species of wader, then such changes could potentially impact on the wading species that use the wetland. This could further decrease the numbers of wading species which have declined dramatically within the Hunter Estuary Wetland since the 1970's which may be a result of the decrease in water quality.

- Cumulative changes to the water quality and water inputs to the Hunter Estuary Wetland should have been considered in more detail. The reduction in the number of migratory species across the wetland could potentially be due to an increased construction and agricultural activities in the Hunter Valley Catchment. These changes should be considered in the report and the cumulative impacts of Tillegra Dam on top of past changes need to be considered. There also should be a consideration of the potential implications for further development in the Hunter Valley Estuary Wetland and whether any future mine proposals may not be able to be approved as a result of the construction of Tillegra Dam.

2.6 Proponent's Ecological Assessment of Impacts

Has the Proponent's ecological assessment of impacts (from the project) on the Hunter Estuary Ramsar wetlands considered all potential impacts resulting from the project on the ecological character of the Ramsar wetlands? (DoP Brief Issue 6)

There are a number of potential impacts that the Proponent's ecological consultants should have considered that are not discussed in the proponent's report. Refer to comments in above Section 2.4 and 2.5 of this report for detailed discussion.

The proponent has not considered all potential ecological impacts of the project. The Proponent has modelled flows and discussed flows and salinity changes. Subsequent reviews of the modelling have suggested that there will be impacts, albeit small.

Water birds and wetlands such as salt marsh were principal reasons for the Hunter Wetlands being listed as Ramsar wetlands. They are very important wetlands for many bird species and for salt marsh. The Proponents ecologists need to conduct a detailed species-specific analysis of the potential impacts on migratory birds, and a habitat-specific assessment on all plant communities, particularly salt marsh.

It is conceivable that some species or plant communities are potentially at greater risk than others from the project but there is no analysis within either the WIA Report or the Proponent's response report to examine this.

2.7 Proponent's Assessment based on Changes of the Project

Whether the Proponent has assessed the potential impacts to the Hunter Estuary Ramsar Wetlands from predicted changes of the project on an annual, seasonal, monthly and daily basis and under drought conditions (DoP Brief Issue 7);

The WIA Report and the Response Report have consistently concluded that modelling has shown that the proposed Tillegra Dam will have a negligible to very small effect on any of the hydrological or hydrodynamic processes of the Hunter Estuary Wetland Ramsar site.

While annual, seasonal, monthly, daily and drought conditions were not addressed in detail within the Proponent's original report, the Proponent addressed this information in detail in the Response to Independent Review prepared by EcoLogical (2010). The information prepared in the Response Report is generally appropriate and responds to many of the issues raised by Kingsford and Hankin (2010) in their independent review.

No detailed analysis of migratory species or wetland types has been conducted to indicate which species/communities could be most at risk from annual, seasonal, monthly, daily and drought conditions. Provided that the hydrological and salinity modelling is correct and accurate, it is relatively unlikely that there would be quantifiable impacts to migratory water birds or wetland plant communities such as salt marsh. However, the Ramsar wetlands are wetlands of international importance that have been declared so based upon migratory waders and significant wetland vegetation – all of which are in decline. The Proponent should conduct a more detailed assessment of the potential sensitivity of individual species and communities to hydrological and salinity changes under annual, seasonal, monthly, daily and drought conditions.

2.8 Checklist of Major Ecological Processes

Has the Proponent adequately addressed "Table 2 -checklist of major ecological processes by which reduced estuary inflows may cause impacts on estuarine ecosystems and the adjacent marine environment" (from Peirson et al 2002) (DoP Brief Issue 8);

The proponent has discussed all of the potential impacts that are included within Table 2 of the Peirson et al (2002) document *Environmental Water Requirements to Maintain Estuarine Processes*. This has been discussed appropriately in the final chapter of the report prepared by WBM BMT (2010).

2.9 Assessment of Cumulative Impacts

Has the Proponent assessed the cumulative impacts on the Hunter Estuary Ramsar Wetlands (DoP Brief Issue 9);

As indicated in the Kingsford and Hankin report, and in the reports on ecological character of the wetlands, water bird numbers and salt marsh area have already declined markedly as a result of cumulative impacts that have not previously been quantified. Given that cumulative impacts to water birds and salt marsh have occurred and presumably continue, the relative contribution of the proposed new dam to cumulative impacts must be assessed in some detail, even if such impacts are small.

Cumulative impacts have not been adequately discussed or analysed in the WIA report. There has been no species-specific or plant community-specific analysis of cumulative impacts. Some key criticisms of the WIA Report raised by Kingsford and Hankin (2010) about cumulative impacts to water birds remain unanswered.

The WIA Report provides one paragraph on page 147 about cumulative impacts as follows:

> *"The consideration of cumulative impacts is difficult to quantify for the Hunter Estuary Wetlands due to the dynamic nature of wetlands and influences from sources that are external to the wetland (e.g. climate change, other proposed developments, impacts on migratory bird breeding habitat in other nations). However, given the modelling undertaken as part of this study demonstrates the limited extent of change that would result from the proposed Tillegra Dam, it is considered highly unlikely that the proposal will contribute to any cumulative impacts or changes to the Hunter Estuary Wetlands."*

The Response Report provides a further page of explanation including:

> "*Or risk assessment process, documented in prior reporting (ELA 2009), shows that the most pressing threats to the ecological character of the wetlands may result from climate change, offsite threats to biodiversity, severe weather*

events, changed hydrological regimes, biochemical changes to water quality and urban/industrial development in approximate order of importance.

None of these threats classified in the risk assessment process are considered to be facilitated or consequential cumulative impact caused by Tillegra Dam."

The Proponent in the original Hunter Estuary Wetland Report briefly discusses the cumulative impacts of the proposed Tillegra Dam on the Hunter Estuary Ramsar Wetlands. The cumulative impacts are largely dismissed because the construction of Tillegra Dam is proposed to have minimal hydrological and salinity impacts based on the results of modelling.

In the Response Report prepared by the Proponent modelling includes a comparison of flows into the Hunter River Estuary from 1940 to the prediction post Tillegra Dam. In this way the Proponent has included a relevant assessment of the cumulative impacts of the proposed construction of Tillegra Dam.

Based on modelling results the Proponent concluded that the cumulative impacts of the dam are assumed to not be significant. In this way the cumulative impacts of the dam have been assessed and further discussed in detail in Chapter 4 of the Proponent's supplementary report.

However, Kingsford and Hankin (2010) present the possibility that cumulative impacts of upstream industry may be the cause of a significant decrease in numbers of wetland birds since the 1970's. The Central and Upper Hunter Valley are renowned as coal mining and agricultural regions. Both of these industries require large quantities of water for effective management and processing. There is potential that these upstream industries have already impacted upon the Hunter Estuary Wetlands resulting in a reduction of the migratory wetland birds. These ongoing cumulative impacts as a result of the development have been considered by the Proponent in the supplementary report. The report concludes that future developments within the Hunter Catchment must put into place appropriate avoidance, mitigation and compensation measures relevant to each specific project to prevent impacts on the Hunter Estuary Wetland.

The future of the Hunter Valley is highly likely to entail additional mine approvals and continued agriculture that have potential to increase the annual drawing of water out of the Hunter Valley catchment.

2.10 Assessment of Worst Case Scenario

Whether the Proponent's assessment considered the worst case scenario for the Hunter Estuary Ramsar Wetlands (DoP Brief Issue 10);

The worst case scenario has not been adequately considered. The worst case scenario is likely to entail protracted filling of the dam during severe drought conditions. This has not been considered and there is no species-specific or habitat specific assessment of such a

scenario in either the WIA report or the response report. Further analysis of individual species and communities, and especially scenarios conceivably protracted filling period/s should be analysed.

The Proponent has included a relevant discussion of the worst case scenario based on numerous modelling and scenarios to determine a worst case scenario of impact for the project. The results of this modelling by the proponent shows that, that no significant impact are predicted for any of the conceivable worst case scenarios. Therefore, the proponent considers that there is no worst case scenario for the project.

Further work may need to be conducted here in the situation that the flood calibration for the Hunter River is incorrect as discussed in the independent review by Peirson (2010).

2.11 Proponent's Conclusions

Whether the Proponent's conclusions regarding the impacts from the project on the Hunter Estuary Ramsar wetlands are supported by the Proponent's assessment and whether the Proponent's mitigation measures would be effective in reducing the impacts of the dam and to what degree (DoP Brief Issue 11);

The Proponents assessment of impacts to the wetlands concludes that under all flow scenarios there is negligible potential for ecological impact. The Proponent concludes that there is unlikely to be a significant impact to migratory bird species or various wetland plant communities. The modelling data generally supports this conclusion, however:

- Peirson's second review indicates that there may be quantifiable impacts to the north western side of Kooragang Island wetlands and that some doubts remain about salinity modelling;
- No species specific or plant community specific analysis has been performed to examine the sensitivity of species or communities to small scale changes; and
- Migratory waders and salt marsh communities in the Hunter Estuary Ramsar wetlands are in decline and the precise reasons for such a decline are not known precisely.

The only mitigation measures proposed by the Proponent are management of flows across Seaham Weir, and monitoring of the wetlands to determine if the construction of the dam is causing a significant impact. Provided that the modelling results are correct it such an approach appears appropriate. However, as discussed above, a more detailed analysis of species and communities is warranted.

2.12 Proponent's Recommendations

Whether the Proponent's recommendations (in relation to the management of ecological impacts on the Ramsar Wetland) are relevant and appropriate (DoP Brief Issue 12);

Based on the proponent's impact assessment the recommendations are generally appropriate provided that the modelling results are accurate, and provided that a detailed species and community-specific impact assessment does not reveal any greater impacts than currently predicted. .

The Proponent stated that "*given the degree of likely change to the Ramsar wetlands that would result from the proposed Tillegra Dam in all river flow scenarios, recommendations have focussed on providing direction on improvements to the management of Seaham Weir*." This recommendation is appropriate provided modelling results are accurate.

Additionally, the Proponent recommends monitoring of water levels, water quality and ecological characteristics downstream of the weir.

Monitoring will only be of use if it is designed and implemented carefully and effectively. The type of monitoring and the ecological "characteristics" focussed on should be determined after analysing individual species and communities at risk from the proposal. Given the low magnitude of predicted impacts, it is likely that some species and communities should be the focus of monitoring, rather than a blanket approach to monitoring.

Monitoring design must be carefully considered because according to past monitoring for other purposes undesirable negative impacts are already happening within the Hunter Wetlands to water birds and estuarine plant communities. It is unlikely that a simplistic monitoring approach will be able to detect small changes predicted, and/or to verify that small changes occurring are due specifically to the dam.

One approach to monitoring could be to monitor selected estuarine characteristics in relation to external reference sites. This may help determine if changes due to dam operation have an impact – though even with reference sites, this may be difficult. An alternate approach to monitoring could be to monitor the nature and extent of change, and then, irrespective of whether changes are definitely due to the dam or not, the Proponent can take steps to help address the change.

Any plan for monitoring should also clearly enunciate the types of corrective action that may be taken should monitoring detect a problem. Management actions can obviously include modification to flows over Seaham Weir, but other alternate actions should be mentioned as a commitment by Proponent.

2.13 Post Construction Impact Minimisation

Based on the review of issues in the Proponent's assessment (as referred to above), whether monitoring and an adaptive management approach (setting trigger points and associated management actions) would be effective in minimising impacts on the Hunter Estuary post construction of the Dam (DoP Brief Issue 13);

The monitoring and adaptive management approach provided by the proponent would be an effective mechanism ecological issues that arise for the Hunter Estuary Wetland based on the Proponent's modelling. However, the trigger points of monitoring, if based upon the information within Table 6 of the Proponent's report, would not provide a satisfactory trigger point for the determination of a significant impact without the provision of quantitative levels of acceptable change. It is possible that impacts could occur on the wetland without any determination of them occurring if quantitative levels of acceptable change are not provided. Additionally qualitative levels that have been provided by the Proponent could potentially be interpreted as being not significant by those associated with the project.

Any plan for monitoring should also clearly enunciate the types of adaptive/corrective action that may be taken should monitoring detect a problem. Management actions can obviously include modification to flows over Seaham Weir, but other alternate actions should be mentioned as a commitment by Proponent.

2.14 Potential Performance-Based Criteria for the Project

Provide performance based criteria for the Hunter Estuary Ramsar wetlands which could be used to monitor the performance of the project in relation to its impacts on the Hunter Estuary Ramsar Wetlands (if the project was approved). (DoP Brief Issue 14)

Performance based criteria for assessing the potential impacts of the project on the Hunter Estuary Wetland are provided within Table 2.1 below. These should be additional to monitoring for the limits of acceptable change within the Ecological Character Description of the Kooragang Component of the Hunter Estuary Wetlands Ramsar Site (DECCW. 2010).

As stated in the previous section on monitoring, it is conceivable that it may not be possible to conclusively prove that deleterious changes that are detected are caused by the dam. For this reason, if KPIs are not maintained, the Proponent could commit to addressing them (or contributing to addressing them) regardless of the ultimate cause.

The timescales for measurement of Key Performance Indicators needs to be carefully considered, but should generally be based upon annual measurements. The variability of the estuarine environment and such factors as bird numbers may also mean it is more appropriate to examine average trends over several years rather than rely on just one year of data.

Table 2.1 POTENTIAL KEY PERFORMANCE INDICATORS FOR THE MONITORING FOLLOWING APPROVAL OF THE CONSTRUCTION OF TILLEGRA DAM

Key Performance Indicators	Description
1. Existing salt marsh and reed land areas must have more than 95% of current native plant cover and plant diversity (as opposed to weeds/exotic species).	Native plant cover in salt marsh and reed land areas must not fall below 95% of the current value in monitoring areas.
2. Area (ha) of salt marsh and reed land does not fall below current value	The total area of salt marsh and reed land within the wetlands does not fall below the current value.
3. Area (ha) of mangroves does not fall below current value	The total area of mangroves within the wetlands does not fall below the current value.
4. Ground cover diversity within forested wetlands does not fall below 95% of current values.	Native plant diversity within forested wetlands must not fall below 95% of current native plant diversity.
5. Salinity in wetlands must be maintained or improved.	Salinity values should be regularly tested across the wetlands prior to construction and used as baseline data and not exceed the 95% of baseline. Changes should be considered relative to external reference sites.
6. Migratory wading bird numbers must not fall below 95% of the current numbers in 10 years.	Migratory wader numbers must not fall below 95% of the baseline values in the 10 years following baseline.
7. Migratory wading bird breeding numbers must not fall below 95% of the current numbers in 10 years.	The numbers of migratory wading birds breeding within the wetlands must not fall below 95% of the baseline values in the 10 years following baseline.
8. Numbers of native breeding bird species must not fall below 95% of baseline.	Native breeding bird numbers must not fall below 95% of the baseline values.
9. Native fish numbers and species diversity must not fall below 95% of the current numbers in 10 years.	Native fish numbers and species diversity must not fall below 95% of baseline value within 10 years.
10. Macroinvertebrate number and species diversity must not fall below 95% of the current numbers in 10 years.	Marcoinvertebrate numbers and species diversity must not fall below 95% of baseline value within 10 years.
11. Reduction in area of Green and Golden Bell Frog habitat must not occur.	The total area of habitat of Green and Golden Bell Frog Habitat within the Hunter Estuary Wetland must remain within 95% of the baseline value within 10 years.

Chapter 3

Conclusion

The Proponent has generally provided a detailed analysis of the major factors that could impact the Hunter Estuary Wetlands as a result of the Tillegra Dam project: hydrological and biochemical (particularly salinity) changes. The modelling results show that under a range of scenarios, the impacts to hydrology and salinity are negligible. Based upon those results and assuming that the modelling is accurate, the conclusions drawn are generally appropriate.

Some areas of uncertainty remain about the modelling and the ecological implications of such uncertainty are unresolved. The second independent review of hydrology and water quality by Peirson (2010) generally supports the modelling approach used by the proponent. However, Peirson believes that more can be done to quantify hydrological and salinity changes in different areas of the estuary and contends that "*possibly the most significantly impacted areas are in the west, near the upstream boundary of the Ramsar area."* He also points out that it appears that no scenarios considering the impacts to salinity on low flows during the filling phase of Tillegra Dam have been presented. Peirson also concludes his report by stating "*The total volumes of freshwater flowing into the Williams River and lost by evaporation should be checked carefully to confirm that no gross errors remain in the determined estuary inflows for pre- and post-dam assessment scenarios."*

Under a worst case scenario involving protracted and extreme drought, the Dam may take 20 years or more to fill. This could conceivably have important implications for salinity and hydrology in parts of the wetland and in turn for some wetland birds and wetland plant communities, particularly saltmarsh. This needs to be thoroughly examined. Hypothetically, assuming that the Dam is approved within 12 months and construction commences shortly thereafter, the dam could be constructed and filled between within 15 to 20 odd years. Sea level rise during this period should therefore also be considered when assessing the worst case scenario because rises in sea level are recognised as a greater risk and will become increasingly relevant with time.

Impacts from the Dam are likely to be dwarfed by predicted changes in climate and sea level. The analysis in the WIA Report indicates that climate change (and sea level rise) constitutes an extreme risk to the Ramsar wetlands, which is appropriate. Relatively small changes in sea level would have major impacts across the Ramsar wetlands that are likely to be much greater than potential impacts from the Tillegra Dam project in the medium to long term. Cumberland Ecology has been supplied with modelling approximate inundation extents of mean high water for a 0.4m sea level rise scenario. A copy of this map is

appended to this report. The map clearly shows that under a 0.4m sea level rise almost the entire Kooragang Island would be inundated – representing a far bigger threat to the wetlands. The predicted 0.4m rise in sea level is predicted to occur within decades and within the operational phase of the dam.

Water birds and wetlands communities such as salt marsh were principal reasons for the Hunter Wetlands being listed as Ramsar wetlands. They are wetlands of international importance for many bird species and for salt marsh. Moreover, migratory waders and salt marsh communities have declined significantly and beyond LAC levels in the Hunter Estuary Wetlands. The Proponents ecologists need to conduct a detailed analysis of the potential impacts on all of the various migratory birds and also such significant habitats as salt marsh.

It is conceivable that some species or plant communities are potentially at greater risk than others from the project but there is no analysis within either the WIA Report or the Proponent's response report to examine this. The species at greatest risk should be clearly identified.

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