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CAIRNS SHIPPING DEVELOPMENT PROJECT

Revised Draft Environmental Impact Statement

Supplementary Report

Appendix D: BMT-WBM Flood Modelling Report R.B22074.013.00

BMT WBM

Cairns Shipping Development Project EIS - Flood and Dredge Materials Mobilisation Technical Studies - Investigation for the Northern Sands Placement Site Alternative Option - Response to Information Request

Reference: Northern Sands R.B22074.013.00.Response to IR_Final
Date: November 2017
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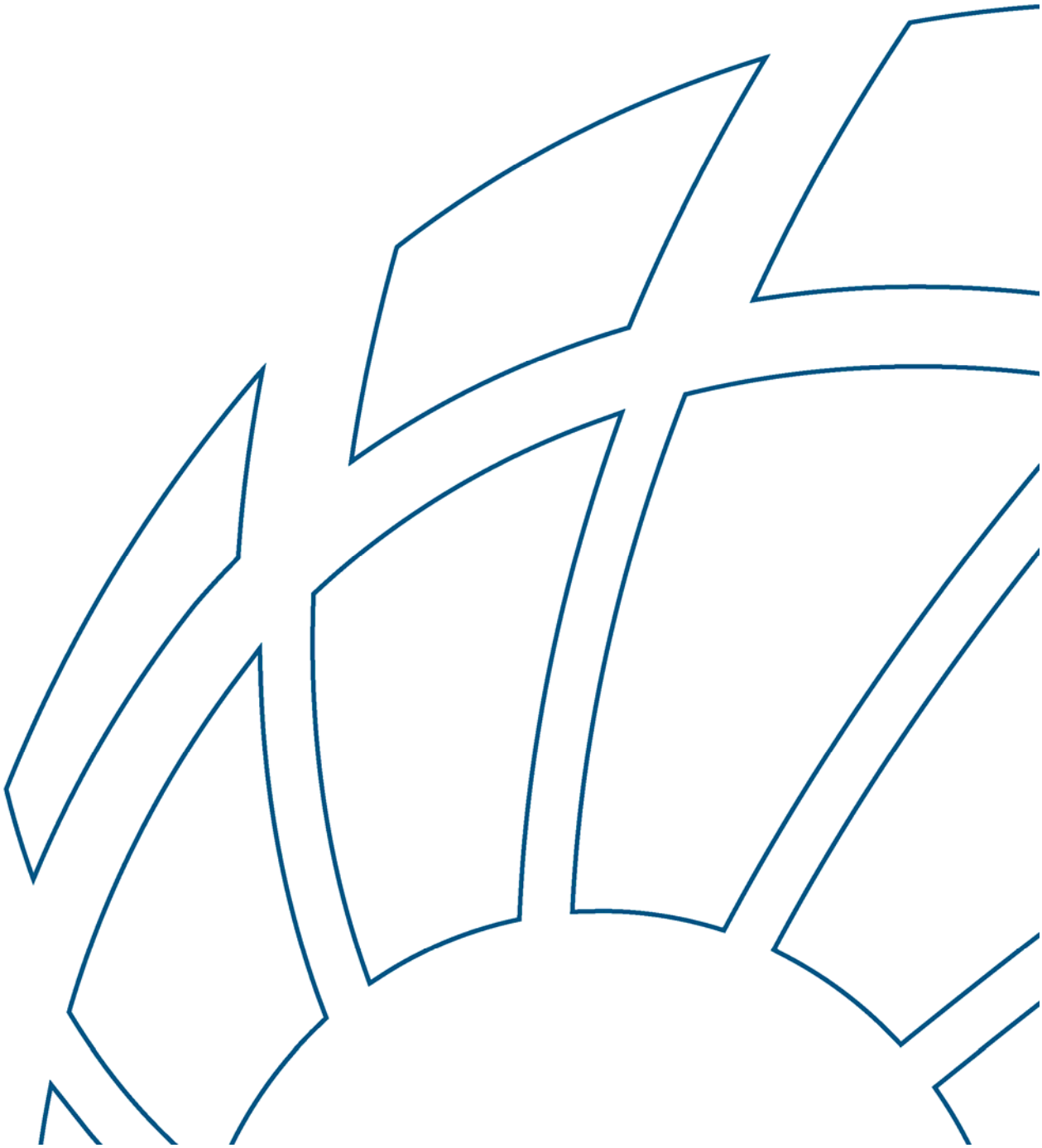

Cairns Shipping Development Project EIS - Flood and Dredge Materials Mobilisation Technical Studies - Investigation for the Northern Sands Placement Site Alternative Option - Response to Information Request

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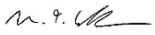
1	1.11.17	N. Collins - RPEQ 2699		I. Clark	

DISTRIBUTION

Destination	Revision										
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Flanagan Consulting Group (FCG)	✔	✔									
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1 Introduction and Purpose of the Report

This report has been prepared in response to an Information Request arising from the Cairns Shipping Development Project EIS – Flood and Dredge Material Mobilisation Technical Studies. Specifically, to investigate the impacts of flooding of an alternate bunding configuration designed to provide flood immunity and to reduce remobilisation risk. It also provides an assessment of the level of risk of adverse flooding impacts occurring during the limited duration when bunds will be in place to protect the dredge material from resuspension due to flooding and represents an alternative assessment to our previous report of June 2017 entitled 'Cairns Shipping Development Project EIS - Flood and Dredge Spoil Mobilisation Technical Studies Investigations for the Northern Sands Placement Site Option.'

The report also provides a response to an agency submission (DEHP) for an assessment of a Consequence Category Assessment (CCA) conducted in accordance with the DEHP Manual for assessing consequence categories and hydraulic performance of structures.

The alternate Northern Sands placement site option is detailed in Flanagan Consulting Group (FCG) drawing number 3527-SK14D, which is included in Attachment 1 of this report.

2 The Alternate Proposal

The proposal presented in this report is an alternative to the 7.5m AHD bunded northern pond proposal that was assessed in our previous report of June 2017 and entitled 'Cairns Shipping Development Project EIS - Flood and Dredge Spoil Mobilisation Technical Studies Investigations for the Northern Sands Placement Site Option.'

The alternate proposal that is the subject of this assessment is detailed in the FCG plan included in Appendix A. Key elements relevant to flooding are as follows:

(1) The proposed placement zone has been expanded to encompass the entire Northern Sands extraction area with proposed dredge material area encompassing an area of approximately 34.6 hectares;

(2) The placement pond will have potential dredged material storage of 2.4 million m^3 at the end of placement.

(3) Bund height is set above the ARI 100-year flood level with a minimum level of RL 5.5m AHD.

The presence of localised impacts within the immediate vicinity of the bund and variation of flood gradient across the site (particularly adjacent to the Barron River) may necessitate the raising of bund levels (over the 5.5m AHD level) in these locations to prevent localised overtopping.

This bund immunity level reflects the current community accepted standard to protect property and given the short term temporary nature of the bunds, offers a very high standard in terms of management of remobilisation risk. Based on advice by FCG and JFA, placement will occur in the dry season, after which settlement of the dredge material will occur, with initial estimates of volume reduction of 20% prior to the wet season.. Bunds are to remain in place through one wet season following completion of placement.

Hence, whilst the protection bunds have the potential to interfere with flood flows and cause off site flood level increases, the period of exposure is low. This is further considered in Section 5.

The dredging works are proposed to be carried out during the dry season where the probability of river flooding is low. However, there is the need for consideration of remobilisation during the subsequent wet season. The final settlement is predicted to be achieved prior to a second wet season, and the bunds can be removed at that time, subject to verification of the settled surface levels. JFA modelling predicts the placed material level at the completion of placement will be RL 4.0m AHD, RL 3.0m AHD at the start of the 2019/20 wet season and RL 0.94m AHD at the start of the 2020/21 wet season. Retention of a suitable void buffer, between top of spoil material and top of bund or natural surface over the dredge material will also assist in mitigating remobilisation risk and the target level of cover, assuming crusting of the dredge spoil material surface, is 0.7m to 1.7m, depending on the degree of crusting.

3 Flood Modelling

3.1 Scope

The scope of this assessment is to provide an input into operational design consideration for the Northern Sands Dredge Material Placement Area. A key requirement is to determine flood impact risks associated with using proposed bunding of the onsite void at the Northern Sands for dredge material placement.

3.2 Methodology

The methodology behind this investigation is based around the use of bunds surrounding the placement area to firstly provide a suitable degree of protection against remobilisation of dredge material within the placement area during periods of Barron River flooding and secondly to provide the maximum amount of void volume available for dredge material placement. Detailed full two dimensional flood modelling of the Northern Sands site was utilised to determine possible flood impacts of 100 year level bund heights surrounding the dredge placement void of the site.

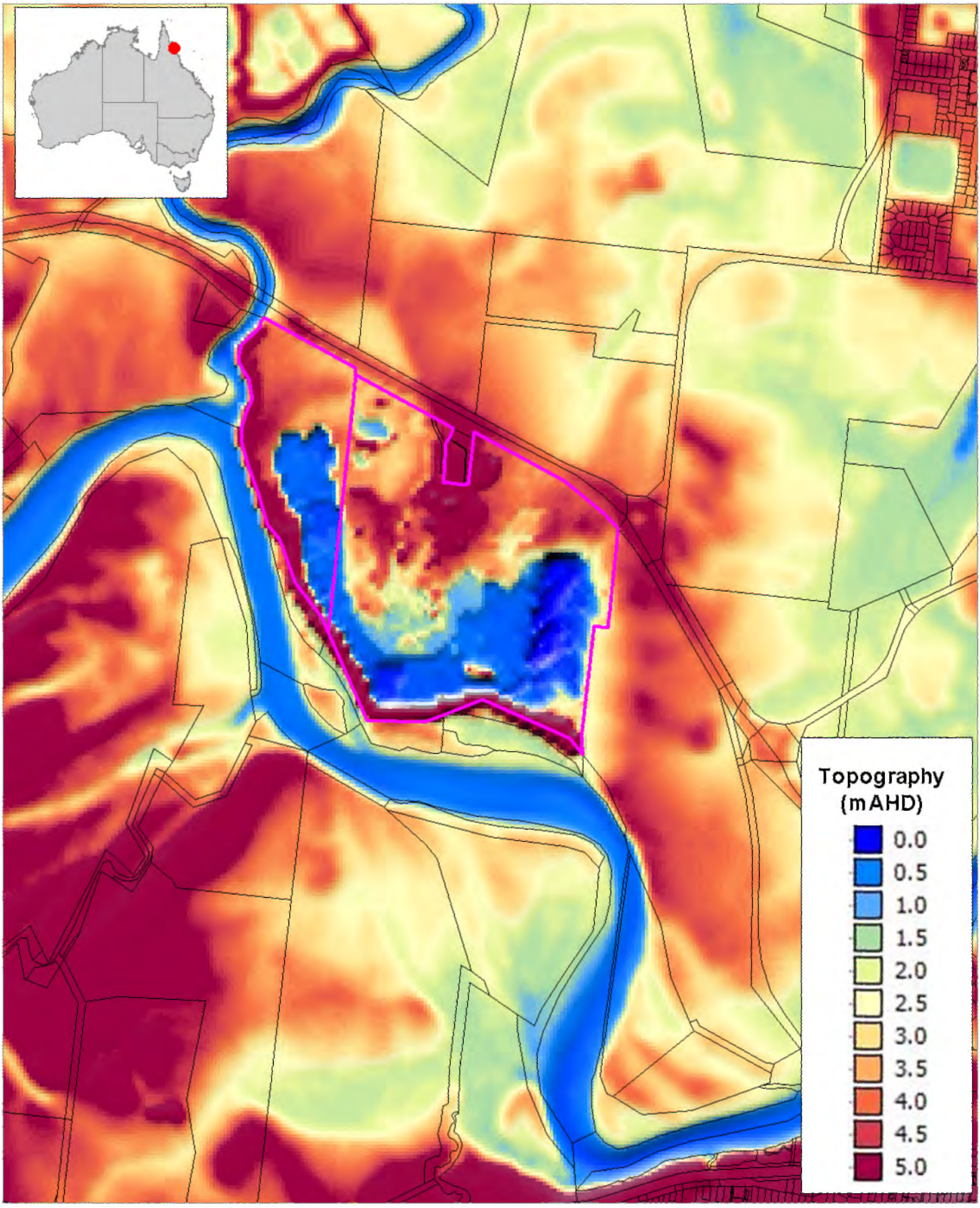
3.3 Bund Assessment

Bund heights determined for the study were set to provide 100 year ARI flood protection for the placement void.

The bund positioning was based on the layout as shown on FCG Sketch 3527-SK14D, a copy of which is provided in Attachment 1.

Figure 3-1 shows pre-dredge material placement topography for the site, and Figure 3-2 the assumed post placement topography.

The proposed bund was assessed against design flood events ranging from the ARI 2 year through to the 100 year flood events.



Title:

Northern Sands Placement Site
Pre-Placement Topography

Figure: 3-1

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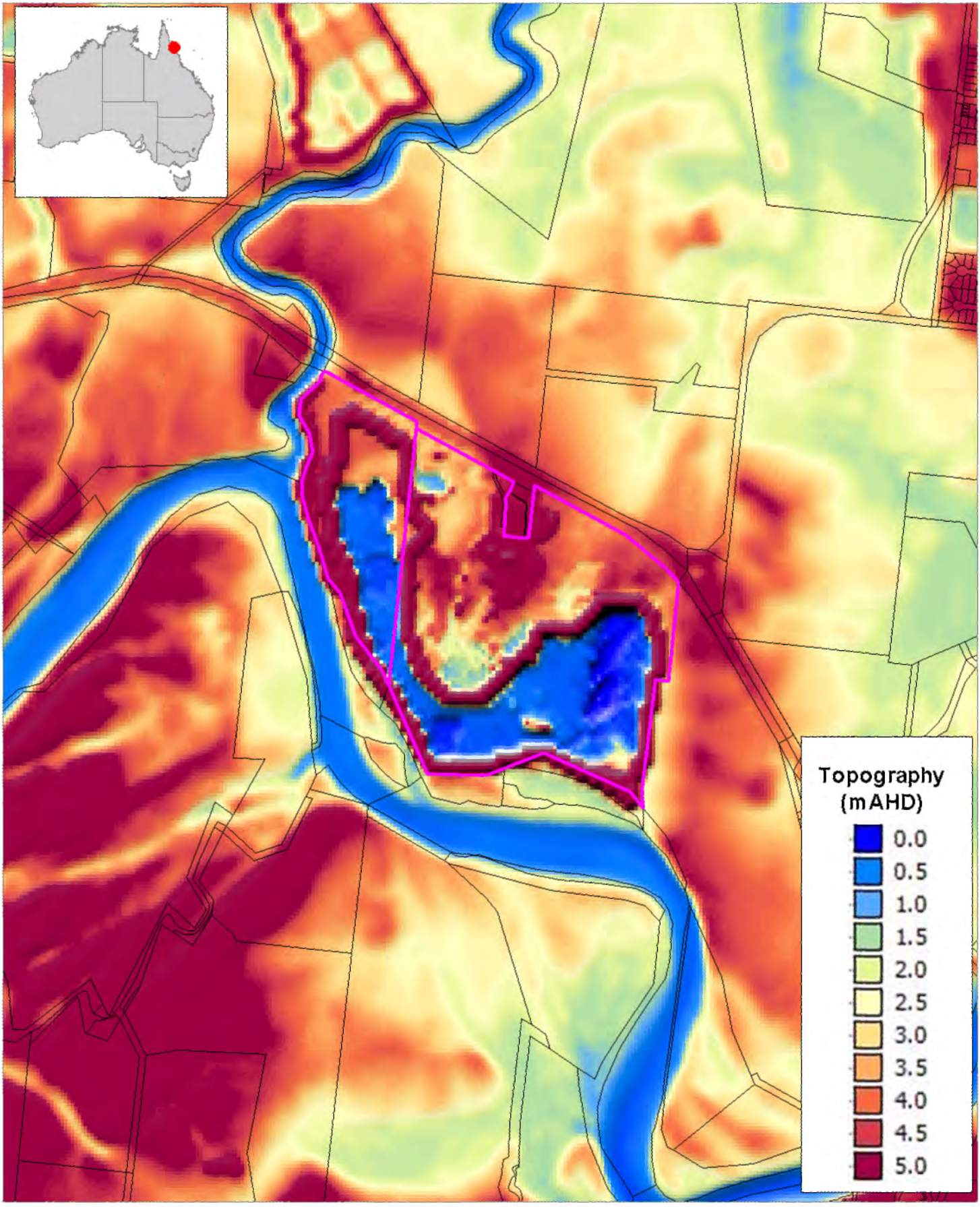

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Northern Sands Placement Site
Placement Bund Topography

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3.4 Modelling Methodology

To carry out this investigation BMT WBM Pty Ltd used the following methodology as the basis for the hydraulic modelling investigation:

- Obtain latest LIDAR for the site
- Update the TUFLOW *model with LIDAR to reflect current conditions
- Obtain current proposed lake bathymetry, ultimate site levels and bunding options to be considered from FCG
- Re-run base case model for full range of ARI events
- Investigate options for both lake filling and bunding and determine flood impacts and bed shear stress for each option.

*The Barron Delta TUFLOW model was built to test the AQUIS Casino Project. The TUFLOW model was based on Council's approved MIKE flood model developed by Connell Wagner (latest version 2007), and was approved for use on that project by Cairns Regional Council.

The TUFLOW model was verified against Council's approved MIKE flood model As required under the planning scheme, the base case used was the base case from the Connell Wagner MIKE flood model.

Based on the latest LIDAR (2011) available, lake bathymetry and advice provided by FCG, a pre-placement site DTM was developed and incorporated in to the model.

For the hydraulic assessment our existing TUFLOW 2D flood model of the Barron River Delta was used to determine baseline flooding characteristics for the site.

Results

Attachment 2 contains the detailed results for the pre-placement case and presents mapped output of peak water levels, depths and velocities for the full range of ARI design storm events.

A summary of peak water level at the placement site is presented in Table 3-1.

Table 3-1 Site Peak Water level

Barron River/Thomatis Ck confluence			North-east corner of site		
Existing	Developed	Impact	Existing	Developed	Impact
(mAHD)	(mAHD)	(mm)	(mAHD)	(mAHD)	(mm)
4.504	4.507	3	3.814	3.792	-22
5.248	5.260	12	4.471	4.474	3
5.618	5.653	35	4.737	4.640	-97
5.903	5.956	53	4.932	4.748	-184
6.247	6.339	92	5.177	4.877	-300
6.576	6.716	140	5.432	5.025	-407

Results for the adopted 3527-SK14D layout are detailed in Figures 3-3 to 3-9.

From the flood impact plots, the following observation can be made:

(1) ARI 2 year flood impacts beyond the Northern Sands site only affect flood affected caneland north of the highway, with no buildings affected. The potential for actionable nuisance under such a flood event is low.

(2) ARI 5 year flood impacts beyond the Northern Sands site are at worst, 4 to 5 cm and these impacts occur over flood affected caneland. The potential for actionable nuisance under such a flood event is low. There is only a 20% chance that the ARI 5 year event will occur in any given year.

(3) ARI 10 year flood impacts beyond the Northern Sand site are generally less than 5cm and these impacts occur over flood affected canelands. The only building affected is a high set Queenslander house on Lot 3, RP800591, which is on an elevated fill platform, adjacent to the highway on the western site of Richters Creek. Over floor flooding is not predicted to occur. The high set Queenslander house is predicted to be affected by 3 to 4 cm; however, over floor flooding is not predicted to occur. Hence, the potential for actionable nuisance under such a flood event is low. There is only a 10% chance that the ARI 10 year flood will occur in any given year.

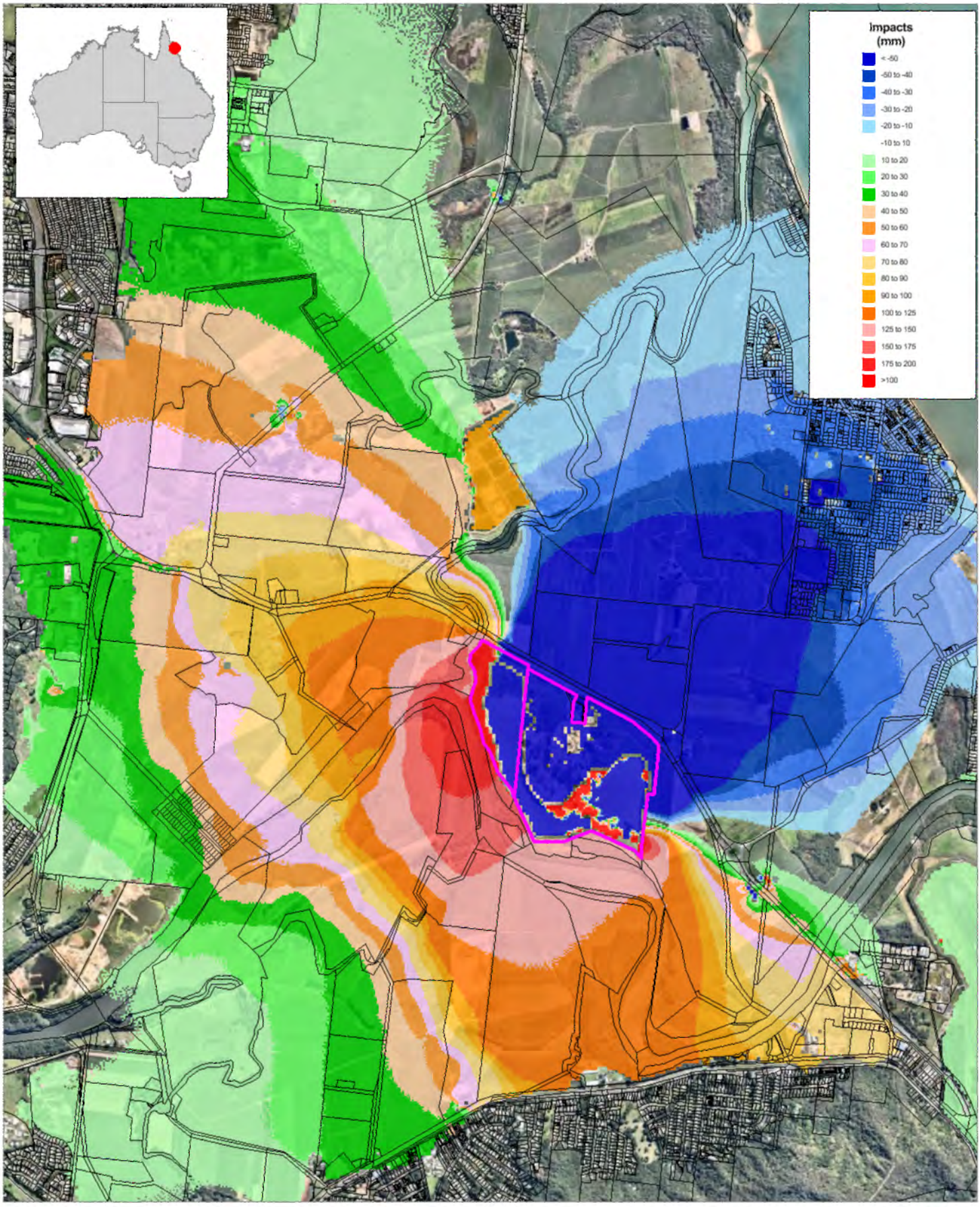
(4) ARI 20 flood impacts, beyond The Northern Sands site are less than 6 cm; however, these impacts occur over flood affected caneland. The same high set Queenslander is predicted to be affected by 4 to 5 cm; however, over floor flooding is not predicted to occur. Another high set Queenslander house (Lot 4, RP748713. Situated east of the site and adjacent to the Captain Cook highway/Machans Beach Access Road roundabout) is also affected by up to 4 to 5 cm, however, over floor flooding is not predicted to occur. No other buildings are impacted. Hence, the potential for actionable nuisance under such a flood event is low. There is only a 5% chance that the ARI 20 year flood will occur in any given year.

(5) ARI 50 year flood impacts beyond the Northern Sands site are up to 0.15m; however, these impacts occur over flood affected caneland generally. The same high set Queenslander is predicted to be affected by up to 0.1m. There are lesser impacts (less than 70mm) on caneland area to the north west of the site (North of the Captain Cook Highway) including the go-cart site and prawn farm site to the north; however all buildings on these sites are generally elevated or on elevated fill platforms above flood. There is only a 2% chance of this flood occurring in any year. Risk level is further discussed in Section 5.3 below. There are positive benefits predicted, in terms of significant flood level reductions, in the Holloways Beach township to the east of the Northern Sands site, with over 100 properties predicted to have 1 to 4cm flood level reductions in the ARI 50 year event.

(6) ARI 100 year flood impacts beyond the Northern Sands site are extension though primarily over flood affected caneland. There is only a 1% chance of this flood occurring in any year. Risk level is further discussed in Section 5.3 below.

(7) There are positive benefits predicted, in terms of significant flood level reductions, in the Holloways Beach township to the east of the Northern Sands site, with majority properties predicted to have 1 to 5cm flood level reductions in the ARI 100 year event.

(8) With the bunds set at the 100 year ARI flood level, the risk of resuspension of placed dredged material is very low, with less than 0.5% chance of an overtopping flood occurring in a year.



Title:

Northern Sands Placement Site
Q100 Bund - ARI 100 Year Flood Impacts

Figure: 3-3

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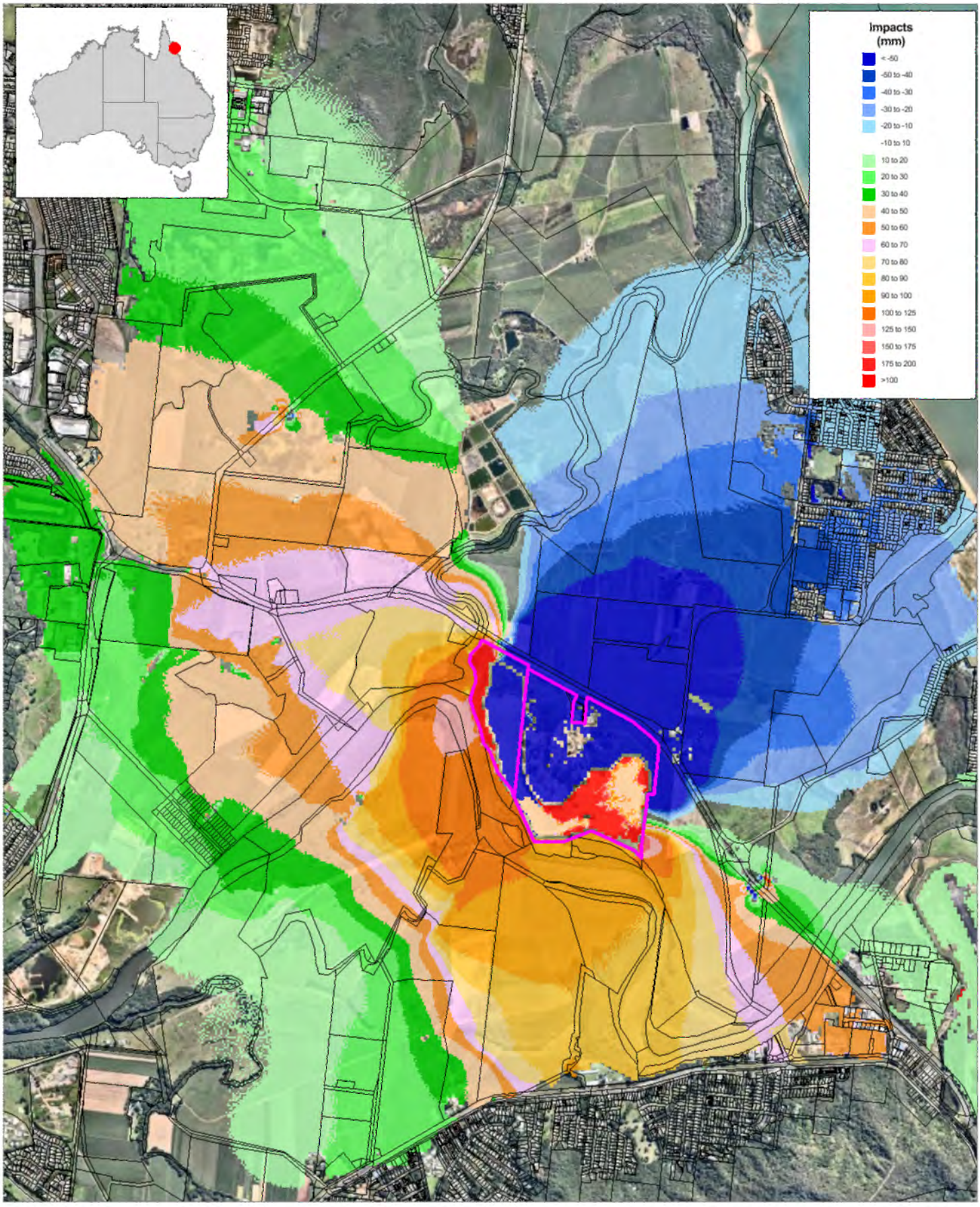

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Q100 Bund - ARI 50 Year Flood Impacts

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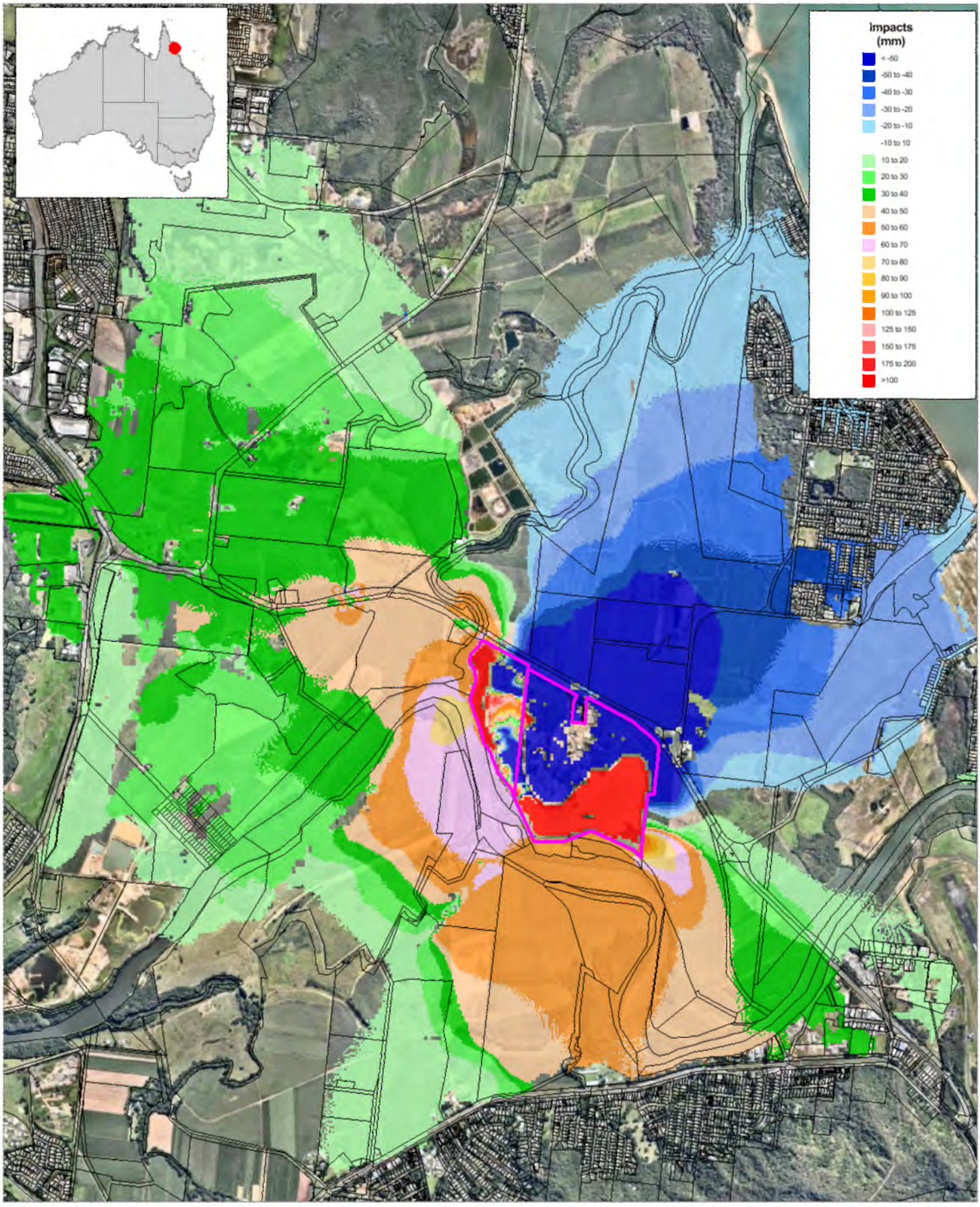

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Q100 Bund - ARI 20 Year Flood Impacts

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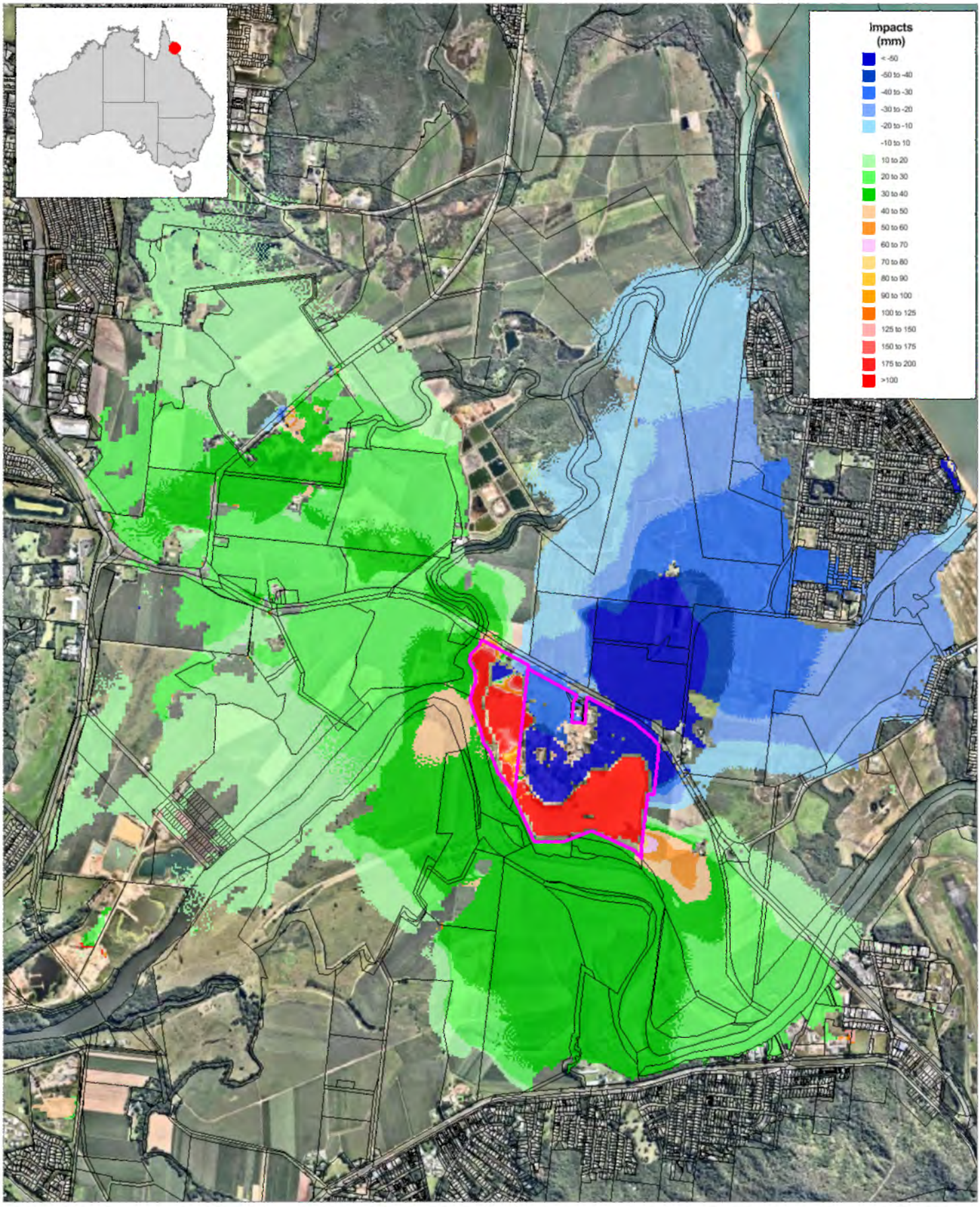

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Northern Sands Placement Site
Q100 Bund - ARI 10 Year Flood Impacts

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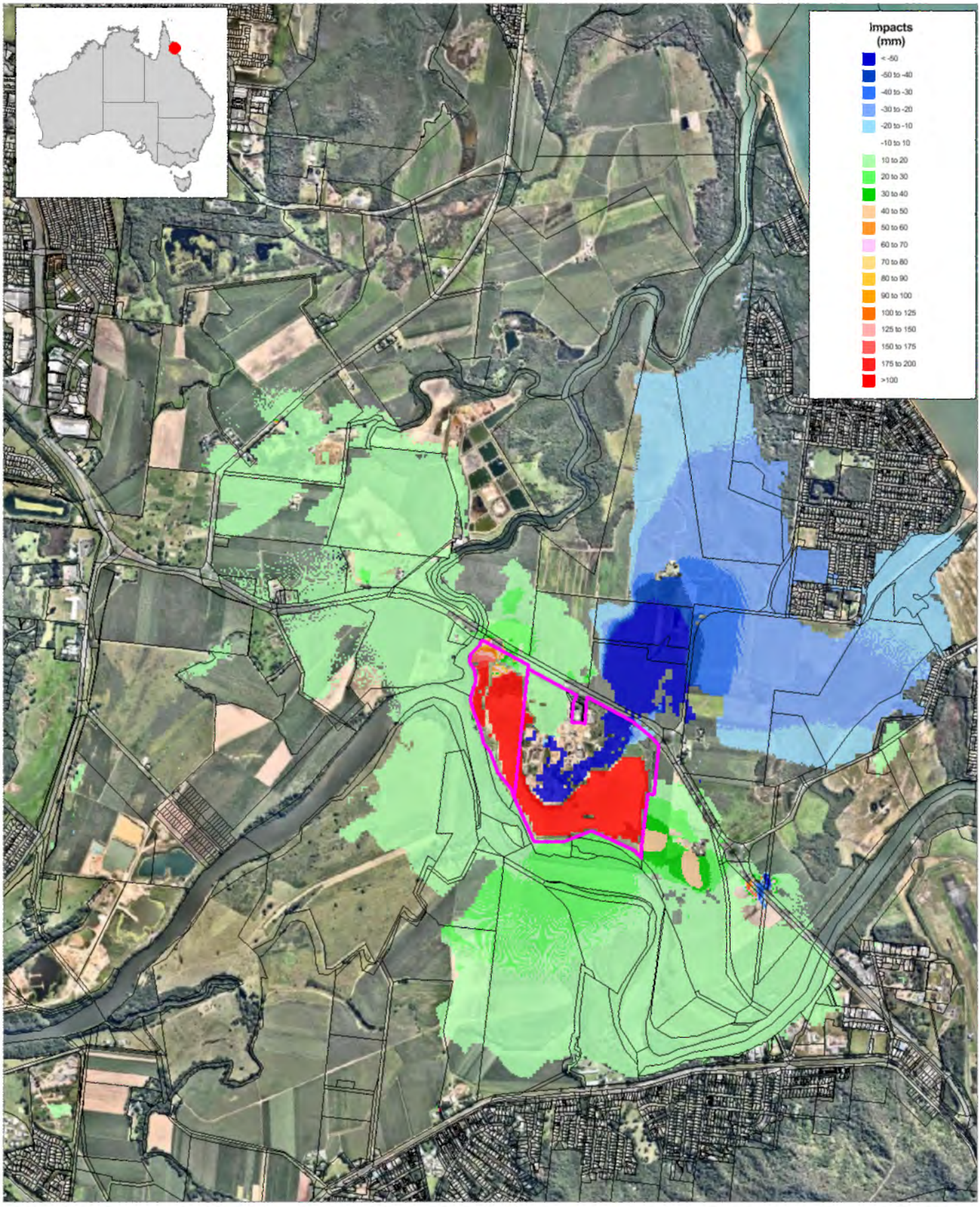

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Northern Sands Placement Site
Q100 Bund - ARI 5 Year Flood Impacts

Figure: 3-7

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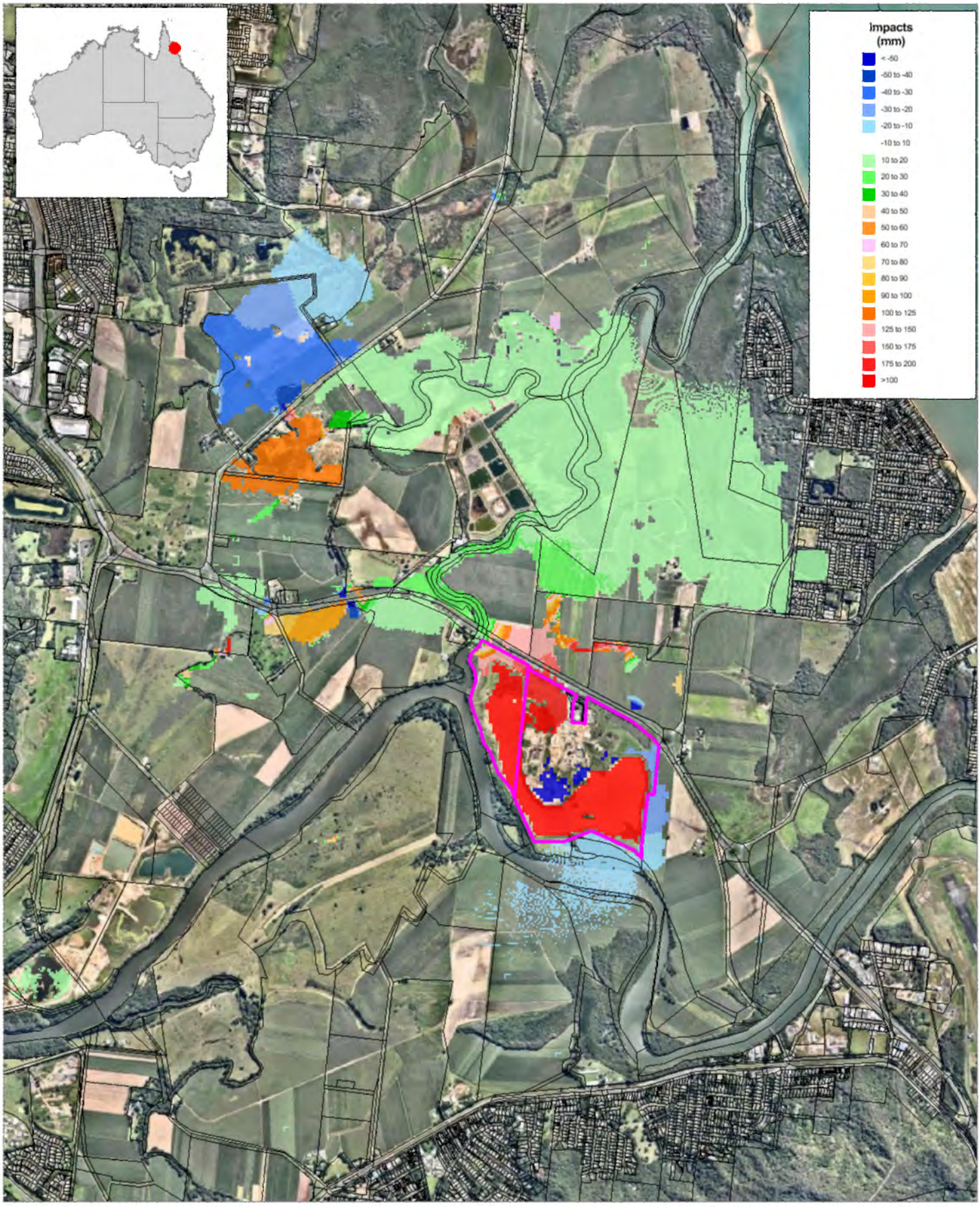

Title:

Northern Sands Placement Site
Q100 Bund - ARI 2 Year Flood Impacts

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4 Assessment of Potential for Bund Wall Collapse and Dredged Material Release

In relation to the Revised Draft EIS DEHP have requested consideration of the potential for bund wall collapse and dredged material release, including the assessment of a Consequence Category Assessment (CCA) conducted in accordance with the DEHP Manual for assessing consequence categories and hydraulic performance of structures.

Based on our assessments, we do not believe that the DEHP's Manual for CCA is appropriate for this situation, since works are temporary in nature, with bunds to be removed within two years, and because dredge material placement is restricted to the dry season, with considerable consolidation and dewatering of the material before the commencement of the wet season. Nevertheless, we have considered this requirement of the manual to conclude that the consequence Category of the proposed works is low, subject to suitable detailed design.

4.1 Details of the Northern Sands Flood Immunity Bunds

Our Flood and Dredge Material Mobilisation Technical Studies Investigation Report of June 2017 details the extent of proposed levee works on the Northern Sands site; for containment of dredged material. Top of bund levels are to be set at or above the ARI 100 year flood level, which is between RL 5.5m and 5.7m AHD across the site. Flanagan Consulting Group (FCG) provided preliminary civil engineering details in their drawing 3527-SK 14D.

An earth perimeter levee / bund is proposed and a concept design based on selectively utilising overburden material available on the site subject to it meeting specified stability and impermeability criteria or the use of a liner if necessary. Industry design standards such as US Department of the Interior, Bureau of Reclamation, Design of Small Dams, 1987should be specified for the bund design. The crest and outside face of the bund, may also require additional armouring where flood velocities adjacent are predicted to be greater than 2m/s.

4.2 Bund Overtopping Mechanisms

There is no external catchment draining to the proposed 34.6 hectare bunded area, hence, the only mechanisms for overtopping of the proposed bund is from prolonged heavy rainfall just after dredge placement has been completed, or from severe to extreme Barron River flood events overtopping the bund. An ARI 100 year, 72 hour rainfall event for example, has 907mm of rain which could slowly fill the containment area, if an adequate buffer air space was not provided.

Based on encounter probability alone, there is only a 2% chance of an ARI 100-year event occurring in any two year period (the period before bund removal). This also takes no account of the actual dredge material water management strategy. This strategy ensures that following completion of placement and following settlement prior to the start of the wet season, the water level is to be reduced to and maintained at a level that is a minimum of 900mm below top of bund. This will ensure that ponded water depths are several metres below the bund crest level before commencement of the wet season thus ensuring the equivalent capacity of a 100 year storm to be stored and controlled. To manage the localised long duration rainfall events under all circumstances, a small armoured spillway and armoured drop structure is recommended, to be located around the north-eastern extent

of Section B of the FCG drawing SK 14D. This would be approximately 3m wide by 0.5m deep. This is an emergency spillway only to protect the integrity of the bund in the extremely unlikely situation of the containment area being full of water at the start of a very large rainfall event. The emergency spillway could be provided via the proposed box weir outlets required for dewatering during dredge material pumping.

During a severe to extreme Barron River flood event, initial bund overtopping would be into the containment area, from all sides of the bund. To ensure that overtopping is such that bund damage does not occur, balancing pipes are proposed that allow high level (RL 4.6mn invert), controlled inflow through the bund embankment into the containment area. These pipes will allow internal containment area water levels to rise at a similar rate to outside water levels. The pipes will be fitted with flap valves to only allow flow in to the containment area, whilst preventing flow out.

Failure by seepage is to be controlled by suitable small embankment design, incorporating stable batters, suitable materials and compaction. In addition, an impermeable geosynthetic liner is proposed, as shown on FCG's drawing SK 14D, should material or compaction standards not be achievable. With these design features, seepage through the bund reduces to a negligible amount.

Failure to contain through overtopping from rainfall over the containment area will be managed by ensuring suitable buffer air space storage is available at all times within the storage area. This buffer volume to contain the 72-hour duration ARI 100 year rainfall event (907 mm in total) is 263,100m3, which requires containment area water levels to be kept at or below RL 4.5mAHD during the wet season.

Failure to contain through river flood overtopping can only occur on flood events more severe the the ARI 100 year event, because of the height of the proposed levees which provide ARI 100 year or better immunity.

The risk of failure by dam break collapse is to be managed by suitable small embankment design, as described above. The maximum driving head, even if the containment area was completely full, is only 4m; however, taking account of the operational management requirement for maintaining a minimum of 1m air space storage, this reduces to a driving head of only 3m. Hence, even if a collapse of a section of bund did occur, the consequences for damage are small, and the potential for harm to humans is low.

4.3 Consequence Category

Taking account of the previous sections, and using the assessment criteria in Table 1 of the DEHP manual, our Consequence Category Assessment is as follows:

(a) Seepage; Consequence Category is low. There are no people routinely in possible failure zones, adjacent to the bund, the proposed bunds will be engineered to prevent seepage and the actual driving head is low. The risk to humans is low, the risk of general environmental harm is low, and the general economic loss or property damage is low, since the containment area is surrounded by cane farms, with the nearest residence being over 250m away or an elevated platform, above the influence of any dam break flow.

(b) Overtopping

(i) Local rainfall over containment area; Consequence Category is low. The risk of harm to humans is low. The containment bunds will be designed and operated to fully contain the ARI 100 year 72-hour rainfall event without overtopping. In any case, emergency spillways are proposed to safely convey local rainfall overflow even under extreme events.

Given the relatively low flow rate of 1m3/s due to the 72 hour, 100 year event falling over the containment area, the risk of general environmental harm and general economic loss or property damage is also low.

(ii) Barron River flooding; Consequence Category is low. The containment area will be immune to river flood overtopping for more severe floods than the ARI 100 year event. With the proposed balancing pipe installations, velocities of flood flow on overtopping the containment bunds in more severe events that the ARI 100 year event will be low and generally non scouring. In areas where flood velocities adjacent to or over the bund are predicted to exceed 2m/s, additional armouring of the bunds in these locations is required.

There will be a minimum of 1.5m clean water immediately after placement over the maximum level of placed dredge material of RL 4mAHD (refer FCG Drawing 3527-SK 15A), hence, the potential for resuspension in an overtopping event is low.

In such a severe river flood event, no person will be on site as all roads including the adjacent highway will be cut and widespread inundation of several metres depth will be occurring across the delta.

Because of the low risk of resuspension, the low probability of having greater than ARI 100 year flood to cause overtopping (estimated to be 1% over a two year period), the risk of general environmental harm is low. Under such a large flood event, overtopping of the bunds would have no effects on economic loss or property damage as the effect of the containment strategy on Barron River flooding is insignificant.

4.4 Other Considerations

The proposed containment strategy on the Northern Sands site does not constitute a dam, but is a levee structure; however, with a low Consequence Category Assessment outcome, as detailed above, the bund is not a regulated structure. Hence, the requirements under the Manual in Section 2.2 and 2.2 do not apply.

5 Assessment of Impacts and Risk

5.1 Impact Assessment Methodology

In order to address the terms of reference, guidelines and other requirements for the currently defined project, the following methodology was adopted:

- Assess impacts (based on the risk assessment format outlined below);
- Provide recommendations for mitigation by design changes; and
- Provide recommendations for mitigation by management.

Our assessment of risk as detailed in our previous June 2017 report has been revised for the alternate development arrangement now proposed

FCG has extracted relevant items from the Queensland Government Terms of Reference.

The initial assessment of impacts utilises a significance table based on that shown in Table 5-1.

Table 5-1 Significance Criteria

Impact Significance / Consequence	Description of Significance (examples)
Very High	• The impact is considered critical to the decision-making process. • Impacts tend to be permanent or irreversible or otherwise long term and can occur over large scale areas. • Very high risk to people or of property damage. Very high risk of harm to receiving environment.
High	• The impact is considered likely to be important to decision-making. • Impacts tend to be permanent or irreversible or otherwise long to medium term. Impacts can occur over large or medium scale areas. • High risk to people or of property damage. High risk to the receiving environment.

Impact Significance / Consequence	Description of Significance (examples)
Moderate	• The effects of the impact are relevant to decision making including the development of mitigation measures • Impacts can range from long term to short term in duration Impacts can occur over medium scale areas or otherwise represents a significant impact at the local scale • Moderate risk to people or of property damage. Moderate risk to receiving environment.
Minor	• Impacts are recognisable/detectable but acceptable. • These impacts are unlikely to be of importance in the decision making process. Nevertheless, they are relevant in the consideration of standard mitigation measures. • Impacts tend to be short term or temporary and/or occur at local scale. (Low risk to people or of property damage. Low risk to receiving environment.
Negligible	• Minimal change to the existing situation. This could include, for example, impacts which are beneath levels of detection, impacts that are within the normal bounds of variation, or impacts that are within the margin of forecasting error.
Beneficial	• Impacts have a positive outcome on the existing situation. This could include for example, an improvement in flood immunity as a result of the project.

After assessing the nature and severity of impacts they are summarised under the following categories:

- Adverse/beneficial;
- Consequential;
- Cumulative;
- Short-term/long term;

- Reversible/irreversible; and
- Predictable/unpredictable.

5.2 Impact Assessment

The following potential impacts relating to flooding and resuspension of dredge material have been identified:

- Increase in flood levels and velocities beyond the Northern Sands site.
- Resuspension of dredged material in extreme flood events

An assessment of these impacts is presented in Table 5-2.

Table 5-2 Classifications of the Duration of Identified Impacts

Relative Duration Of Impacts	
Temporary	Days to Months
Short Term	Up to one year
Medium Term	From one to five Years
Long Term	From five to 50 Years
Permanent/Irreversible	In excess of 50 Years

The likelihood of an impact occurring is assessed as per Table 5-3.

Table 5-3 Likelihood of Impact

Likelihood of Impacts	Risk Probability Categories
Highly Unlikely	Highly unlikely to occur but theoretically possible
Unlikely	May occur during construction of the project but probability well below 50%; unlikely, but not negligible
Possible	Less likely than not but still appreciable; probability of about 50%
Likely	Likely to occur during construction or during a 12 month timeframe; probability greater than 50%
Almost Certain	Very likely to occur as a result of the proposed project construction and/or operations; could occur multiple times during relevant impacting period

A risk rating is assigned by assessing significance versus likelihood with a risk matrix. Risk is described as the produce to likelihood and significance as shown in Table 5-4.

Table 5-4 Risk Matrix

Likelihood	Significance				
	Negligible	Minor	Moderate	High	Very high
Highly Unlikely/ Rare	Negligible	Negligible	Low	Medium	High
Unlikely	Negligible	Low	Low	Medium	High
Possible	Negligible	Low	Medium	Medium	High
Likely	Negligible	Medium	Medium	High	Extreme
Almost Certain	Low	Medium	High	Extreme	Extreme

The rating of risk assessed in the risk matrix is presented in Table 5-5.

Table 5-5 Risk Rating Legend

Extreme Risk	An issue requiring change in project scope; almost certain to result in a 'significant' impact on a Matter of National or State Environmental Significance
High Risk	An issue requiring further detailed investigation and planning to manage and reduce risk; likely to result in a 'significant' impact on a Matter of National or State Environmental Significance
Medium Risk	An issue requiring project specific controls and procedures to manage
Low Risk	Manageable by standard mitigation and similar operating procedures
Negligible Risk	No additional management required

After assessing the nature and severity of impacts they are summarised under the following categories:

- Adverse/beneficial;
- Consequential;
- Cumulative;
- Short-term/long term;
- Reversible/irreversible; and
- Predictable/unpredictable.

5.3 Results of Impact Assessment

The following potential impacts relating to flooding and resuspension of dredge material have been identified:

- Increase in flood levels and velocities beyond the Northern Sands site.
- Resuspension of dredged material in extreme flood events.
- Loss of spoil and potential damage due to containment embankment failure

An assessment of these impacts is presented in Table 5-6.

In conclusion, compared to the initial northern pond arrangement considered in the EIS the alternate pond and bund configuration does not change the impact assessment. The impact remains Low for flooding and overtopping impacts and negligible for remobilisation impacts

Table 5-6 Assessment of Impacts

	Primary Impacting Process	Assessment with Proposed Bunding in Place			Comment
		Significance of Impact	Likelihood of Impact	Risk Rating	
1	Increased in flood levels beyond the Northern Sands site	'minor' on ARI 2, 5, 10 and 20 years	5% to 50% chance, therefore 'possible'	Low	The potential for actionable nuisance on there ARI events is low.
		'moderate' on ARI 50 and 100 years	1% to 2% chance therefore 'unlikely'	Low	The chance of these events occurring is low.
2	Bund Overtopping – Local rainfall	'minor'	'unlikely'	Low	The containment bunds will be designed and operated to fully contain the ARI 100 year 72-hour rainfall event without overtopping. Emergency spillways are proposed to safely convey local rainfall overflow even under extreme events.
3	Bund Overtopping – Barron River Flooding	'minor'	'unlikely'	Low	With proposed balancing pipe installations, velocities of flood flow on overtopping in more severe events than the ARI 100 year event will be low and generally non scouring.
4	Bund Failure	'minor'	'highly unlikely'	Negligible	Failure of levee collapse is to be managed by appropriate small embankment design.
5	Resuspension of dredged material in extreme flood events	'minor'	'highly unlikely'	Negligible	The proposed bunds provide protection to above the ARI 100 year flood levels. Even if overtopped, the amount of material resuspended will be small and this volume is insignificant compared to the sediment load in the river flood.