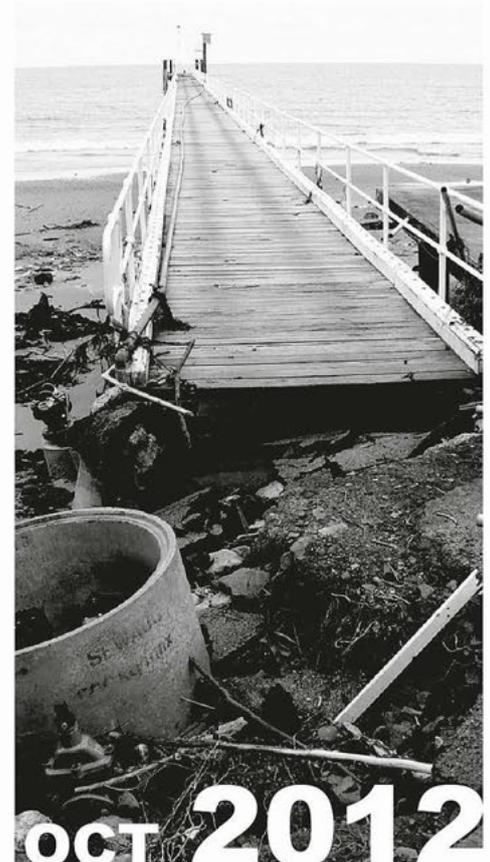


# VULNERABILITY & RISK ASSESSMENT

Coastal Hazard Strategy for Townsville City Council [Pilot Project]



Australian Government  
Department of Climate Change  
and Energy Efficiency



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# 1. Introduction

The Townsville CHAS Study has been undertaken to provide a detailed risk analysis to identify current and future assets at risk in high coastal hazard areas and determine their vulnerability (DERM Invitation to Offer 11-20, 2011). The risk analysis main purpose is to inform the decision process on allocating adaptation options.

## 2. Risk Assessment Criteria

The following details the method that has been adopted to develop the 88 risk maps presented in Appendix A.

### 2.1 Risk Types

The CHAS has considered the following risks:

1. **Risk to Infrastructure** (including transportation assets such as roads – Refer below)
2. **Risk to Property**

The rationale is that the other risk types (e.g. risk of isolation, risk to personal safety) mostly have to do with emergency management and evacuation procedures which are not a focus of CHAS' vulnerability analysis (yet emergency and evacuation procedure considerations are taken into consideration in later parts of the process).

### 2.2 Vulnerability Analysis Thresholds

The vulnerability thresholds developed for the CHAS include:

**Acceptable risk** – individuals and society can live with this risk without feeling the necessity to reduce the risks any further.

**Tolerable risk** – society can live with this risk but believe that as much as is reasonably practical should be done to reduce the risks further. Note that individuals may find this risk unacceptable and choose to take their own steps, within reason, to make this risk acceptable.

**Unacceptable risk** – individuals and society will not accept this risk and measures must be put in place to reduce risks to at least a tolerable level.

The following tables provide with detail on the thresholds agreed with TCC. Hazards are split as '1% AEP storm tide' or 'under tidal influence'. i.e. within the extent of the Highest Astronomical Tide (HAT)".

**Table 1 Risk to Property risk table – storm tide hazard**

Event Range	Residential Buildings - Above floor flooding	Commercial/ Industrial Buildings – Above floor flooding	Open Space/ Rural-Other
100 yr ARI			

**Table 2 Risk to Property risk table – permanent inundation hazard**

Permanent Sea Level	Residential Property	Commercial/ Industrial Property	Open Space/ Rural-Other
>5% of block inundated	Red	Red	Yellow
<5% of block inundated	Yellow	Red	Green

Table 3 below lists the hazard thresholds considered for the types of infrastructure agreed to be included in the analysis. Infrastructure identified stems from information provided by TCC. Major infrastructure not provided was identified by inspecting Google Maps® and using local knowledge where applicable.

**Table 3 Risk to Infrastructure risk table**

Infrastructure Type	Within infrastructure categorisation					
Water Supply		Trunk mains	Reservoirs/ Towers	Water Treatment Plant processing infrastructure		Source (e.g. weir)
Electricity					Transmission lines	275/110 kV substation
Telecommunications					Telephone exchanges	
Emergency Services				Minor Evacuation Centre	Station (Police/Fire brigade/Ambulance/SES)	Major Evacuation Centre
Cultural Heritage Facilities				Cemetery		Strand
Transport/Freight			Main Roads	Rail Lines	Transport Depots, Highway/Motorway	Evacuation Routes, Sea Ports/Airports/Marinas
Sewage and waste		Scour Pipe		Sewage pump stations, gravity pipes		Sewage Treatment Plant
Health services						Regional Public Hospitals Private Hospitals and aged care facilities Local Public Hospitals
100 year ARI						
Permanent Sea Level (>1% of block inundated)						

### 3. Identified Assets to be Included in the Vulnerability Assessment

The list of identified assets that were included in the vulnerability assessment are listed in the table below.

**Table 4 Identified assets that were included in the CHAS vulnerability assessment**

Feature	Dataset	Note	Source
Sea Port, Marinas	Properties	Verified by Transport Facilities Points of Interest	TCC
Embellished Open Space	Properties		TCC
Emergency Routes & Centres	Infrastructure		GHD/TCC
Airport	Properties	Verified by Transport Facilities Points of Interest	TCC
Deference	Other_Centres	Verified by local GHD's Knowledge and TCC	GHD and TCC
Major Industry (e.g. Nickel and Zinc factories, aquacultures)	Other_Centres	Verified by local GHD's Knowledge and TCC	GHD and TCC
Transport Depots	Properties	Verified by Transport Facilities Points of Interest	TCC
Telephone exchanges	Telecommunication		GoogleMaps®
Rail	Railways		TCC
Waste Water Structure and Mains	Wastewater_Network_Structure ; Wastewater_Gravity_Main Wastewater_Pressure_Main		TCC
Water Structure and Mains	Water_Network_Structure Water_Main		TCC
Evacuation Centres	Major_evac_centres, Community_Recovery_Centres		TCC
Emergency Health Centres	Hospitals, Community Centres, Aged Care		TCC
Emergency Centres	Fire, Police		TCC
Council Buildings	Council facilities		TCC
Other Centres (e.g. cemetery)	Shopping_Centres, Education_Centres, Other_Centres		TCC

## 4. Development of Floor Level database

Floor levels of residential, commercial and industrial properties are fundamental in defining the vulnerability of an asset as well as estimating the damages relating to a storm tide/permanent inundation event. During the CHAS, TCC, GHD and DERM discussed a solution to determine floor levels by correlating existing parameters of the cadastre to recorded floor level surveys. The resulting database was envisaged to be used by TCC as a reliable database that would inform Floodplain Management Studies and similar projects requiring such extensive datasets. Similarly, Geoscience Australia expressed their interest in acquiring such dataset to inform their NEXUS database.

Subsequently, GHD has adopted a methodology to determine floor levels for properties within TCC's Digital Cadastral Database (DCDB) using the readily available recorded floor level datasets:

1. JCU dataset comprising of drive-by observations and Building structure details including Detail of Storeys for more than 14,000 properties. This survey identified Highset, Lowset, Highset built-in-under etc The drive-by survey was undertaken in 1996-97.
2. TCC dataset comprising a kerb side survey defined reference levels for commercial, industrial and selected residential areas for 32 suburbs in the Townsville LGA prior to Council amalgamations. The survey was undertaken in 2005.
3. TCC datasets containing Land parcel and Property details.
4. TCC dataset comprising Digital Elevation Model of the ground elevation.
5. The methodology adopted by GHD to define the floor level elevations for each parcel comprised of:
  6. In the absence of known building locations, a floor level for the centroid of each Property will be calculated.
  7. Calculate a Ground Level for each centroid from the Digital Elevation Model.
  8. Assume a Floor Height of 300mm above Ground level for all Properties where more detailed information is not available.
  9. Override this Floor Height where known reference levels have been determined for selected suburbs in the Maunsell Report.
  10. Override this Floor Height where known reference levels have been determined for selected addresses in the JCU Survey
11. Mask precincts where it is reasonable to assume buildings will not exist (District Open Space, Local Open Space, Regional and City Wide Open Space, Breakwater, Green Space).

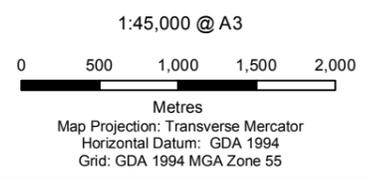
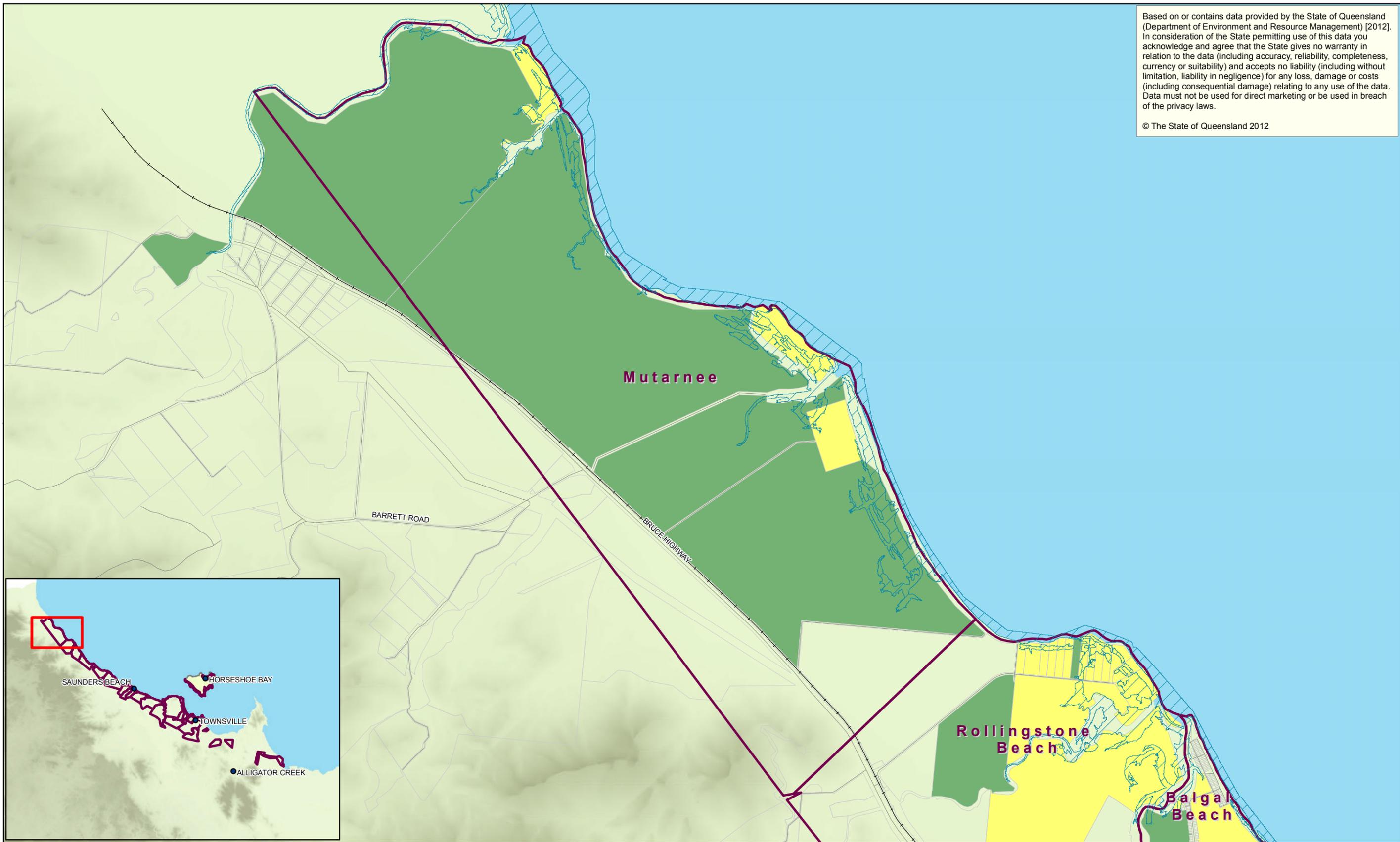
## 5. Risk Analysis Results

Appendix A presents with the results of the risk analysis mapped across the 11 TCC districts. 88 maps are provided grouped as:

- A1- Tidal Influence - Current Conditions (2012) x Risk to Property
- A2- Tidal Influence - 2100 Conditions (0.8 m SLR) x Risk to Property
- A3- 1% AEP (Annual Exceedance Probability) Storm Tide Event - Current Conditions (2012) x Risk to Property
- A4- 1% AEP Storm Tide Event - 2100 conditions (0.8 m SLR) x Risk to Property
- A5- Tidal Influence - Current Conditions (2012) x Risk to Infrastructure
- A6- Tidal Influence - 2100 Conditions (0.8 m SLR) x Risk to Infrastructure
- A7- 1% AEP Storm Tide Event - Current Conditions (2012) x Risk to Infrastructure
- A8- 1% AEP Storm Tide Event - 2100 conditions (0.8 m SLR) x Risk to Infrastructure

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**LEGEND**

● Town / Locality	HAT (2012)
— Road	Urban Locality
— Railway	Properties Boundary

**Risk to Property**

	Acceptable Risk
	Tolerable Risk
	Unacceptable Risk



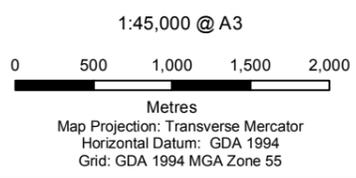
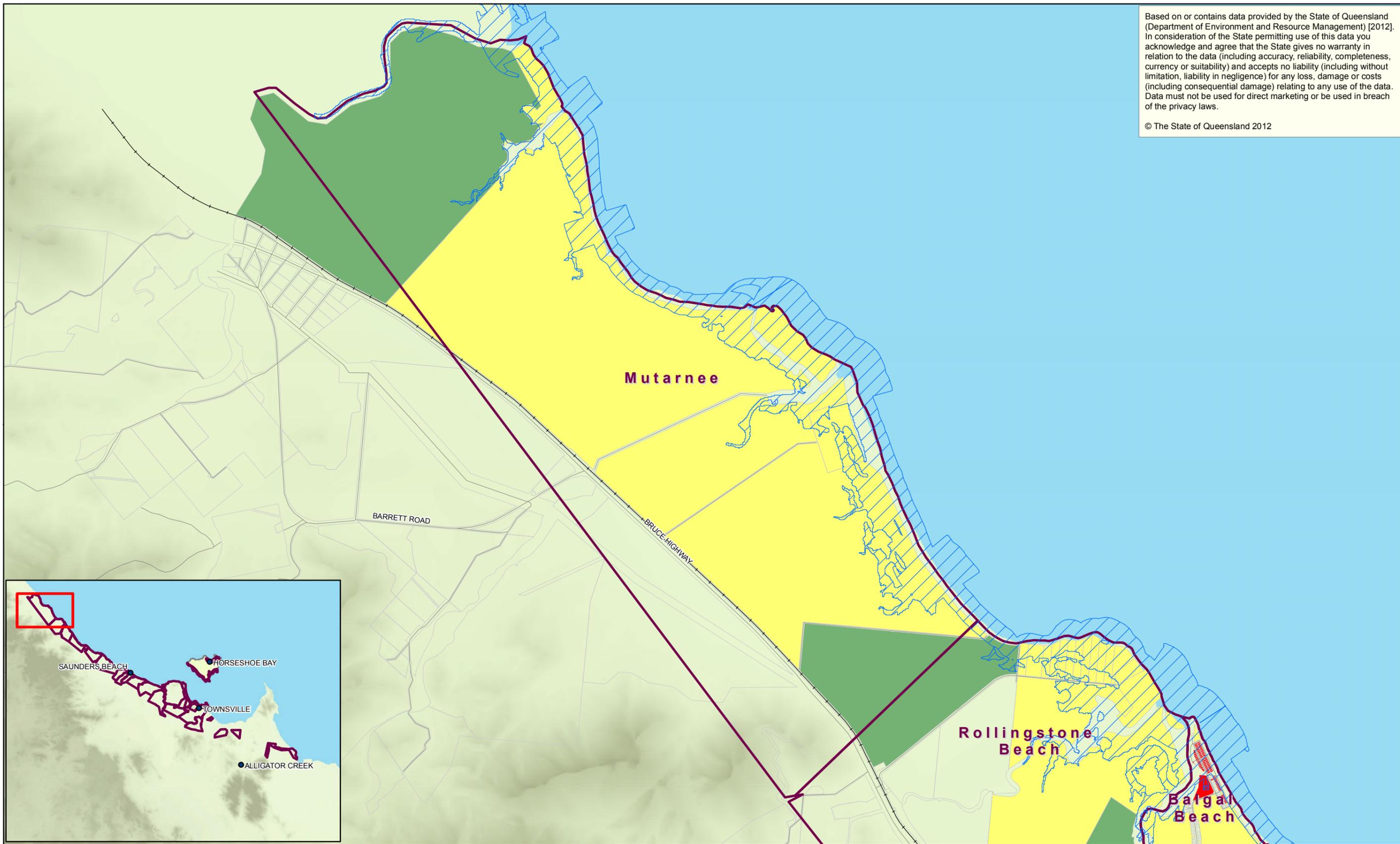
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Coastal Hazard Adaptation Strategy  
Tidal Influence -  
Current Conditions (2012)  
Risk To Property  
District: Rollingsstone

Job Number	41-24609
Revision	A
Date	12 Oct 2012

Map Series A1  
Sheet 1 of 11

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**LEGEND**

● Town / Locality	▭ Urban Locality
— Road	▭ Properties Boundary
— Railway	▨ HAT
	▨ 2100 Condition (0.8m SLR)

**Risk to Property**

▭ Acceptable Risk
▭ Tolerable Risk
▭ Unacceptable Risk



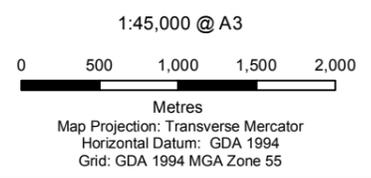
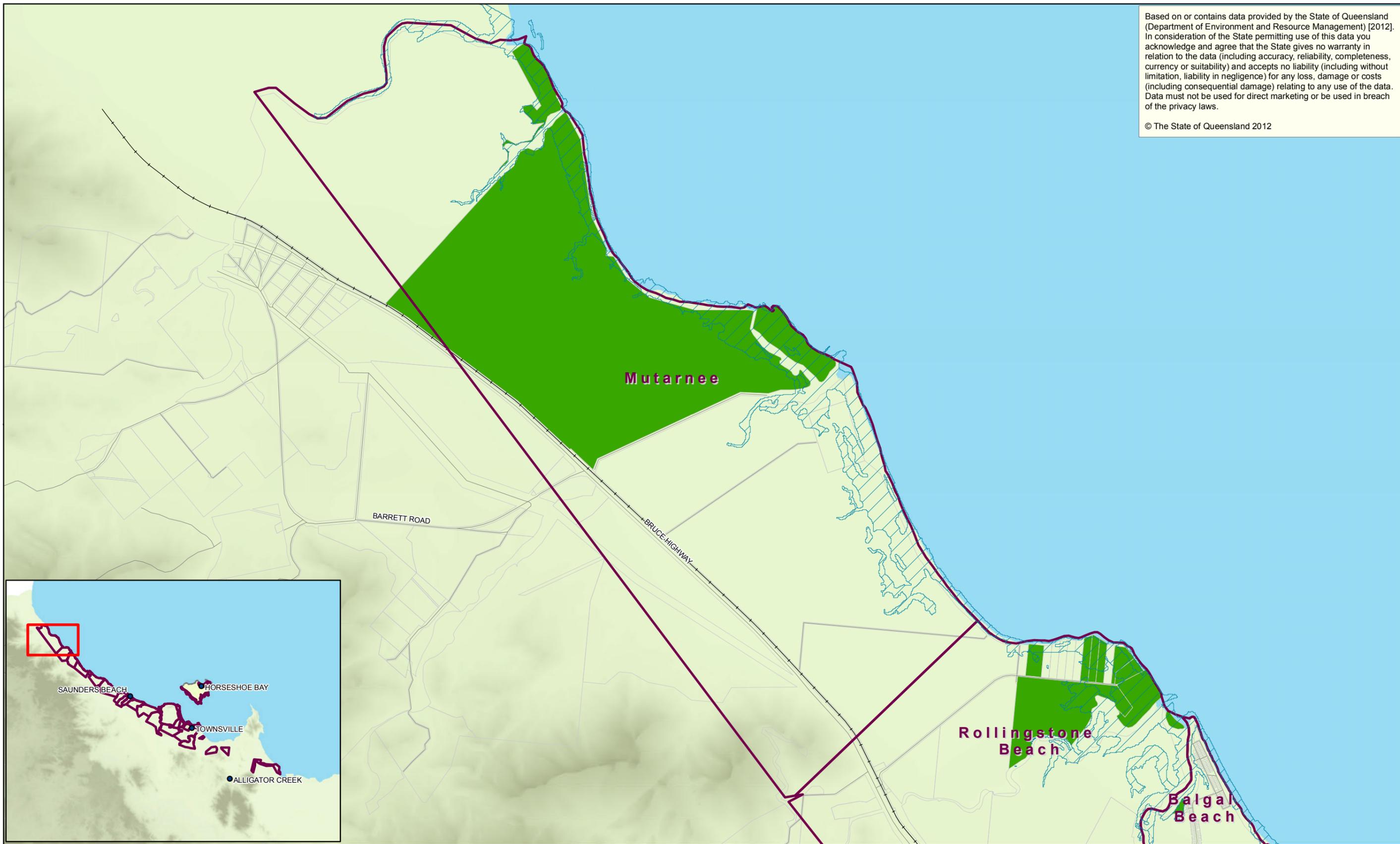
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Tidal Influence -  
2100 Conditions (0.8m SLR)  
Risk To Property  
District: Rollingstone

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**LEGEND**

● Town / Locality	Urban Locality
— Road	Properties Boundary
—+— Railway	Storm Tide Event
	Current Conditions (2012)

**Risk to Property**

Green box	Acceptable Risk
Red box	Unacceptable Risk



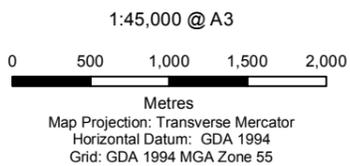
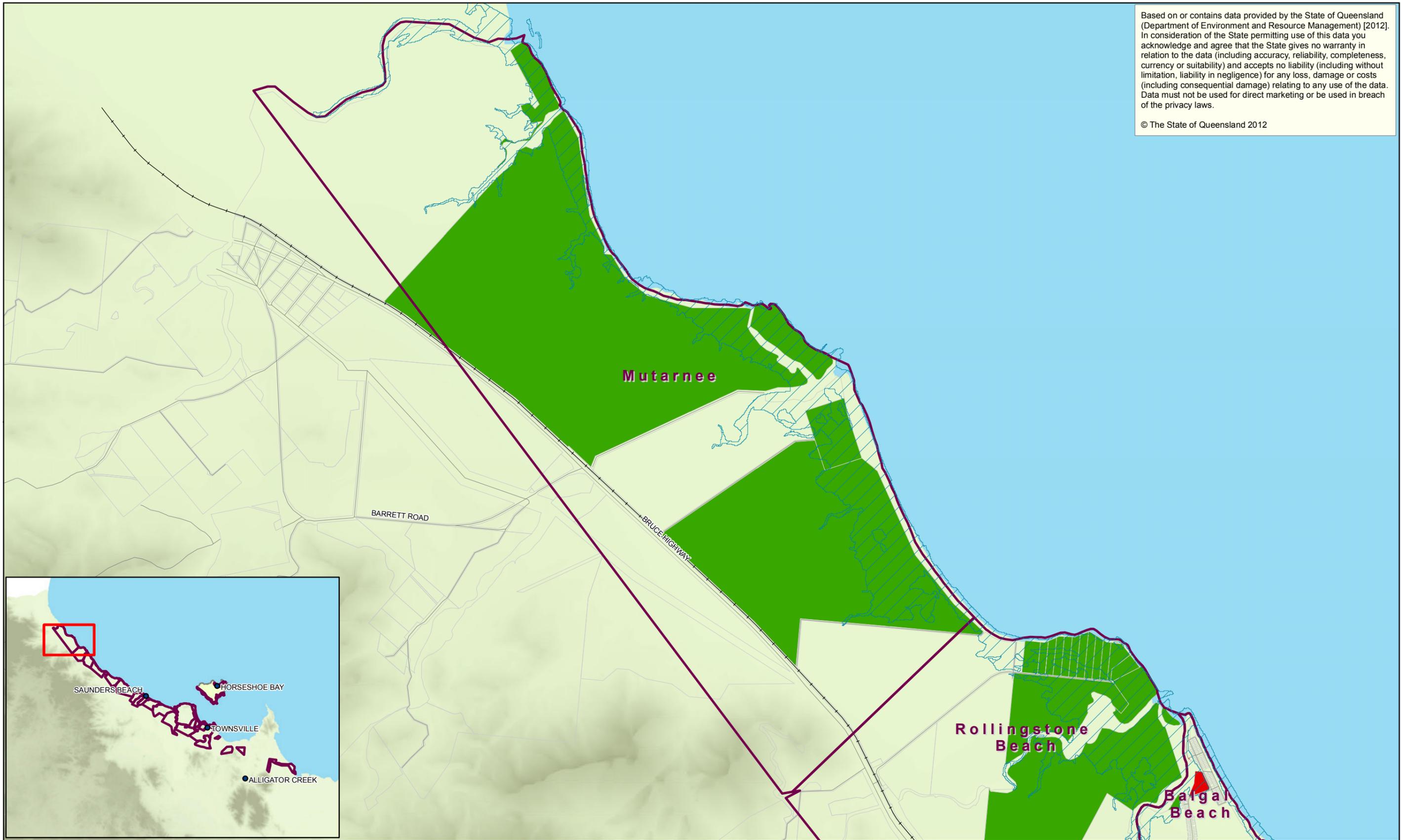
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 Coastal Hazard Adaptation Strategy  
 Storm Tide -  
 Current Conditions (2012)  
 Risk To Property  
 District: Rollingsstone

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LEGEND

- Town / Locality
- Road
- +— Railway
- ▭ District Boundary
- ▭ Properties Boundary
- ▨ 100 y Return Period Storm Tide Event 2100 Conditions (0.8m SLR)

- Risk to Property**
- ▭ Acceptable Risk
  - ▭ Unacceptable Risk



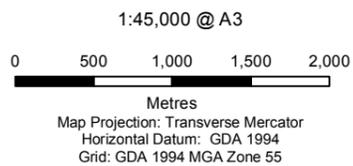
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Coastal Hazard Adaptation Strategy  
Storm Tide -  
2100 Conditions (0.8m SLR)  
Risk To Property  
District: Rollingsstone

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LEGEND

- Town / Locality
- Road
- +— Railway
- ▨ HAT (2012)
- ▭ Urban Locality
- ▭ Properties Boundary

Risk to Infrastructure

- ▭ Acceptable Risk
- ▭ Unacceptable Risk



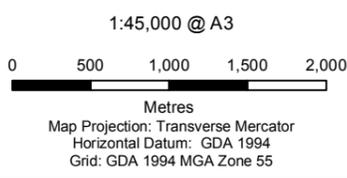
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Coastal Hazard Adaptation Strategy  
Tidal Influence -  
Current Conditions (2012)  
Risk To Infrastructure  
District: Rollingsstone

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**LEGEND**

● Town / Locality	Urban Locality
— Road	Properties Boundary
—+— Railway	HAT 2100 Condition (0.8m SLR)

**Risk to Infrastructure**

<span style="display:inline-block; width:15px; height:15px; background-color:lightgreen; border:1px solid black;"></span> Tolerable Risk
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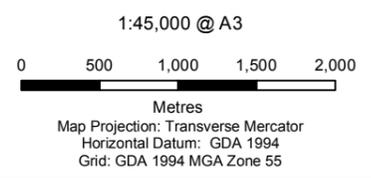
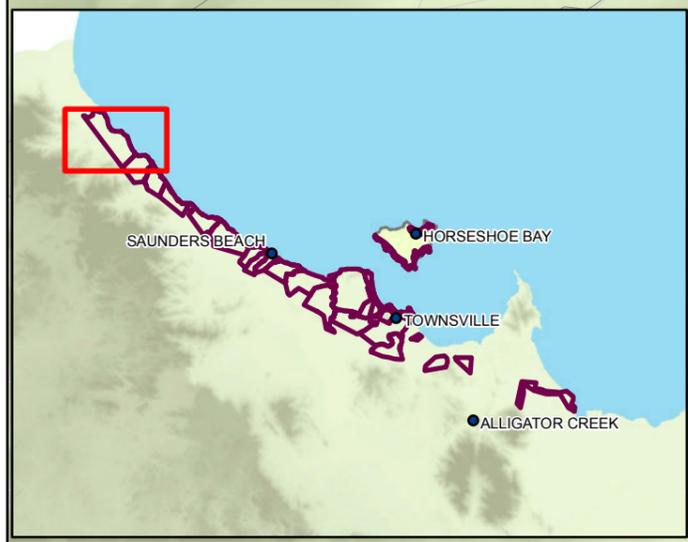
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Coastal Hazard Adaptation Strategy  
Tidal Influence -  
2100 Conditions (0.8m SLR)  
Risk To Infrastructure  
District: Rollingsstone

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**LEGEND**

● Town / Locality	Urban Locality
— Road	Properties Boundary
—+— Railway	Storm Tide Event
	Current Conditions (2012)

**Risk to Infrastructure**

<span style="display:inline-block; width:15px; height:15px; background-color:lightgreen;"></span> Acceptable Risk
<span style="display:inline-block; width:15px; height:15px; background-color:yellow;"></span> Tolerable Risk
<span style="display:inline-block; width:15px; height:15px; background-color:red;"></span> Unacceptable Risk



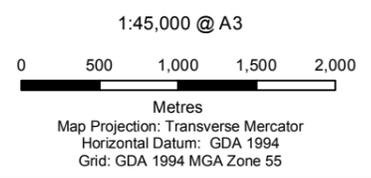
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Storm Tide -  
Current Conditions (2012)  
Risk To Infrastructure  
District: Rollingsstone

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**LEGEND**

● Town / Locality	▭ Urban Locality
— Road	▭ Properties Boundary
—+— Railway	▨ 100 y Return Period Storm Tide Event 2100 Condition (0.8m SLR)

**Risk to Infrastructure**

▭ Acceptable Risk
▭ Tolerable Risk
▭ Unacceptable Risk



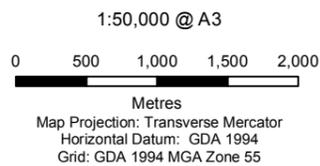
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Storm Tide -  
2100 Conditions (0.8m SLR)  
Risk To Infrastructure  
District: Rollingsstone

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LEGEND

- Town / Locality
- Road
- +— Railway
- ▨ HAT (2012)
- ▭ Urban Locality
- ▭ Properties Boundary

Risk to Property

- Acceptable Risk
- Tolerable Risk
- Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
Current Conditions (2012)  
Risk To Property  
District: Balgal Beach

Job Number | 41-24609  
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Map Series A1  
Sheet 2 of 11

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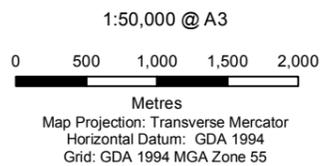
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**LEGEND**

- Town / Locality
- Road
- Railway
- Urban Locality
- Properties Boundary
- HAT 2100 Condition (0.8m SLR)

**Risk to Property**

- Acceptable Risk
- Tolerable Risk
- Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
2100 Conditions (0.8m SLR)  
Risk To Property  
District: Balgal Beach

Job Number | 41-24609  
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Sheet 2 of 11

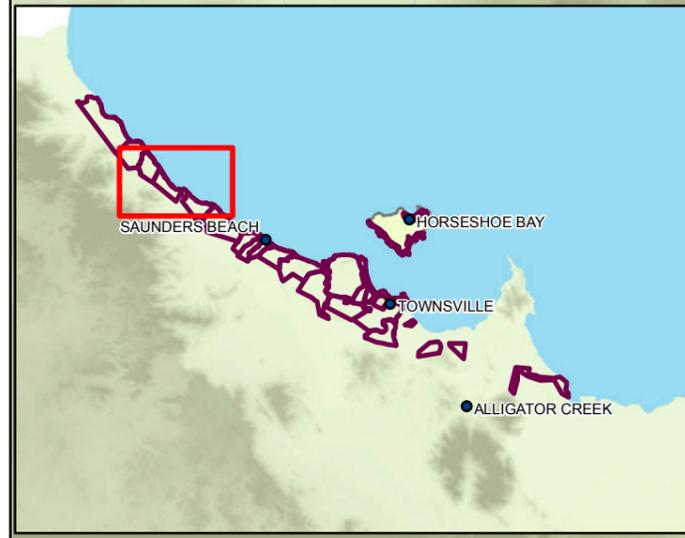
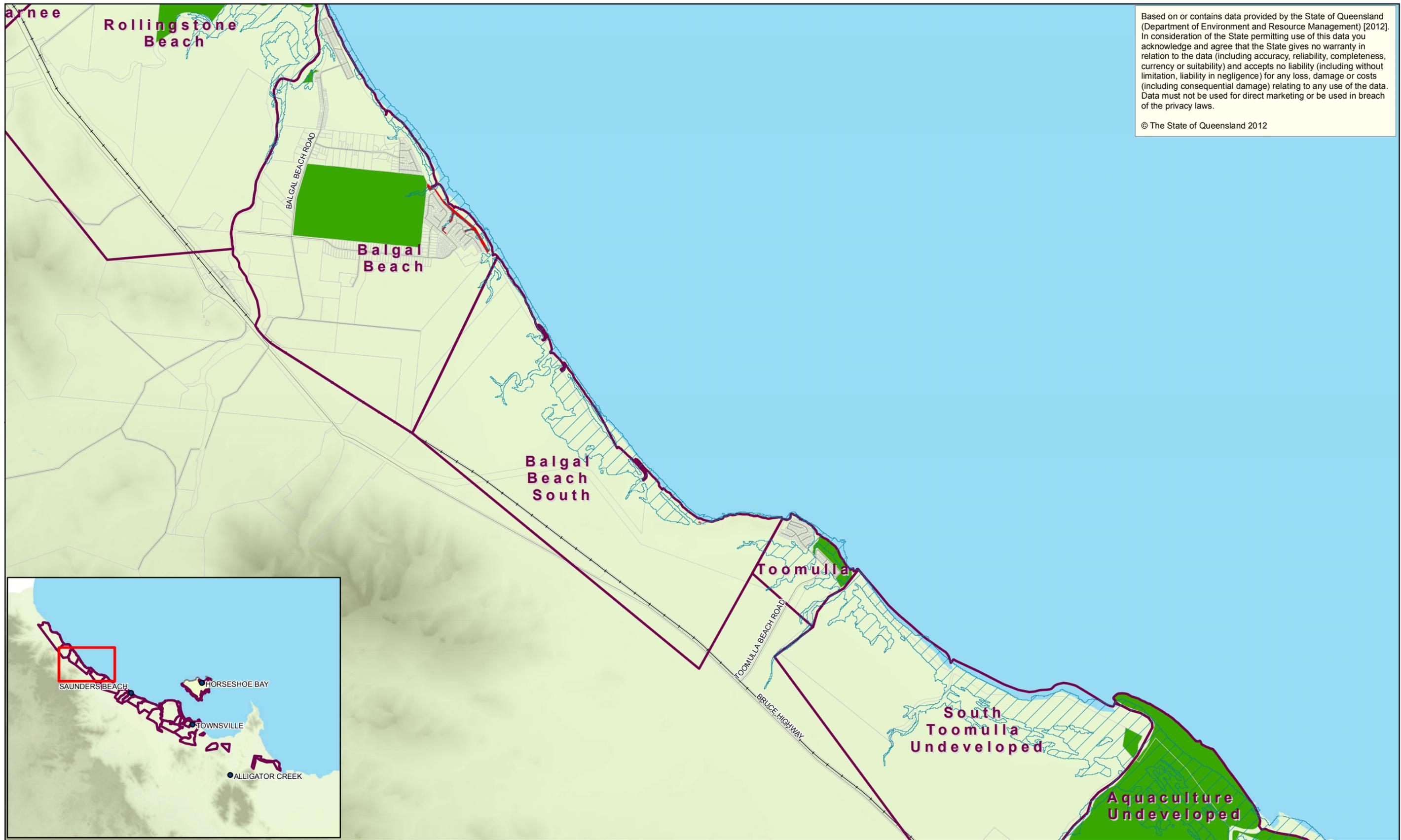
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1:50,000 @ A3  
 0 500 1,000 1,500 2,000  
 Metres  
 Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- +— Railway
- ▭ Urban Locality
- ▭ Properties Boundary
- ▭ Storm Tide Event
- ▭ Current Conditions (2012)

- Risk to Property**
- ▭ Acceptable Risk
  - ▭ Unacceptable Risk



Townsville City Council  
 Coastal Hazard Adaptation Strategy  
 Storm Tide -  
 Current Conditions (2012)  
 Risk To Property  
 District: Balgal Beach

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 Sheet 2 of 11

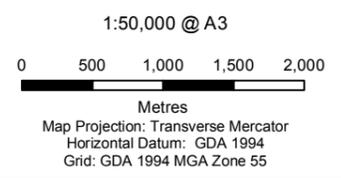
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 Data source: TCC - Railway, Roads, Properties, Districts (2011). Geoscience Australia - Populated Places (2008). DERM - DEM (2007), Place Names (2010). GHD - Ocean Boundary (2012).

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**LEGEND**

● Town / Locality	▭ District Boundary
— Road	▭ Properties Boundary
—+— Railway	▨ 100 y Return Period Storm Tide Event 2100 Conditions (0.8m SLR)

**Risk to Property**

■ Acceptable Risk
■ Unacceptable Risk



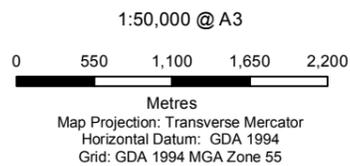
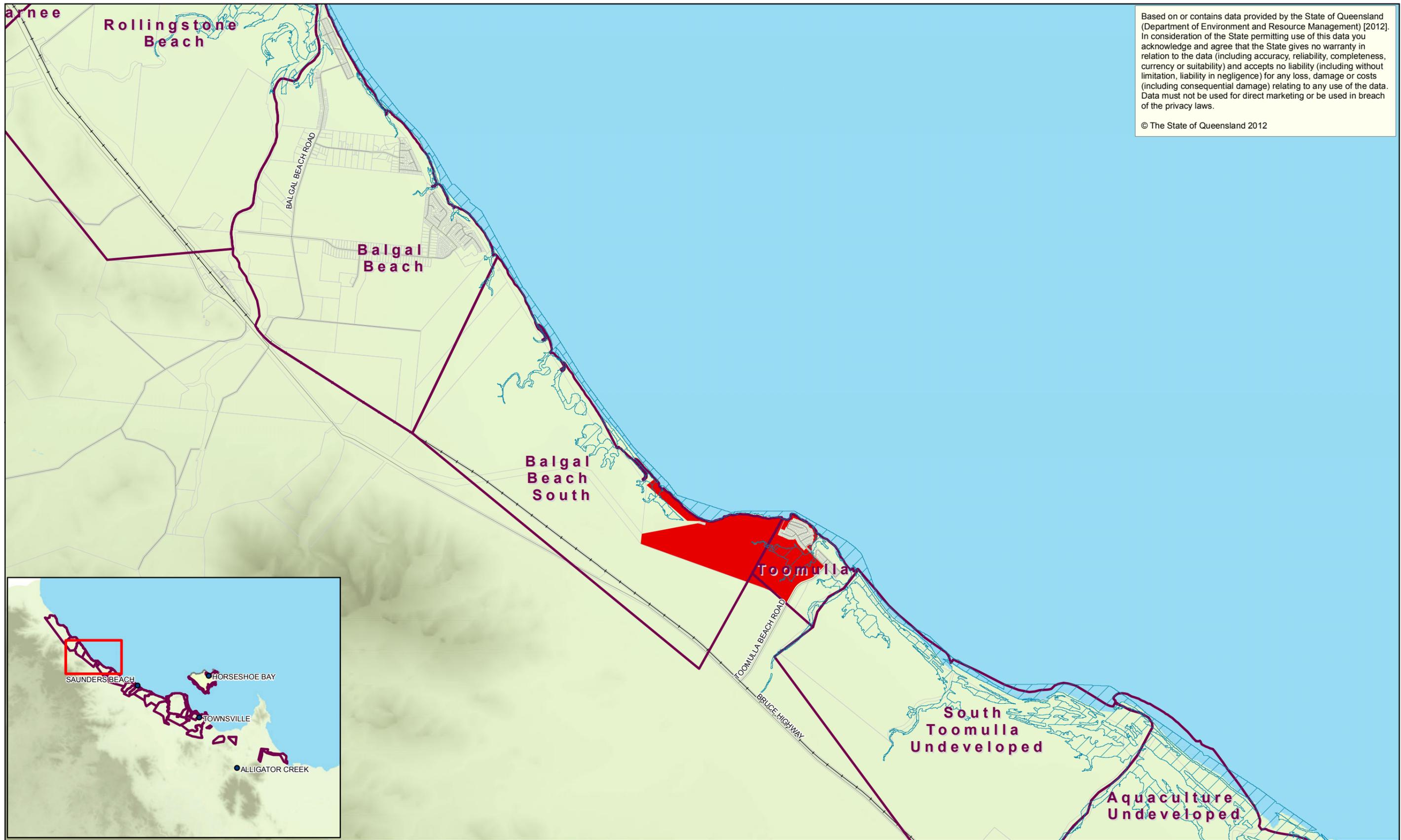
Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
2100 Conditions (0.8m SLR)  
Risk To Property  
District: Balgal Beach

Job Number	41-24609
Revision	A
Date	12 Oct 2012

Map Series A4  
Sheet 2 of 11

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LEGEND

- Town / Locality
- Road
- +— Railway
- ▨ HAT (2012)
- ▭ Urban Locality
- ▭ Properties Boundary

Risk to Infrastructure

- ▭ Acceptable Risk
- ▭ Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
Current Conditions (2012)  
Risk To Infrastructure  
District: Balgal Beach

Job Number | 41-24609  
Revision | A  
Date | 12 Oct 2012

Map Series A5  
Sheet 2 of 11

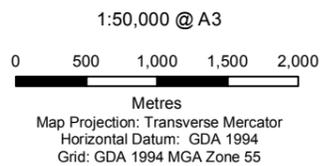
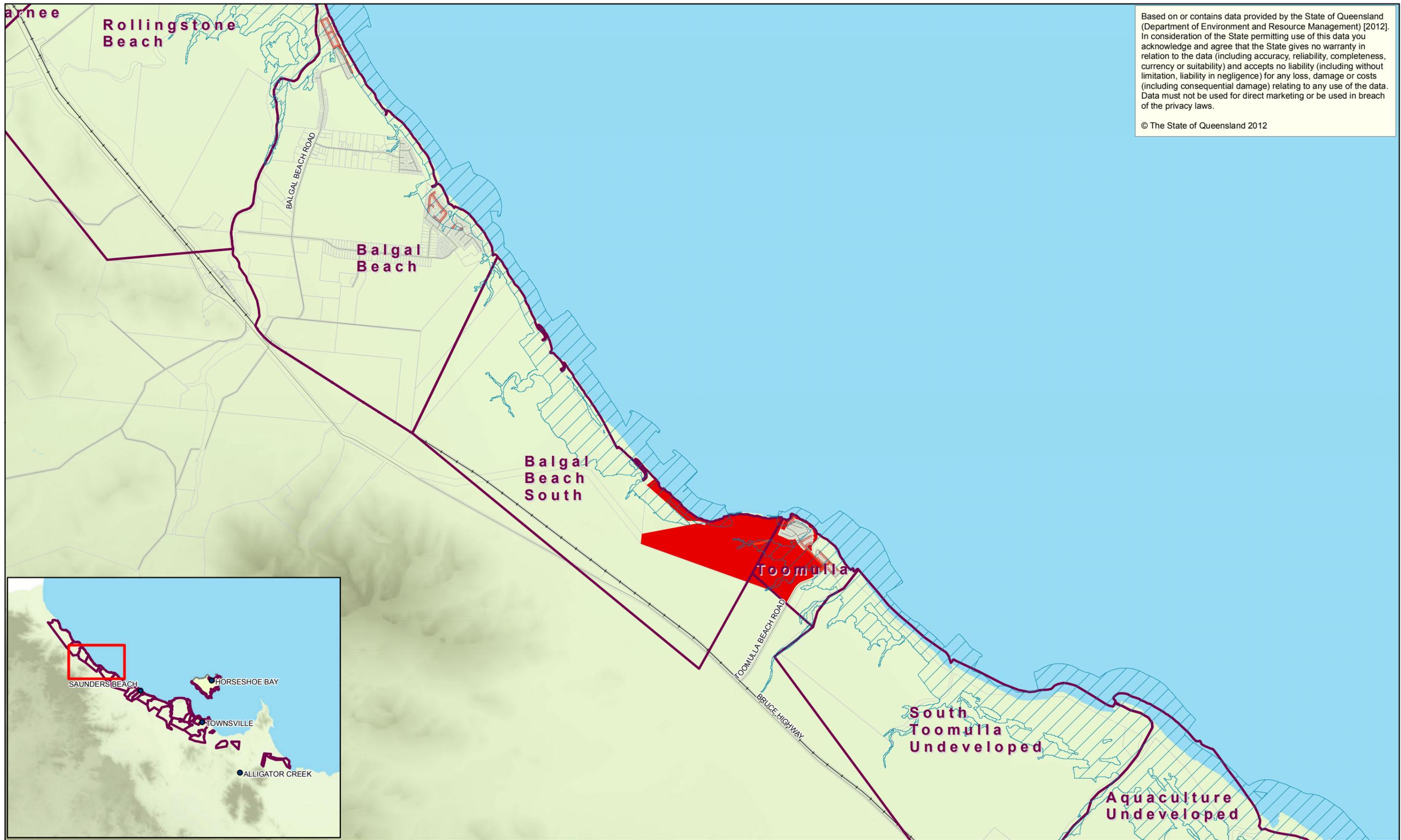
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Data source: TCC - Railway, Roads, Properties, Districts (2011). Geoscience Australia - Populated Places (2008). DERM - DEM (2007), Place Names (2010). GHD - Ocean Boundary (2012).

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LEGEND

- Town / Locality
- Road
- +— Railway
- ▭ Urban Locality
- ▭ Properties Boundary
- ▭ HAT 2100 Condition (0.8m SLR)

Risk to Infrastructure

- ▭ Tolerable Risk
- ▭ Unacceptable Risk



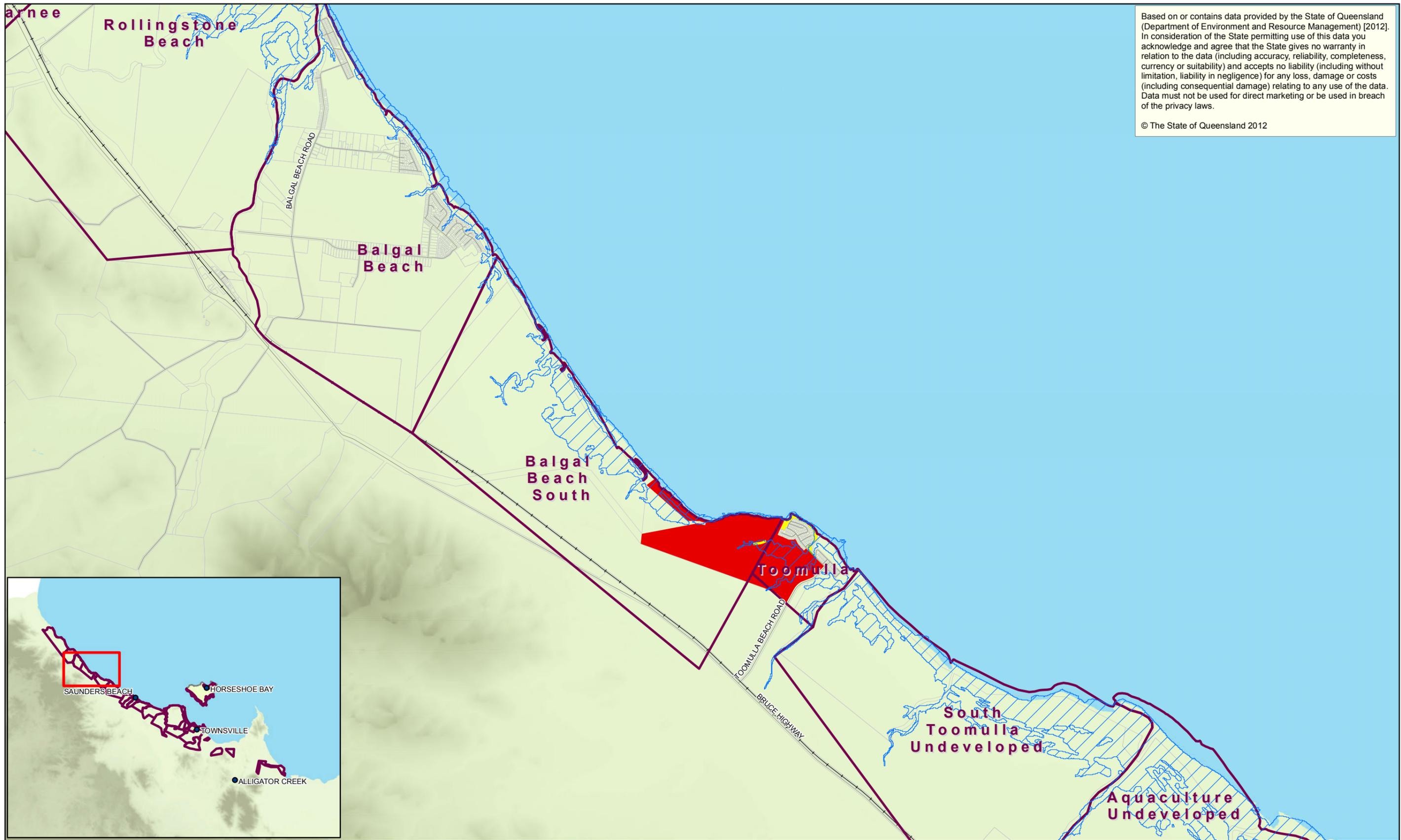
Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
2100 Conditions (0.8m SLR)  
Risk To Infrastructure  
District: Balgal Beach

Job Number | 41-24609  
Revision | A  
Date | 12 Oct 2012

Map Series A6  
Sheet 2 of 11

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1:50,000 @ A3  
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 Metres  
 Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 55



LEGEND

- Town / Locality
- Road
- Railway
- ▭ Urban Locality
- ▭ Properties Boundary
- ▭ Storm Tide Event
- ▭ Current Conditions (2012)

Risk to Infrastructure

- ▭ Acceptable Risk
- ▭ Tolerable Risk
- ▭ Unacceptable Risk



Townsville City Council  
 Coastal Hazard Adaptation Strategy  
 Storm Tide -  
 Current Conditions (2012)  
 Risk To Infrastructure  
 District: Balgal Beach

Job Number | 41-24609  
 Revision | A  
 Date | 12 Oct 2012

Map Series A7  
 Sheet 2 of 11

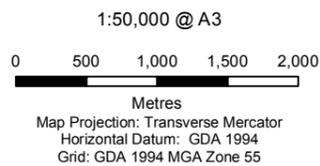
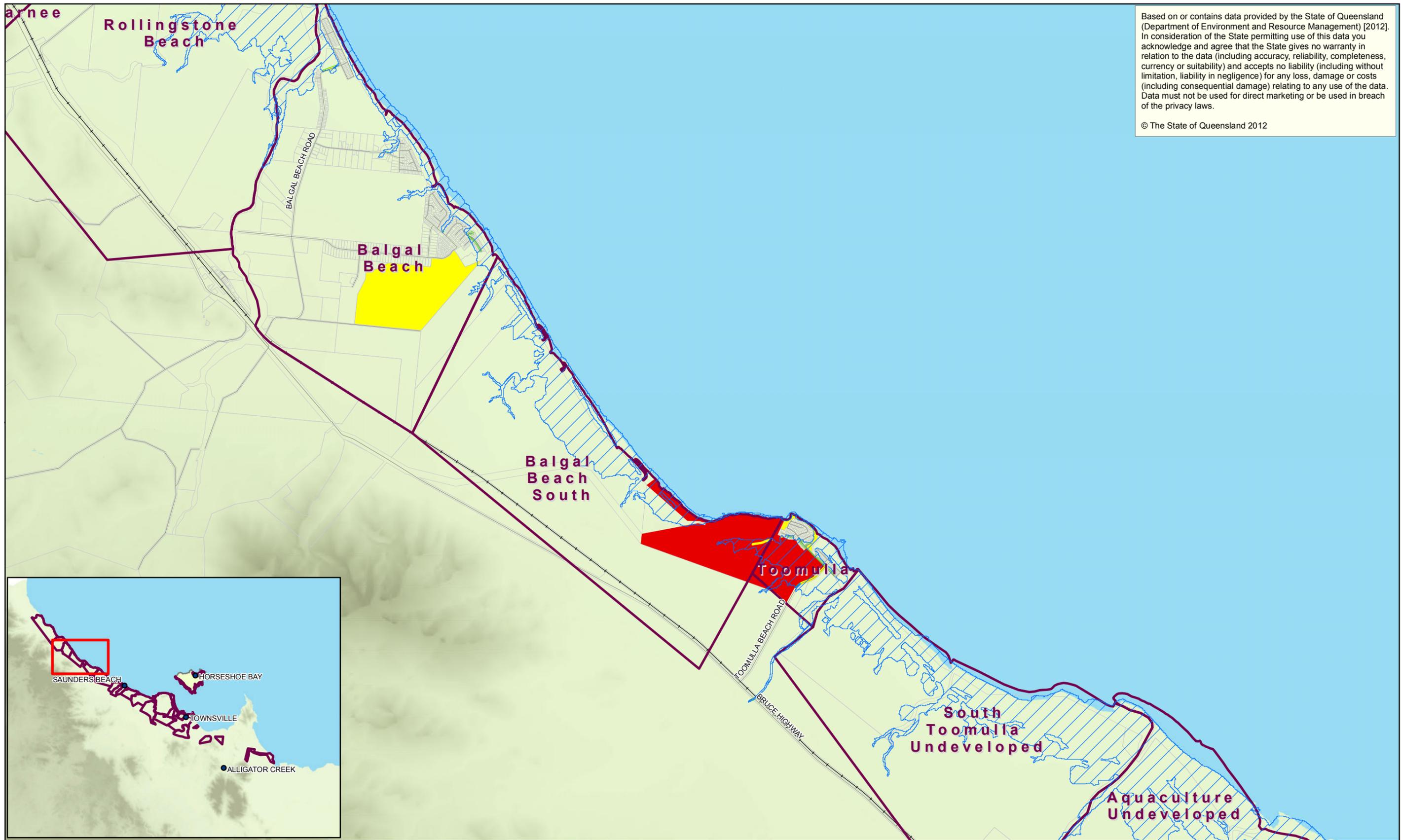
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LEGEND

- Town / Locality
- Road
- Railway
- ▭ Urban Locality
- ▭ Properties Boundary
- ▨ 100 y Return Period Storm Tide Event 2100 Condition (0.8m SLR)

Risk to Infrastructure

- ▭ Acceptable Risk
- ▭ Tolerable Risk
- ▭ Unacceptable Risk



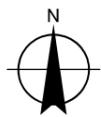
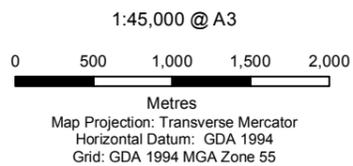
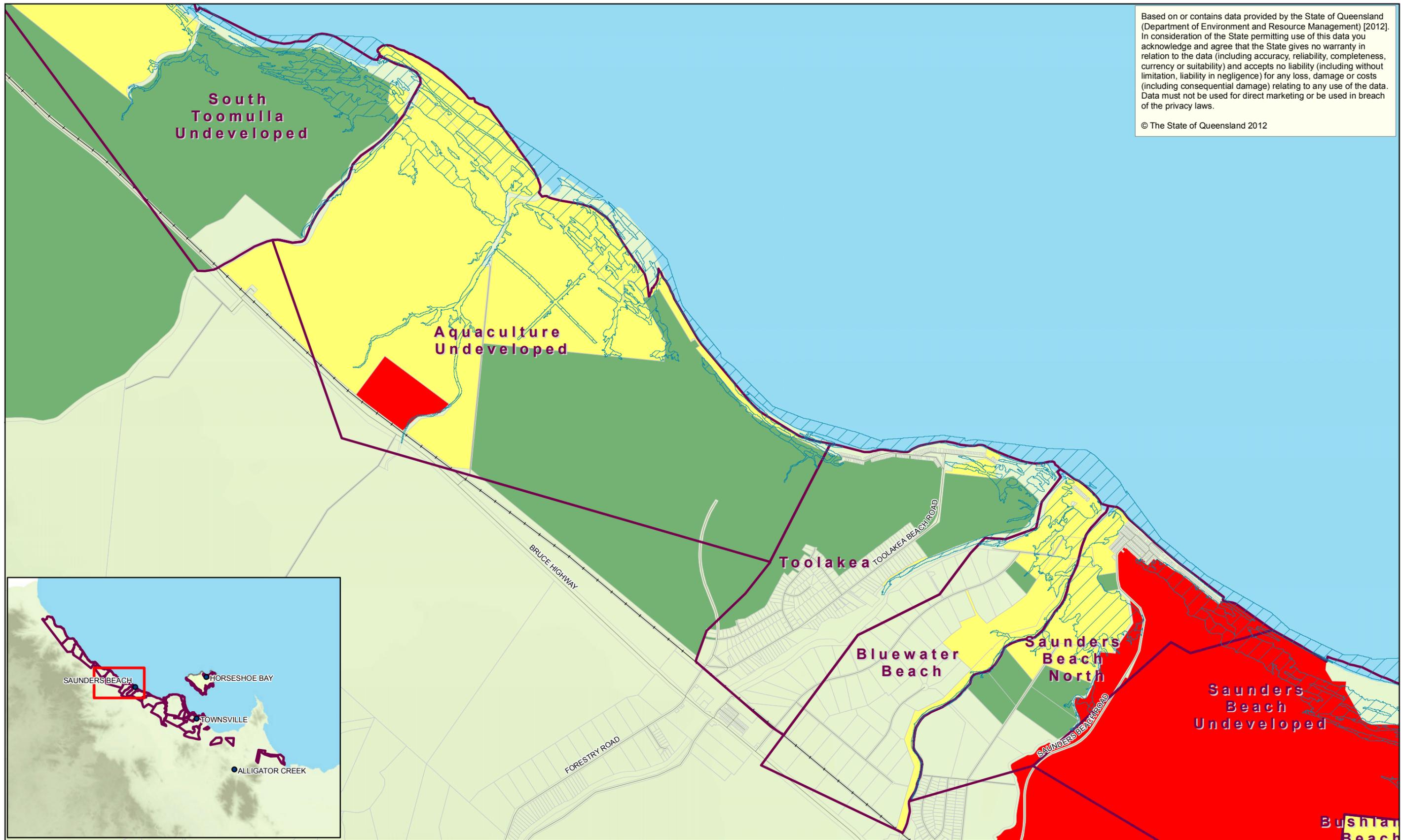
Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
2100 Conditions (0.8m SLR)  
Risk To Infrastructure  
District: Balgal Beach

Job Number | 41-24609  
Revision | A  
Date | 12 Oct 2012

Map Series A8  
Sheet 2 of 11

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LEGEND

- Town / Locality
- Road
- Railway
- ▨ HAT (2012)
- ▭ Urban Locality
- ▭ Properties Boundary

Risk to Property

- Acceptable Risk
- Tolerable Risk
- Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
Current Conditions (2012)  
Risk To Property  
District: Toolakea

Job Number | 41-24609  
Revision | A  
Date | 12 Oct 2012

Map Series A1  
Sheet 3 of 11

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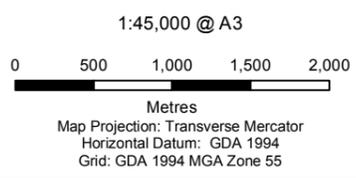
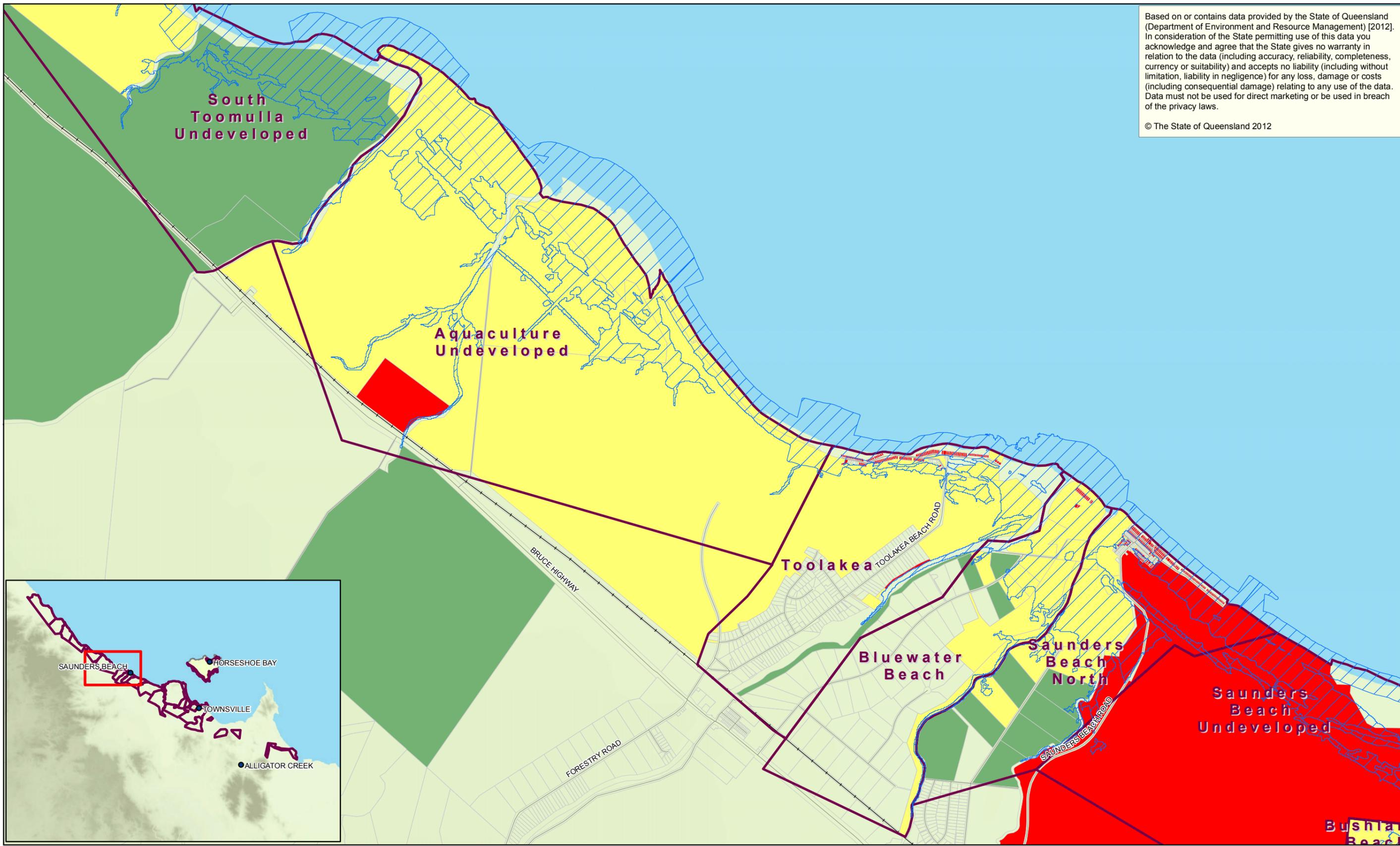
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Data source: TCC - Railway, Roads, Properties, Districts (2011). Geoscience Australia - Populated Places (2008). DERM - DEM (2007), Place Names (2010). GHD - Ocean Boundary (2012).

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LEGEND	
● Town / Locality	Urban Locality
— Road	Properties Boundary
— Railway	HAT 2100 Condition (0.8m SLR)

Risk to Property	
Green	Acceptable Risk
Yellow	Tolerable Risk
Red	Unacceptable Risk



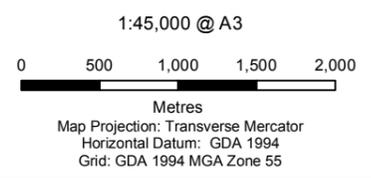
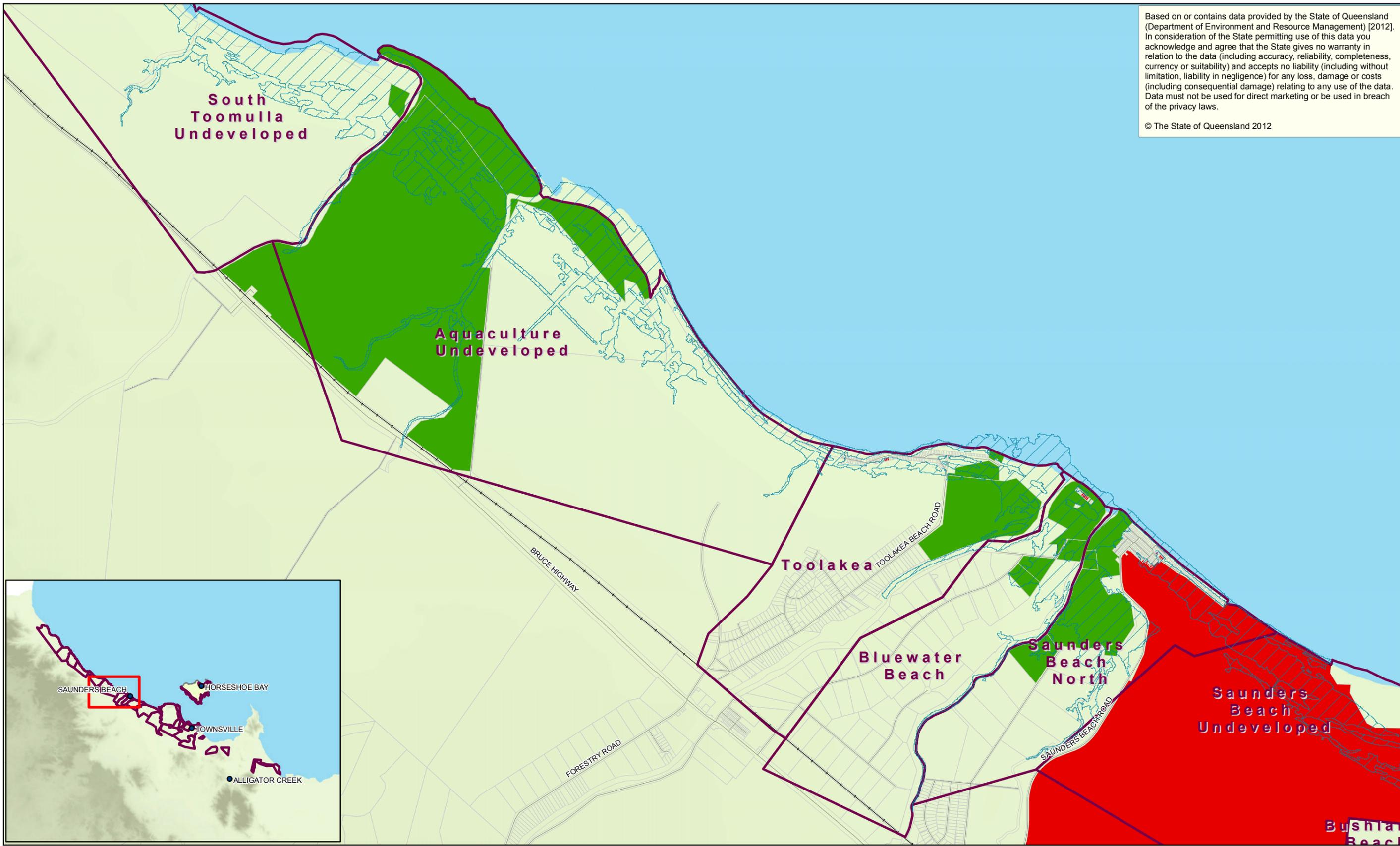
Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
2100 Conditions (0.8m SLR)  
Risk To Property  
District: Toolakea

Job Number | 41-24609  
Revision | A  
Date | 12 Oct 2012

Map Series A2  
Sheet 3 of 11

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**LEGEND**

● Town / Locality	Urban Locality
— Road	Properties Boundary
—+— Railway	Storm Tide Event
	Current Conditions (2012)

**Risk to Property**

<span style="display:inline-block; width:15px; height:15px; background-color:green; border:1px solid black;"></span> Acceptable Risk
<span style="display:inline-block; width:15px; height:15px; background-color:red; border:1px solid black;"></span> Unacceptable Risk



Townsville City Council  
Coastal Hazard Adaptation Strategy  
**Storm Tide -  
Current Conditions (2012)  
Risk To Property  
District: Toolakea**

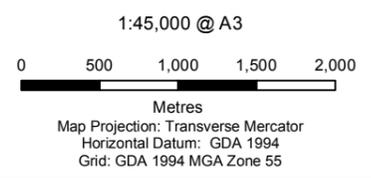
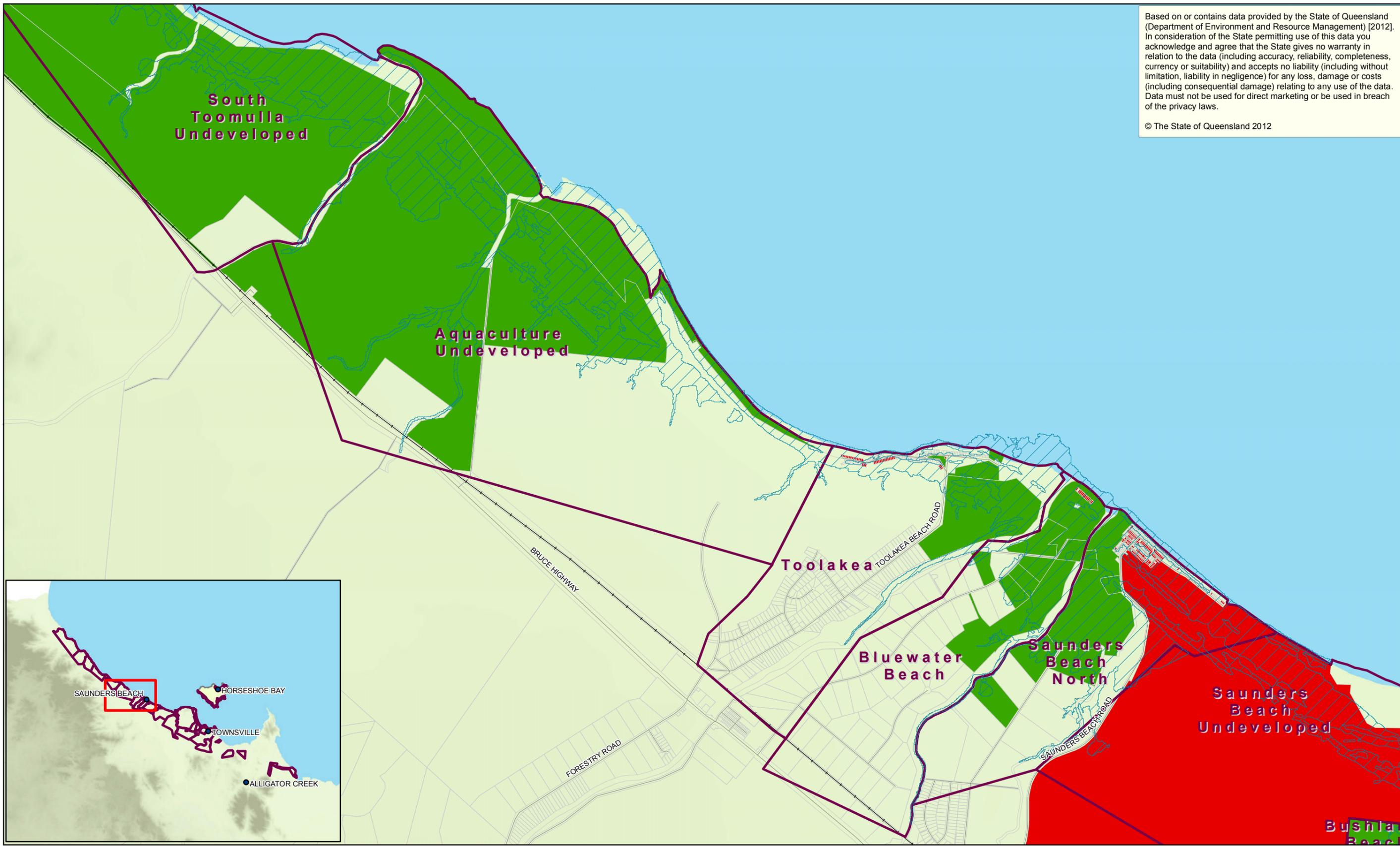
Job Number | 41-24609  
Revision | A  
Date | 12 Oct 2012

Map Series A3  
Sheet 3 of 11

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Data source: TCC - Railway, Roads, Properties, Districts (2011), Geoscience Australia - Populated Places (2008), DERM - DEM (2007), Place Names (2010), GHD - Ocean Boundary (2012).

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LEGEND	
● Town / Locality	▭ District Boundary
— Road	▭ Properties Boundary
—+— Railway	▨ 100 y Return Period Storm Tide Event 2100 Conditions (0.8m SLR)

Risk to Property	
■ Acceptable Risk	■ Unacceptable Risk



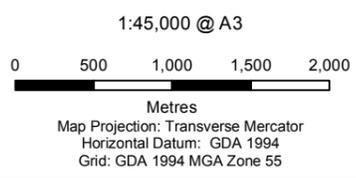
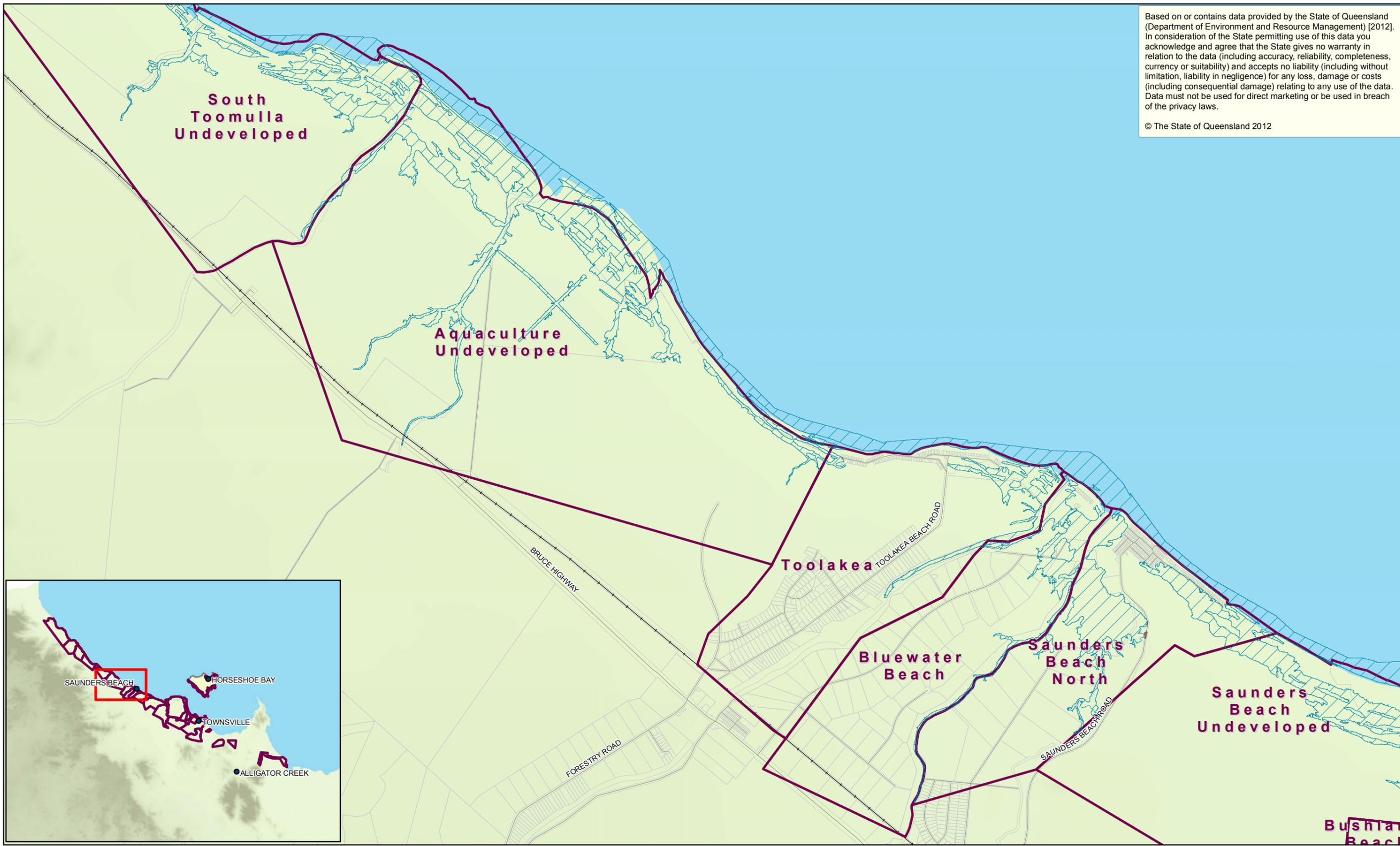
Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
2100 Conditions (0.8m SLR)  
Risk To Property  
District: Toolakea

Job Number	41-24609
Revision	A
Date	12 Oct 2012

Map Series A4  
Sheet 3 of 11

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<b>LEGEND</b>		<b>Risk to Infrastructure</b> <span style="display: inline-block; width: 15px; height: 15px; background-color: yellow; border: 1px solid black;"></span> Acceptable Risk <span style="display: inline-block; width: 15px; height: 15px; background-color: red; border: 1px solid black;"></span> Unacceptable Risk
● Town / Locality	<span style="border: 1px dashed blue; width: 20px; height: 10px;"></span> HAT (2012)	
— Road	<span style="border: 2px solid purple; width: 20px; height: 10px;"></span> Urban Locality	
—+— Railway	<span style="border: 1px solid grey; width: 20px; height: 10px;"></span> Properties Boundary	



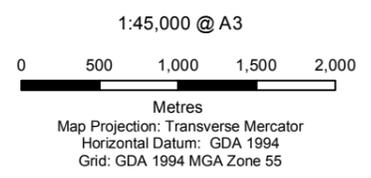
Townsville City Council  
 Coastal Hazard Adaptation Strategy  
**Tidal Influence -  
 Current Conditions (2012)  
 Risk To Infrastructure  
 District: Toolakea**

Job Number	41-24609
Revision	A
Date	12 Oct 2012

**Map Series A5**  
**Sheet 3 of 11**

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LEGEND	
● Town / Locality	Urban Locality
— Road	Properties Boundary
—+— Railway	HAT 2100 Condition (0.8m SLR)

Risk to Infrastructure	
Green box	Tolerable Risk
Red box	Unacceptable Risk



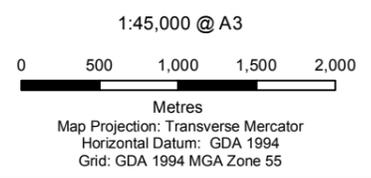
Townsville City Council  
Coastal Hazard Adaptation Strategy  
Tidal Influence -  
2100 Conditions (0.8m SLR)  
Risk To Infrastructure  
District: Toolakea

Job Number	41-24609
Revision	A
Date	12 Oct 2012

Map Series A6  
Sheet 3 of 11

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LEGEND	
● Town / Locality	Urban Locality
— Road	Properties Boundary
—+— Railway	Storm Tide Event
	Current Conditions (2012)

Risk to Infrastructure	
Green	Acceptable Risk
Yellow	Tolerable Risk
Red	Unacceptable Risk



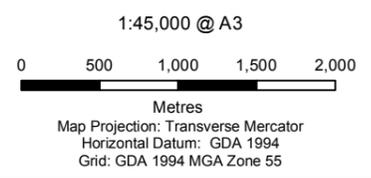
Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
Current Conditions (2012)  
Risk To Infrastructure  
District: Toolakea

Job Number	41-24609
Revision	A
Date	12 Oct 2012

Map Series A7  
Sheet 3 of 11

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LEGEND	
● Town / Locality	Urban Locality
— Road	Properties Boundary
— Railway	100 y Return Period Storm Tide Event 2100 Condition (0.8m SLR)

Risk to Infrastructure	
Green	Acceptable Risk
Yellow	Tolerable Risk
Red	Unacceptable Risk



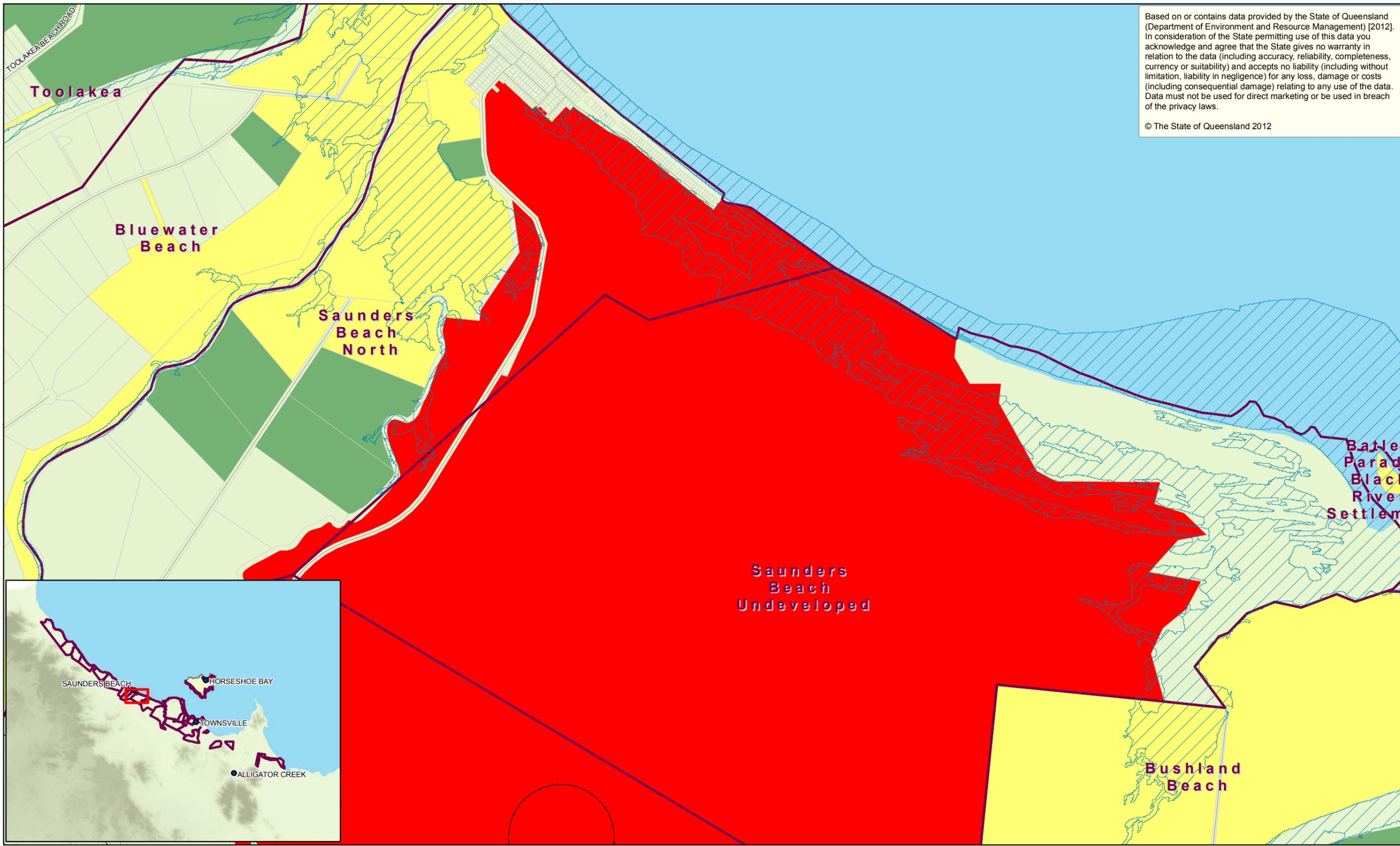
Townsville City Council  
Coastal Hazard Adaptation Strategy  
Storm Tide -  
2100 Conditions (0.8m SLR)  
Risk To Infrastructure  
District: Toolakea

Job Number | 41-24609  
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Map Series A8  
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1:20,000 @ A3  
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 Metres  
 Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 55



**LEGEND**

- Town / Locality
- Road
- Railway
- ▨ HAT (2012)
- ▭ Urban Locality
- ▭ Properties Boundary

**Risk to Property**

- Acceptable Risk
- Tolerable Risk
- Unacceptable Risk



Townsville City Council  
 Coastal Hazard Adaptation Strategy  
 Tidal Influence -  
 Current Conditions (2012)  
 Risk To Property  
 District: Saunders Beach

Job Number | 41-24609  
 Revision | A  
 Date | 12 Oct 2012

Map Series A1  
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