## TOWNSVILLE CITY NATURAL DISASTER RISK MANAGEMENT STUDY

# FORMER THURINGOWA CITY COUNCIL AREA

# **ADDENDUM REPORT**



October 2010



Australian Government

Attorney-General's Department





## **REVISION HISTORY**

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TCC - 02	Final Report	23 Nov 2010	Report accepted by Council		

## **DISTRIBUTION LIST**

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## Abbreviations

ABS	Australian Bureau of Statistics
ARI	Annual Recurrence Interval
AS/NZS	Australian Standard / New Zealand Standard
BCA	Building Code of Australia
BMWG	Bushfire Management Working Group
BoM	Bureau of Meteorology
CCD	Census Collection District
CERA	The Centre for Earthquake Research in Australia
CTS	Cyclone Testing Station
DEM	Digital Elevation Model
DLGP	Department of Local Government and Planning
DMR	Department of Main Roads
DNRMW	Department of Natural Resources, Mining and Water (Qld)
EMA	Emergency Management Australia
EMP	Emergency Management Plan
EMQ	Emergency Management Queensland
FABC	Fire and Biodiversity Consortium
GIS	Geographical Information System
IID	Institute for International Development
LDCC	Local Disaster Coordination Centre
LDMG	Local Disaster Management Group
LGA	Local Government Area
LGAQ	Local Government Association Queensland
MOU	Memorandum of Understanding
NDMP	Natural Disaster Management Plan
NDRM	Natural Disaster Risk Management
NDRP	Natural Disaster Resilience Program
QFRS	Queensland Fire and Rescue Service
QPS	Queensland Police Service
QPWS	Queensland Parks and Wildlife Service
SAA	Standards Association of Australia
SAG	Study Advisory Group
SES	State Emergency Service
SEWS	Standard Emergency Warning Signal
SPP	State Planning Policy
TCC	I ownsville City Council
TLDMP	I ownsville Local Disaster Management Plan

## PREFACE

The initial report, TOWNSVILLE CITY NATURAL DISASTER RISK MANAGEMENT STUDY STAGE 1, was commissioned by the former Townsville City Council prior to the amalgamation of Townsville and Thuringowa Cities. As a result, this initial report does not include the former Thuringowa City area.

The Townsville City Council Natural Disaster Risk Management Study Report outcomes and strategies were accepted by Council at its December 2009 meeting.

Prior to the amalgamation, the former Thuringowa City Council had not commissioned a similar report.

The purpose of this report is to extend the TOWNSVILLE CITY NATURAL DISASTER RISK MANAGEMENT STUDY STAGE 1 report to include the former Thuringowa City.

A requirement of the study is to form a study advisory group (SAG) to advise on and review the report outcomes. The member of the group were:

Name	Position	Department / Organisation
Allen Morris	Executive Officer	Emergency Management
Lindsay Groat	Executive Manager	Technical Services
Neil Allen	Director	Infrastructure Services
Gavin Lyons	Director	Community & Environment
Paul Johnston	Coordinator City Plan	Planning & Development
Doug Millican /	Technical Officer	Planning and Development
Cameron Finter		
Colin Phillips	Executive Manager	Strategic Planning, Planning &
		Development
Geraldine Wood	Executive Manager	Corporate Services
Wayne Preedy	Area Director	Emergency Management
		Queensland
Kenneth Melchert	Manager	Geospatial Solutions
Andrew Hannay	Coordinator	Environmental Management &
		NRM
Greg Bruce	Executive Manager	Integrated Sustainability
Sue Court	Support Officer	Emergency Management
Geoff Hughes	Consultant	Emergency Management

Early in this process it was recognised that some advantages would be gained if the needs of the Planning and Development, City Plan Unit, were included in the tender documentation for Bushfire and Landslide Hazard Studies. The maps produced and the planning scheme requirements were acceptable to the City Plan Unit.

Acknowledgement is given to the author of the initial report by The Institute for International Development (IID) for the investigation and works undertaken which have formed the basis for this addendum report.

This report format intentionally follows the assessment approach of the IID report including chapters and subheadings of the initial report to enable the reader to easily combine the information from both reports.

The specialised secondary reports commissioned as part of this report have adopted a differing approach to the vulnerability assessment of hazards but for the sake of consistency the approach utilised by IID was adopted for this report.

The project manager for this report was Mr. Allen Morris of Townsville City Council and supported by consultant Mr. Geoff Hughes BEng. Assistance was also afforded by the members of the study advisory group (SAG) convened for the purpose of guiding and reviewing this report.

Thanks also to the Strategic Planning Department of Council's Planning and Development Division for their assistance in obtaining census demographic and Council infrastructure information and in particular Mr. Brian Bailey and Mr. Robert Male.

## 1. THE CONTEXT

## 1.1 THE STUDY AREA

The study area is bounded on the south east by the Bohle River, to the north west by Crystal Creek and to the south west by the mountain ranges of Hervey and Paluma Ranges. The area is shown in fig 1.1 below.



Figure 1.1 Former Thuringowa City

## 1.1.1 Terrain

The topography of the area is similar to the Townsville area with the four main regions:

- Low lying costal plain but without extensive mud flats and clay pans
- Low lying flood plains of the Bohle River, Black River, Bluewater Creek, Rollingstone Creek and Crystal Creek. The flood plain is also intercepted by a number of other smaller creeks.
- The foothills of Hervey and Paluma Ranges rise to elevations of 900 m. These foothills are closer to the coast towards the northern end of the area.
- Individual isolated hills including Toomulla Hill (28 m), Kilburn (138 m), The Pinnacles (500 m), Mount Low (60 m).

The northern part of the study area is drained by a number of smaller creeks flowing directly into the ocean and the two larger rivers (Bohle and Black) together with their tributaries drain the southern areas.

## 1.1.2 Geology

The geology of the area is the same as the initial study area based on the DNRMW data.

## 1.1.3 Vegetation

In the lower flood plain, large areas of native vegetation have been removed from the area for agriculture and residential development. The area towards the north is wetter and hence a denser bushland exists (especially in the ranges) to the extent that the Paluma Range area has been designated as part of the Wet Tropics. A more detailed investigation of the vegetation is undertaken in the latter Bushfire hazard section.

## 1.1.4 Climate

The southern area is similar to the original Townsville study area but the costal area from Rollingstone north and the range area from Bluewater north has a higher rainfall. The coastline south of Rollingstone runs parallel to the direction of the south east trade winds and has resulted in this section of coast not receiving the rainfall the coast north of Rollingstone receives. This has resulted in a "rain shadow" in the area south of Rollingstone.

Tables 1.1 and 1.2 gives the BoM rainfall data for the Rollingstone and Mutarnee areas. The southern areas rainfall data is shown in the initial IID (2009) report for the Townsville Airport.

Statistic	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	402.6	391.2	208.3	117.3	51.6	17.5	11.8	21.8	24.4	44.2	137.2	183.1	1592.7
Lowest	0	39.8	12.6	0	0	0	0	0	0	0	0	0	862.4
5th %ile	49.9	62	24	11.8	0	0	0	0	0	0	4.5	34.2	900.2
10 <sup>th</sup> %ile	59	84.6	33.6	14.2	1.1	0	0	0	0	3.7	10.9	53.1	1035.1
Median	370.4	307.1	157	60.6	30.5	9	6.8	7.2	5.1	21.7	105.3	145.1	1483.4
90 <sup>th</sup> %ile	852	831.2	481.7	264.6	127.7	47.5	30	61	82.7	76.1	322.1	355.1	2346.5
95 <sup>th</sup> %ile	1041.2	906.4	505.8	402.6	149.1	61.7	35.6	75.6	94.4	152.2	406.2	385.2	2448.4
Highest	1336.4	1127	737.4	528	295.2	109.7	90.6	197.8	126.5	347.3	574.6	892.8	3136.2

#### Table 1-1 Rollingstone Rainfall

#### Table 1-2 Mutarnee Rainfall

Statistic	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	454.3	481.9	295.4	136.6	70.1	30.8	20.7	27.5	35.6	57.4	153.4	217.1	1900
Lowest	48.2	52.2	43	11.2	1.4	0	0	0	0	0	3.6	54.2	1154.8
5th %ile	65	95.8	77.2	22.9	2.9	1.4	0	0	0	1.1	12.4	67.2	1230.7
10th %ile	112.6	130.6	94.8	31.9	15.7	2.5	0	0.1	0.8	14.8	19	76.7	1287.4
Median	384.2	422	199.9	99.1	53.4	17.8	15.6	10.3	10.2	43.2	90.2	157.4	1793.4
90th %ile	983.2	959.9	568.2	314	136.1	74.8	45.8	61.5	94.9	116	329.5	394.4	2873
95th %ile	1233.3	1101.6	682.5	350.2	191.6	94.4	57.2	84.9	106	171.9	423.7	509.7	3143
Highest	1457	1324.8	1092.6	384.2	381.8	140.2	109.9	241.6	247.2	194.8	760.2	1111.3	3289.2

The mean average for Rollingstone is 1592.7 mm and Mutarnee is 1900 mm compared with Townsville Airport at 1110 mm. No records were available for temperatures and max. wind speed gusts.

No rainfall data was available for the Paluma area where it is expected that rainfall would be higher again.

The study area is subject to the same cyclone activity as the Townsville area.

## 1.1.5 Population and Settlement

The 2006 census population and the DLGP forecast for the area is summarised in table 1.3.

Э											
	Year	Low	Medium	High							
	2006		63002								
	2011	84393	86099	88607							
	2016	104099	108419	115268							
	2021	118654	124878	135825							
	2026	129914	137333	151735							

Table 1-3 Forecast Population

The median projection for the study area is 137,333 to June 2026 at an annual growth rate of 4.8% from the 2006 population. The majority of this population will be in urban detached dwellings but with an increasing trend towards units.

The 2006 population distribution per Census Collection District (CCD) is shown in figure 1.2 below.



Figure 1.2 Population densities no./sq km

The Thuringowa area has an average population density of 39 persons per sq. km. The densities across the 97 CCDs used in 2006 range from 0 in Beach Holm to 1582 pop/sq km in a Kirwan CCD.

There are 89 CCDs in the study area and they were grouped into eight (8) risk assessment zones. The groupings were based on like areas as described in the zone name. Paluma is a unique area perched atop the Paluma Range and was considered separately. These risk zones are shown in table 1.4.

ZONE	RISK ZONE	DESCRIPTION	AREA (SQ KM)	POPULATION	
1	Paluma	Paluma	414.38	144	
2	Nth Beaches	Bohle River to Crystal Creek; Bruce Hwy to coast	216.76	7718	
3	Inland	Bohle River to Crystal Creek; Bruce Hwy to ranges	1196.17	9663	
4	Kirwan East	Kirwan east of Thuringowa Drive	3.54	8321	
5	Kirwan Mid	Kirwan between Thuringowa Drive and Kern Drive	3.52	7099	
6	Kirwan West	Kirwan west of Kern Drive to Bohle River	5.99	7684	
7	Lower Upper Ross	Condon and Rasmussen	11.61	9843	
8	Upper Ross	Kelso	16.30	8698	

## 1.1.6 Land Use

The land use in the area is predominately agricultural crops in the north (mainly pineapples and sugar cane) and beef cattle in the balance of the rural areas with some orchards (mangoes) and fish farms closer to the urban areas. There are some smaller pursuits in the rural residential areas such as turf farming.

There are also large areas of public land such as the Clement State Forrest and the Wet Tropics reserved area.

## 1.2 THE HISTORICAL CONTEXT

Thuringowa was initially a shire that surrounded the small port township of Townsville. As the population of Townsville grew the boundary between the two was moved to include the urban overspill areas of Thuringowa into the Townsville local authority area. There have been a number of these boundary alterations over the period until finally both local authorities were amalgamated in March 2008.

Thuringowa has a long rural history and its population has strong links to the Townsville City area. The Aboriginal and European history described in the initial Townsville study applies equally to this study.

#### 1.3 LAND MANAGEMENT

As mentioned in the Townsville study, land tenure has a bearing on the management of natural hazards. The various land tenure and management jurisdictions are the same in Thuringowa only the numbers of properties varies.

## 1.4 OTHER SPECIAL INTERESTS

The range of special interest groups identified in the initial report also has an interest in this study area. These being:

- Landcare groups;
- Coastcare groups;
- Environmental groups;
- Tourist industry groups and
- Development industry.

#### 1.5 LEGISLATION AND STANDARDS

The legislation and standards identified in the initial report are also applicable to this study area except for the former Thuringowa City planning Scheme.

Section 5.4, Natural Hazards, of the Thuringowa City Planning Scheme has the provisions for development shown in table 1.5.

Natural Hazard	Planning Scheme Requirement
Flooding	Finished floor levels to be above the defined flood event and habitable floor level to be 450mm above the defined flood event.
Steep or Unstable Land	No building on land over 15% slope
Acid Sulphate Soils	No excavation below 5 m AHD
Storm Surge	Floor height to be above 3.9m AHD
Bushfire	20m clear of bushland and other provisions
Salinity	No condition

#### Table 1-5 Planning Scheme Requirements

With respect to the Disaster Management Act 2003 the "disaster response responsibilities" stated in the initial report apply equally to Thuringowa.

#### 1.6 THE HAZARDS

Similarly to the initial study the hazards considered in this study are:

- Tropical Cyclones and Severe Storms
- Floods (including the potential failure of Ross River Dam)
- Storm Tides
- Bushfires
- Landslides
- Earthquakes
- Climate Change (effect on frequency and severity of above hazards)

The most recent hazard studies undertaken in the area are shown in table 1.6.

Locality / Stream	Year	Brief Description	Report no.
Bohle Plains Flood Planning Report	2010	The major watercourses on the Bohle Plain. Includes Bohle River, Saunders Creek. Stoney Creek and Black River.	
Ross River	2001	Ross River hydraulic study	639
Toolakea	2008 2004	Toolakea Beach flood study Toolakea Beach flood study	Not reg 624
Bluewater	2001 1998 1993	Bluewater Ck flood study Bluewater Ck flooding 1998 Bluewater Ck flood study	512 395 385
Purono Pk	2000	Purono Pk flood study	509
Black River	1998 2002	Black/Bohle coastal assessment Black River Geomorphological and Stabilisation Study	355 Not reg.
Rollingstone/Hencamp Creeks		Model developed for reaches of the creeks from the Bruce Highway to the coast.	
Crystal Ck	1998	Bank erosion	392, 360
Regional	2003	Cyclone wind damage model (CTS and SEA 2003	
Ross Dam	2005	Ross Dam upgrade risk analysis	
Regional	2006	Earthquake risk assessment (CERA 2006)	
Coastal	2007	Storm tide study (GHD and SEA 2007)	

#### Table 1-6 Recent Hazard Studies

The notable exceptions to the studies undertaken to date for Thuringowa are:

- Earthquake;
- Bushfire and
- Landslide

Studies of these hazards were commissioned as part of this report and the results are discussed in the vulnerability, risk analysis and treatment chapters of this report.

## 1.7 RISK MANAGEMENT METHOLOGY

An identical risk management method was adopted for this study area. This method is based on the Risk Management – Principles and Guidelines AS/NZS ISO 31000:2009.

The outcomes and strategies identified in the initial Townsville Study were workshopped by the SAG and were accepted as applying equally to the former Thuringowa LGA.

## 1.8 EVALUATION CRITERIA

The tolerable or acceptable level of community risk established in the initial report have been adopted for this report. For completeness these levels of hazard severity are repeated in the following table 1.7.

Table 1-7: Notional 'design' level of hazard severity employed in the Townsville region

HAZARD	THRESHOLD	COMMENTS
Destructive wind	500 year ARI	Established in the wind loading standard of the BCA since about 1981.
		This has been the threshold for development in the planning scheme for many years, but it has been increased to
Flood	50 year ARI	the 100 year ARI level in the past few years.
		Established under the State Coastal
		Management Plan and implemented since
Storm tide	100 year ARI	2005.
Landslide	Planning boundary only	Established under SPP 1/03 and implemented since 2004.
Bushfire	Planning boundary only	Established under SPP 1/03 and implemented since 2004.
Earthquake	500 year ARI	Established in the earthquake loading standard under the BCA since about 1985

Again for consistency this study has adopted the same likelihood of between 50 to 100 years ARI as was adopted in the initial report. An identical evaluation criteria was utilised for this study. These criteria are as follows:

- "1. reduce, and preferably eliminate, the risk of death or injury to emergency workers engaged in responding to any hazard impact;
- 2. reduce, and preferably eliminate, the risk of death or injury to the general population;
- 3. reduce, to an acceptable level, the risk of destruction or damage to public infrastructure and facilities;
- 4. reduce, to an acceptable level, the risk of destruction or damage to private property;
- 5. manage the impact of natural hazard impacts on cultural heritage and the natural environment to the extent that loss of heritage is minimised and the biodiversity of flora and fauna is maintained;
- 6. minimise the long-term impact on the local economy."

## 2. THE HAZARDS

The hazards identified in this section are those identified in the initial study.

#### 2.1 NATURAL HAZARD TYPOLOGY

The comments given in the initial study report are also applicable to this study.

#### 2.2 TROPICAL CYCLONES AND SEVERE THUNDERSTORMS

The occurrence and impact of tropical cyclones and severe thunderstorms are a regional phenomena and the comments made in the initial report apply equally to this study area.

The destructive winds of a tropical cyclone are the most significant hazard to be considered.

#### 2.3 FLOODS

The study area contains the balance of the Ross River and Bohle River catchments and also a number of smaller coastal streams that have their source in the hinterland range that follows the coast. The Paluma area is located on the saddle between two catchments, one flowing towards the coast (Crystal Creek) and the other flowing westwards (Running River). The names of these streams and rivers are shown in Table 2.1.

The unlikely failure of the Ross River Dam would also impact the study area and the risk analysis undertaken by GHD (2005a and b) also applies to sections of this study area.

There are no flood control structures on any of the other rivers or streams in the area.

Catchments
Running River
Crystal Creek
Ollera Creek
Hencamp Creek
Rollingstone Creek
Saltwater Creek
Sleeper Log Creek
Bluewater Creek
Deep Creek
Althause Creek
Healey Creek
Black River
Stoney Creek
Saunders Creek
Bohle River
Ross River

Table 2-1 The river and stream catchments

A further flood modelling report is currently being prepared to update and map flooding of the developing areas of the amalgamated Townsville City.

City wide flood constraints mapping project objectives are:

"The primary objectives for the project are to develop city wide flood maps for widespread Council use in:

- developing overlays to the new Planning Scheme;
- identifying potential flood mitigation strategies;
- determine flood levels within the local government area;
- setting development controls (both infill and growth);
- developing Priority Infrastructure Plans for trunk stormwater infrastructure;
- understanding areas requiring attention for emergency management;
- locating critical infrastructure; and
- deciding on the Defined Flood Event (DFE) for the new Planning Scheme.

In developing the flood maps for the city it is important that:

- the impacts of climate change are considered;
- a range of storm frequencies are assessed;
- a consistent approach for the level of urbanisation is adopted across all catchments; and
- the peak flood levels are determined by reviewing all design storm durations."

The Bohle Flood Plain has been subject to flood study completed late 2009. A summary of the results of the model and the inundation levels for various ARIs are shown below in table 2.2.

Suburb	ARI	Description of Flooding
Beach Holm	50	Flooding along Svensson Road
Black River	50	Inundation of the Black River Road Bridge crossing Black River to depths of 1m
		Widespread flooding in Black River along Black River Road and Church Road
		Immunity of the Bruce Highway Bridge crossing Black River
		Inundation of properties bordered by the highway and North Coast Railway to the west of the Bohle River
		Immunity of the North Coast Railway crossing Black River
		Inundation of properties along Bowden Road bordering the Black River
Burdell	50	Inundation of properties bordering Stony Creek in Kingston Park
		Inundation of Kayleen Court
		Immunity of the North Shore Boulevard crossing of Saunders Creek
<b>Bushland Beach</b>	50	Inundation of Coutts Drive
Bohle	2	Inundation of the Northbound Bruce Highway Bridge crossing the Bohle River
	50	Minimal Inundation of the North Coast Railway Bridge (4 mm)
	100	Immunity of the Southbound Bruce Highway Bridge
Condon	2	Significant Inundation of Bowhunters Road (3.4 m

Table 2-2	<b>Bohle Plains Catchment</b>	- Flood Inundation	(AECOM,	2009	Table
Ex-1)			•		

Suburb	ARI	Description of Flooding
		Approximately)
	50	Inundation of properties around Gollogly Lane Beck Drive intersection
		Inundation of properties bordering Rivergum Court including road itself
		Inundation of areas to the west of Beck Road south of Herveys Range Road
	100	Inundation of Gollogly Lane
		Inundation of properties around Gollogly Lane Beck Drive intersection
		Inundation of properties bordering Rivergum Court including road itself
		Inundation of Chardonnay Drive
		Inundation of Chelsea Drive
		Inundation of areas to the west of beck Road south of Herveys Range Road
		Immunity of the Ring Road crossing the Bohle River
Deeragun	50	Inundation of properties on the southern boundary of Geaney Lane bordering the bridge
		Immunity of the Geaney Lane Bridge
		Breakout flows at the Geaney Lane bridge
		Inundation of properties bordering Stony Creek in Hansen Court and Brenton Circuit
		Immunity of the upgraded Bruce Highway crossing Stony Creek
		Immunity of the existing Bruce Highway crossing Stony Creek
		Immunity of the North Coast Railway crossing Stony Creek
		Inundation of Woodland Court
		Immunity of Northbound Bruce Highway Bridge crossing Saunders Creek
		Immunity of Southbound Bruce Highway Bridge crossing Saunders Creek
		Immunity of North Coast Railway Bridge crossing Saunders Creek
Gumlow	50	Inundation of properties between the Little Bohle River and Herveys Range Road
		Breakout flows from Little Bohle River to Bohle River
		Breakout flows from the Bohle River over Bohle Road
	100	Inundation of properties between the Little Bohle River and Herveys Range Road
		Breakout flows from Little Bohle River to Bohle River
		Breakout flows from the Bohle River along One Mile Drive
		Breakout flows from the Bohle River over Bohle Road
Jensen	50	Significant inundation of the Jensen Transfer Station Borrow Pits
		Inundation of properties bordering Stony Creek in Kilcora Street
		Inundation of properties bordering Stony Creek in Kingston Park

Suburb	ARI	Description of Flooding
Kelso	2	Inundation of properties directly adjacent to Kelso Drive drainage channel
		Inundation of properties within Tennessee Way
		Inundation of properties bordering Carbine Court
		Inundation of properties bordering Kensei Court
		Inundation of properties in Hammond Way - directly bordering Blacks Gully and the Bohle River
		Minimal inundation of Melrose Court
		Inundation of Wayne Street
		Significant Inundation of the Allambie Lane crossing of the Bohle River (Approximately 3m)
	5	Inundation of properties bordering Kelso Drive between the Bohle River and Blacks Gully
		Inundation of properties bordering Carbine Court
		Inundation of Properties bordering Beerborough Court
		Inundation of properties within Tennessee Way
		Inundation of properties within Hammond Way
		Inundation of Melrose Court
		Inundation of Wayne Street
	50	Inundation of properties bordering Kelso Drive between the Bohle River and Blacks Gully
		Inundation of properties bordering Carbine Court
		Inundation of Properties bordering Beerborough Court
		Inundation of properties within Tennessee Way
		Significant inundation of properties within Hammond Way
		Significant inundation of Melrose Court
		Bohle Plains Flood Planning Report AECOM
		Inundation of Wayne Street
		Significant Inundation of Allambie Lane crossing
		Breakout flows to the west of Allambie Lane
	100	Significant inundation of properties bordering Kelso Drive between the Bohle River and
		Blacks Gully
		Significant inundation of properties bordering Carbine Court
		Significant inundation of Properties bordering Beerborough Court
		Significant inundation of properties within Tennessee Way
		Inundation of Welsh Court
		Inundation of Oldenburg Place
		Significant inundation of properties within Hammond Way
		Significant inundation of Melrose Court
		Inundation of Wayne Street
		Significant Inundation of Allambie Lane
		Inundation of areas bordered by the Bohle River and Shetland Place
		Breakout flows to the west of Allambie Lane
Kirwan	2	Significant Inundation of Dairymple Road crossing of the Bohle River

Suburb	ARI	Description of Flooding
	5	Minimal Inundation of Herveys Range Road crossing the Bohle River (100 mm)
	50	Inundation of Saint Andrews Close
		Inundation of Willows Golf Course
	100	Significant Inundation of properties at St Andrews Close
		Inundation of Nineteenth Avenue
		Breakout flows from Herveys Range Road joining flooding in Willows Golf Course
		Significant inundation of Willows Golf Course
Mount Low	50	Flooding along Svensson Road
		Inundation of properties along Mount Low Parkway
		Inundation of properties bordering Stony Creek in Kilcora Street
		Immunity of the North Shore Boulevard crossing of Stony Creek
Rasmussen	50	Inundation of flood storage area bordering Glenrock Drive
		Inundation of flood storage area bordering Feeney Avenue
		Breakout flows to the west of Allambie Lane
	100	Significant Inundation of Allambie Lane
		Inundation of properties bordering flood storage area bordering Glenrock Drive
		Inundation of properties around Feeney Avenue
		Inundation of Gollogly Lane
Shaw	2	Minimal inundation of Tompkins Road
	5	Minimal inundation of Tompkins Road
	50	Inundation of properties bordering Tompkins Road to the north
	100	Inundation of Tompkins Road

The Ross River catchment for this study area is wholly contained behind the Ross River dam. Apart from the dam hazard study no additional flood study has been undertaken.

As mentioned above there have been a number of flood studies in various catchments but not all catchments have been studied. Further inundation studies are required in the more urbanised areas of City and Northern Beach zones to indicate the flood level to the major access roads into the areas for various ARIs.

The dam failure study undertaken by Maunsell (2001) is applicable to the parts of the study area adjacent to the Bohle River.

The BoM also has a network of automatic weather stations (AWS) across the study area together with stream gauges.

There is a history of flash floods in the study area especially:

- Crystal Creek
- Rollingstone/Hencamp Creeks
- Bluewater Creek
- Deep/Healey/Althause Creeks

- Black River
- Stoney Creek
- Saunders Creek and
- Bohle River

The Time of Concentration of some of these catchments is small (a few hours) and the current Alert system has been found to be inadequate in some instances but no better alternative or improvement has been found.

#### 2.4 STORM TIDE

The comments on storm tide in the initial report apply equally to this study area.

Table 2.3 provides an estimate, from the GHD and SEA Storm Surge Study Report, of the inundation depths above the highest astronomical tide (HAT) for various locations along the coast of the study area.

Return Periods (metres) (from GP	ID and S	EA, 2007 I	able 6-2)		
Site	50y	100y	500y	1000y	10000y
Crystal Creek	0.6	1.0	1.9	2.0	5.2
Ollera Creek	0.6	0.9	1.1	1.8	4.6
Road End (Moongabulla)	0.4	0.5	1.2	1.8	4.8
Mutarnee	0.5	0.9	1.9	2.6	4.5
Balgal	0.6	0.9	1.9	2.4	4.1
Rollingstone	0.4	0.7	1.7	2.3	3.9
Mystic Sands	0.6	0.9	1.9	2.6	4.1
Surveyors Creek	0.6	0.9	1.4	1.6	3.9
Toomulla	0.4	0.7	1.6	2.1	3.5
Leichhardt Creek	0.1	0.3	0.9	1.4	3.4
Christmas Creek	0.4	0.4	0.8	1.3	3.5
Toolakea	0.4	0.7	0.9	1.3	3.2
Bluewater Beach	0.4	0.6	0.9	1.2	3.2
Deep / Healy Creek	0.6	0.8	0.9	1.3	3.2
Saunders Beach	0.4	0.7	1.4	1.9	3.4
Black River	0.4	0.4	0.8	1.2	3.2
Bushland Beach	0.5	0.8	1.5	1.9	3.2
Bohle River	0.1	0.2	0.7	1.0	2.7

Table 2-3 Estimated Storm Tide Inundation Depths above HAT for Selected Return Periods (metres) (from GHD and SEA, 2007 Table 6-2)

Warnings of estimated storm tides generated by Tropical Cyclones are issued by the BoM as part of their cyclone warnings system.

#### 2.5 LANDSLIDES

The general comments on Landslides in the initial report apply equally to this study area.

There are no previous reports on landslides for the study area and the Planning Scheme provision states:

"Building work must not be permitted on premises with a slope exceeding 15%."

The planning provision goes on to quote the SSP (1/03) requirements.

As part of this study, Pells Sullivan Meynink was commissioned to investigate the landslide potential for developed areas and areas indicated for future rezoning under the former Thuringowa planning scheme. Landslide risk zone maps have been produced and will be available on Council's GIS.

Only low and very low risk areas were identified within the study areas investigated.

#### 2.6 BUSHFIRES

The comments on Bushfire in the initial report apply equally to this study area. Queensland Fire and Rescue under the requirements of the SPP (1/03) have produced a risk analysis map for the region dated June 2008. The map is available on the following site:

http://www.ruralfire.qld.gov.au/Bushfire Safety/Building in Bushfire Prone Are as/Shire Risk Maps Page.html

This map is currently being updated and the revised map is expected to be available in 2010.

As part of this study Council commissioned C&R Consulting to undertake a Bushfire Hazard Study for the amalgamated Townsville City Council. This report updates Townsville's bushfire mapping to the current SPP 1/03 and AS 3959-2009 requirements and will be available on Council's GIS.

## 2.7 EARTHQUAKES

## 2.7.1 Earthquake History

The Centre for Earthquake Research in Australia (CERA) was commissioned by Council to undertake a further Earthquake study of the former Thuringowa area. CERA undertook the initial Townsville earthquake study.

Earthquakes are a regional phenomenon and the comments, history etc of earthquakes in the initial IID report are applicable to this area and as modified by the more recent CERA (2010) report.

The following figures 2.1 and 2.2, from the CERA (2010), indicates the locations of recorded seismic activity within the Townsville and Thuringowa region.

When an earthquake happens there is the potential for a number of hazards to occur being:

- Ground failure (faults, cracking)
- Ground shaking
- Ground movement amplification
- Ground liquefaction (quicksand)
- Seiche (tilting or oscillating)

Any of these conditions may result in secondary hazards such as fire, pollution, flooding, health issues, landslides, failure of critical infrastructure etc.



Figure 2.1: Epicentres Of Earthquakes With MI >3.0 That Have Occurred In North Queensland

(Epicentral Distances Within 400km From Townsville).

Closed Circles – Earthquakes that affected the populous

Open Circles – Earthquakes with no reported effects



Figure 2.2: Seismicity In The Coral Sea Basin At Distances Of About 300-1000km From The City Of Townsville

The report compiled by CERA indicates that the former Thuringowa area is considered to have an

Earthquake Hazard rating LOW.

The report also states that:

In deliberations of the QDES-SCDO (Queensland Department of Emergency Services - State Counter Disaster Organisation) State Mitigation Committee, a <u>qualitative</u> preliminary Earthquake Hazard Map (2000, unpublished) was prepared (FIGURE 17). This map is a guide for the relative hazard potential for the State of Queensland as a whole (based on the hazard maps of Rynn, 1987, 1989; Gaull et al, 1990; Jaume et al, 1997). The former City of Thuringowa has an assigned

#### **RELATIVE EARTHQUAKE HAZARD POTENTIAL OF 3 (low to medium level).**

The CERA(2010) report also states that **CAUTION MUST BE EXERCISED** in interpreting earthquake hazard assessment especially in regions with a LOW levels of activity and it would be easy to underestimate the potential.

## 2.7.2 Earthquake Study

The initial IID study of the former Townsville area identified site classes based on the notional soil geomorphology of the site. These soil classes were then utilised to analyse and rank the earthquake risk across the risk zones. The CERA (2010) study commissioned for this project did not support this approach because there is not enough information available. Following is the comment included in the report:

"The Soil Classes classifications (soil geomorphology) as used with the AGSO Cities Project were very preliminary at least, and very generalised at best, and really based on the US Geological Survey studies in California. Indeed CERA/TVL/2006 did not provide any analyses because no reliable definitive studies were available. Specific studies for Australia currently still remain in progress at Geoscience Australia. Caution shall be exercised in using the "notional" site classes IID (2009) map of Figure 2.25. it would necessitate a specific geotechnical study to accurately define site classes and then consider the potential for amplification and liquefaction effects from earthquake."

## 2.8 CLIMATE CHANGE

Climate Change is a global event and no additional comments to those made in the original report can be made concerning the former Thuringowa area. The comments on Climate Change in the initial report apply equally to this study area.

The effect of climate change on the natural hazards identified in this report was included as part of the study into the hazards. Council, through Integrated Sustainability, has also commissioned a separate report into climate change in the Townsville LGA and the results of this study will be presented separately to Council in the near future.

## 3. THE ELEMENTS AT RISK AND THEIR VULNERABILITY

The six main groups potentially exposed to risk adopted in the initial study have also been adopted in this study. These being:

- Buildings and property;
- People;
- Lifeline infrastructure;
- Economic activity;
- Environment and
- Institutions

#### 3.1 DATA SOURCES AND ASSUMPTIONS

To quantify the number of buildings, infrastructure and people being exposed to natural hazard risks Council's GIS system was utilised.

In quantifying the vulnerability of the population, as with the initial study, the 2006 census data was utilised. To simplify this process the study area has been divided into 8 risk assessment zones as described in chapter 1. The 8 zones were chosen so as to group communities together that are exposed to similar risks and are of a similar population. Paluma was selected as a unique case as the majority of the population is located on the top of the Paluma Range and exposed to different natural hazards to the balance of the former Thuringowa. These risk zones are shown in table 3.1.

RISK ZONE	DESCRIPTION
Paluma	Paluma
Nth Beaches	Bohle River to Crystal Creek; Bruce Hwy to coast
Inland	Bohle River to Crystal Creek; Bruce Hwy to ranges
Kirwan East	Kirwan east of Thuringowa Drive
Kirwan Mid	Kirwan between Thuringowa Drive and Kern Drive
Kirwan West	Kirwan west of Kern Drive to Bohle River
Lower Upper Ross	Condon and Rasmussen
Upper Ross	Kelso

#### Table 3-1: Study area risk assessment zones

#### 3.2 DEVELOPED PROPERITIES

Following is a summary of the existing properties located in the zones as classified in the table above. The information on the building types available in the Thuringowa area is slightly different from the classifications arrived at for the Townsville study but the end result is felt to be similar.

The categories for properties are:

- Business commercial, industrial and professional facilities including factories, shops and offices;
- Community Facilities including churches, halls, scout and guide huts, libraries, recreation facilities, government services
- Public Safety Police, fire, ambulance, SES, defence force, medical (incl hospitals and nursing homes). These are classed as critical infrastructure.
- Residential all detached dwellings, units including rural properties.
- Utility telecommunications (mobile phone towers, telephone exchanges), electrical power (power stations, substations), water

# supply (treatment plants, dams, weirs, reservoirs); sewerage (treatment plants, pump stations)

This distribution is shown in table 3.2.

Risk Zone description	Total Business	Community	Public Safety	Total Residential	Utility	Total
Paluma (unique area)	1	2	2	232	6	243
Beaches - Bohle to North / Hwy to Coast	21	11	6	5478	20	5536
Inland - Bohle to North / Hwy to Inland Boundary	30	13	5	5003	12	5063
Kirwan East - T'gowa Dr to East	163	5	7	2829	7	3011
Kirwan Mid - T'gowa Dr to Kern Dr	134	7	5	2309	6	2461
Kirwan West - Kern Dr to Bohle river	37	6	0	3326	5	3374
Condon Rasmussen	91	10	3	3478	10	3592
Kelso	5	2	1	3740	8	3756
Total	482	56	29	26395	74	27036

#### Table 3-2: Study area risk assessment zones and developed properties

The numbers of Business and Residential properties were determined from the population growth model being developed by Council while the Community, Public Safety and Utility facilities were determined from phone book counts, Council's property services department and local knowledge. The telecommunications facilities may be understated as there are a number of private companies operating mobile phone networks and it was difficult to locate their towers. (Microwave link towers are out of service with the introduction of the optical cable network.)

The type of critical and sensitive facilities detailed in the initial report is also relevant to this study area.

## 3.3 POPULATION DISTRIBUTION

The Thuringowa area has an average population density of 39 persons per sq. km. spread across the 97 CCDs used in 2006 census. The density ranges from 0 in Beach Holm to 1582 pop/sq km in a Kirwan CCD.

The major population centre reside the Kirwan and Upper Ross area. This area is typical urban overspill from the former Townsville City urban population area. The urban expansion is now concentrated in the Bohle Plains, Burdell, Deeragun, Mount Low and Bushland Beach areas. 70.38% of the population resides in the Kirwan / Upper Ross area while 16.12% of the population resides in the northern beach suburbs. Only 1.05% of the population resides in the fully rural areas and the remainder of the population resides in rural residential settlements and smaller townships. This distribution is shown in table 3.3.

RISK ZONE	DESCRIPTION	AREA (SQ KM)	POPULATION
Paluma	Paluma	414.38	144
Nth Beaches	Bohle River to Crystal Creek; Bruce Hwy to coast	216.76	7718
Inland	Bohle River to Crystal Creek; Bruce	1196.17	9663

RISK ZONE	DESCRIPTION	AREA (SQ KM)	POPULATION
	Hwy to ranges		
Kirwan East	Kirwan east of Thuringowa Drive	3.54	8321
Kirwan Mid	Kirwan between Thuringowa Drive and Kern Drive	3.52	7099
Kirwan West	Kirwan west of Kern Drive to Bohle River	5.99	7684
Lower Upper Ross	Condon and Rasmussen	11.61	9843
Upper Ross	Kelso	16.30	8698
Total		1868.27	59170

## 3.4 LIFELINE INFRASTRUCTURES

As described in the initial study, the interdependence of lifeline assets also applied to this study area. The Interdependence table is repeated in table 3.4 for information.

		. micrucy	aller Granger, 1557							
	POWER	WATER	SEWER	COMMS	ROAD	RAIL	AFLD	PORT	FUEL	
POWER		S	S	S	М	М	S	М	S	
WATER	М		S					М		
SEWER		S						М		
COMMS	S	S	S		М	S	S	S		
ROAD	М	М	М	М		М	S	S	S	
RAIL					М			S	S	
AFLD										
PORT									S	
FUEL	S				S	S	S	S		

Table 3-4: Interdependence of lifeline assets (after Granger, 1997)

The earthquake report from CERA (2010) includes a more comprehensive listing of interdependencies and priority matrix. This is shown in table 3.5.

Table 3-5: Interdependence matrix for infrastructure – lifeline components (after CERA 2010)
For potential earthquake impact on the former City of Thuringowa as a whole within approximately the first week
following the event.

NOTE: Columns are dependent on Rows	Water	Sewerage System	Septic System	Drainage Stormwater	Food Supplies	Fuel Supplies - Petroleum/Diesel	Fuel Supplies -Gas	Electricity - Mains	Electricity - Standby	Communications - Telephone	Communications - Telemetry	Communications - Emergency	Media - Broadcasting Radio	Media - Broadcasting - Television	Media - Newspaper	Transport - Road	Transport - Rail	Refuse	Evacuation Shelter	TOTAL IMPORTANCE
Water		3	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3	12
Sewerage System	0		0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4
Septic System	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
Drainage Stormwater	0	0	1		1	1	0	0	0	0	0	0	0	0	0	1	1	0	1	6
Food Supplies	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	3	6
Fuel Supplies - Petroleum/Diesel	3	0	2	0	3		2	0	3	1	1	2	2	2	2	3	3	2	3	34
Fuel Supplies - Gas	0	0	0	0	0	0		0	0	0	0	0	0	0	0	2	0	0	2	4
Electricity - Mains	3	3	0	0	3	3	3		0	3	3	3	3	3	3	3	3	0	3	42
Electricity - Standby	3	3	0	0	3	3	1	0		3	3	3	3	3	3	1	1	0	3	36
Communications Talanhana	4	4	0	4	<u> </u>	_		_			_						~	~	0	00

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NOTE: Columns are dependent on Rows	Water	Sewerage System	Septic System	Drainage Stormwater	Food Supplies	Fuel Supplies - Petroleum/Diesel	Fuel Supplies -Gas	Electricity - Mains	Electricity - Standby	Communications - Telephone	Communications - Telemetry	Communications - Emergency	Media - Broadcasting Radio	Media - Broadcasting - Television	Media - Newspaper	Transport - Road	Transport - Rail	Refuse	Evacuation Shelter	TOTAL IMPORTANCE
Communications - Telemetry	2	2	0	0	0	0	0	3	1	3		3	3	3	3	2	3	0	1	29
Communications - Emergency	1	1	1	1	1	1	1	1	1	1	1		2	2	3	1	1	0	3	23
Media - Broadcasting - Radio	2	2	1	1	1	1	1	1	0	1	0	0		1	2	1	0	0	3	18
Media - Broadcasting - Television	1	1	0	0	0	1	0	0	0	1	0	0	0		0	0	0	0	1	5
Media - Newspaper	1	1	1	1	1	1	1	0	0	0	0	0	0	0		1	0	0	3	11
Transport - Road	3	2	3	0	3	3	3	3	3	3	3	2	1	2	1		3	3	3	44
Transport - Rail	0	0	0	0	3	3	2	0	2	1	1	1	0	0	0	0		0	0	13
Refuse	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0
Evacuation Shelter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL DEPENDENCE	20	19	14	4	25	20	16	11	12	17	14	17	17	19	20	17	17	5	41	
	32	23	17	10	31	54	20	53	48	55	43	40	35	24	32	61	30	5	41	
DEPENDENCE: 3=HIGH; 2=MEDIUM; 1 Priority Factor = Importance + Dependence	=LO' ;	W;	0=N	ONE	•															

To maintain consistency with the initial report the interdependence matrix in table 2.4 was accepted.

## 3.4.1 Roads

There is approximately 665.6 km of roads in the study area. The most important roads are the Bruce Highway and the City ring road. The density of roads and the type of road is shown in the following table 3.6. The CCD with the highest concentration of roads is in Kirwan east at 23.45 km/sq km. There are a number of CCDs with low km but there are few residents in these areas.

Risk Zone description	Sealed	Unsealed	Km/sq km
Paluma (unique area)	12.01	17.71	0.07
Beaches - Bohle to North / Hwy to Coast	134.77	18.72	0.71
Inland - Bohle to North / Hwy to Inland Boundary	143.94	78.57	0.19
Kirwan East - T'gowa Dr to East	48.66	0.00	13.75
Kirwan Mid - T'gowa Dr to Kern Dr	34.30	0.00	9.75
Kirwan West - Kern Dr to Bohle river	50.53	0.00	8.43
Condon Rasmussen	56.38	0.50	4.90
Kelso	69.51	0.00	4.26
Total	550.09	115.51	0.36

Table 3-6: Study area road network by assessment zone.

## 3.4.2 Rail

The QR main north south rail corridor follows the coast through the length of the study area and is approximately 65 km in length. And in places is as close as 1.5 km from the coastline. The rail link is particularly vulnerable to washout from the numerous small localised gullies and streams that drain from the range foothills to the coast.

## 3.4.3 Airport

The regional airport is situated in the former Townsville City area and was covered in the initial Natural Disaster report. There is a disused private air strip just to the north of Rollingstone. This is occasionally use by army helicopters during exercises but is unsuitable for light aircrafts unless extensive upgrading is undertaken.

## 3.4.4 Port

The Port of Townsville and fuel storage depots were treated in the original Townsville study area and the same risks identified apply equally to the former Thuringowa area.

## 3.4.5 Power and Natural Gas

There is a peak load gas turbine (160 MW) power station at Yabulu. This power station was developed to supply the Yabulu nickel refinery but, when operational, could supply power to the local grid.

There is a total of 1,018 km of high voltage and reticulation power lines and cables supplying the former Thuringowa area. This is made up of the classes and lengths as shown in table 3.7 following.

Class	Length (km)
HV Line	596
HV Cable	109
TR Line	313
TR Cable	0.45

Table 3-7: Class and length of electrical supply

There is 109.5 km of underground cables. All the new residential development, since about 1984, have been required to include underground reticulated electrical supply and in addition Ergon Energy has an ongoing program to underground its critical high voltage supply to make the area's electrical network cyclone resistant.

There are also 9 sub-stations identified in the area. Of these there are 6 in zone 2 with 1 in each of zones 3, 7 and 8.

A high pressure natural gas pipeline, owned and operated by Chevron Australia, connecting Townsville to the Bowen Basin gas field has also been installed through the rural area. It follows a route to the south of the Ross River Dam then to the north west of the Upper Ross suburbs, following Black River Road and onto Yabulu. The pipeline also supplies the Townsville suburb of Stuart. The approximate length within the former Thuringowa area is 35.3 km. Figure 3.1 below indicated the approximate location of this pipeline. This gas supply is mainly utilised by industry and is owned and operated by Chevron Energy.



Figure 3.1 Route of natural gas pipeline

There is some limited reticulated natural gas supplied to residential areas. This is limited to the newer suburbs and is generally supplied via holding tanks within each suburb. Origin Energy operates and maintains this network. The following figure 3.2 shows the suburbs with reticulated gas and are in the western Kirwan area, Bohle Plains and in the new area of Burdell.



Figure 3.2 Reticulated gas network within Townsville

## 3.4.6 Water Supply

The urban areas and some rural residential areas of the study area are serviced by 612.8 km of reticulated pipeline operated by Townsville City. The water is sourced from Paluma Dam and Ross River Dam. At present the Paluma Dam water receives only primary treatment but will be treated by the new Kinduro treatment plant at Rollingstone by the end of 2010. The majority of the reticulated supply is underground but one of the supply pipelines from the Paluma Dam / Crystal Creek intake is above ground for its entire length through the study area.

There are six storage reservoirs within the former Thuringowa area. Their locations are indicated in table 3.8 below.

Reservoir	Location
Paluma ground storage	Paluma township
Rollingstone	West of Hway, opposite Rollingstone Hotel
Deep Creek	West of Hwy at Deep Creek south of
	Bluewater
Kilburn	Mt. Kilburn
Bushland Beach	Mount Low
Mt Margaret	Mt. Margaret, Alice River
Ponti	Mount Stuart foothills, opposite Ponti Rd,
	Kelso

Table 3-8: Water Reservoirs in former Thuringowa

The reticulated water within the Kirwan / Upper Ross areas is treated at the Douglas Treatment Plant within the former Townsville and the storage reservoirs are on the foothills of Mt Stuart.

## 3.4.7 Sewerage

The sewer network is confined to the urban areas with an extensive network in the urban zones but with only some of the Northern Beaches zone being sewered. There is a major sewer treatment plant in Condon (urban zones) and minor plants at Toomulla, Bushland Beach and Deeragun.

It is planned that the flows to the Condon, Deeragun and Bushland Beach plants will be diverted to Mt. Saint John Plant (within the former Townsville City area) and these plants to be decommissioned. The plant at Toomulla will to be retained.

There is a total of 322.38 km of gravity sewer pipe, 22.42 km of sewer pressure mains and 57 sewer pump stations within the area.

Table 3.9 below gives the distribution of power, gas, water, sewer and sewer pump stations in the study area.

Risk Zone description	Sewer Gravity Mains	Water Mains	Sewer Pump Stations	Sewer Pressure mains	Natural Gas Pipeline	Power Lines (km)
Paluma (unique area)	0.00	2.73	0	0.00		82
Beaches - Bohle to North / Hwy to Coast	53.55	166.96	15	6.30	3	245
Inland - Bohle to North /	22.53	139.10	8	1.42	32.3	450

Table 3-9: Summary of Lifeline Infrastructure

Risk Zone description	Sewer Gravity Mains	Water Mains	Sewer Pump Stations	Sewer Pressure mains	Natural Gas Pipeline	Power Lines (km)
Hwy to Inland Boundary						
Kirwan East - T'gowa Dr to East	40.34	45.66	5	1.76		19
Kirwan Mid - T'gowa Dr to Kern Dr	54.84	62.65	6	1.76		19
Kirwan West - Kern Dr to Bohle river	41.50	47.04	5	1.76		30
Condon Rasmussen	61.49	68.40	10	6.45		58
Kelso	48.15	80.27	7	2.96		54
Total	322.38	612.82	57	22.42	35.3	957

## 3.4.8 Telecommunications

The telephone network in the area is mainly underground and consists of copper wire and a growing quantity of optical fibre. The main route for connections to areas outside the study area is along the Bruce Highway corridor. Telstra operates a major exchange in Kirwan and minor exchanges in various other locations. Telstra also has a number of microwave link and mobile phone towers. There are also private operators providing a communication service.

There is also 2 way radio and satellite communications available. Restricted radio bands are operated by the Police, Ambulance, Fire Service, Council, Defence etc. The citizen band radio is also available with a repeater on Mt. Stuart. Satellite communications require the use of special handsets which a currently not in wide spread use.

The commercial Television and AM FM radio broadcasts are also available but are transmitted mainly from Mt. Stuart which is outside the study area.

## 3.4.9 Logistic Facilities

There are limited logistic facilities in the study area with the majority of these facilities located in the former Townsville area. There are some light industries in the suburb of Shaw in risk zone 3 and in a section of Condon in risk zone 7.

There are 9 service stations throughout the Thuringowa area retailing petrol and diesel to the general public.

## 3.5 ECONOMY

Employment by sector is shown in table 3.10 below. The largest employment sectors are retail trade, education & training and health care.

It is noted that the total number of employment opportunities in the study area is 10,638 compared to a total population of 59,170. This is approximately 16.9% of the population compared to Townsville of 49.7%. This is explained by the fact that the majority of employees in the Thuringowa area are employed in the Townsville area.

When the type of employment opportunities are compared to the state average there are a number of large differences but when combined with the Townsville

data the averages align more closely to the state averages. The exception is the public administration area and is a reflection of the army base situated in Townsville. Agriculture, forestry & fishing are also down on the state average which is a reflection of the fact that the majority of the area is not highly valued as quality agricultural land.

INDUSTRY	Employed	Study %	Townsville	Total	total %	State %
Agriculture, forestry & fishing	181	1.7	413	594	1.0	3.4
Mining	286	2.7	1112	1,398	2.4	1.7
Manufacturing	786	7.4	3573	4,359	7.5	9.9
Electricity, gas, water & waste services	29	0.3	647	676	1.2	1.0
Construction	1,506	14.2	4219	5,725	9.9	9.0
Wholesale trade	180	1.7	1422	1,602	2.8	3.9
Retail trade	1,533	14.4	4914	6,447	11.1	11.6
Accommodation & food services	798	7.5	3600	4,398	7.6	7.0
Transport, postal & warehousing	251	2.4	2297	2,548	4.4	5.1
Information media & telecommunications	38	0.4	845	883	1.5	1.4
Financial & insurance services	185	1.7	833	1,018	1.8	2.9
Rental, hiring & real estate services	215	2.0	896	1,111	1.9	2.1
Professional, scientific & technical services	464	4.4	2399	2,863	4.9	5.6
Administrative & support services	269	2.5	1291	1,560	2.7	3.1
Public administration & safety	628	5.9	6317	6,945	12.0	6.7
Education & training	1,397	13.1	4092	5,489	9.4	7.6
Health care & social assistance	1,286	12.1	5386	6,672	11.5	10.2
Arts & recreation services	163	1.5	660	823	1.4	1.3
Other services	307	2.9	1478	1,785	3.1	3.7
Inadequately described/Not stated	136	1.3	1065	1,201	2.1	2.7
Total	10,638		47459	58097		

#### Table 3-10: Thuringowa employment by industry sector (2006 census data)

## 3.6 ENVIRONMENT

The comments made in the initial report on the flora and fauna on the area applies equally to this study area.

## 3.7 VULNERABILITY OF BUILDINGS

The buildings in this study area and the initial former Townsville study area were designed and constructed by the one community and hence the techniques and materials used at the various periods of development are identical. The contribution of building characteristics to building vulnerability as shown in Table 3.6 of the initial IID (1009) report also applies to the building in this area.

The initial study looked at the vulnerability of building to the various hazards being studied. The comments made with respect to

- Engineering codes;
- Age of construction;
- Construction features and
- Design, landscaping and maintenance

apply equally to this study area.

Table 3.11 shows the percentage of building in the various risk zones that fall within the shown age categories. Existing records do not allow further division of buildings built prior to 1961.

Risk Zone description	< 1961	< 1971	< 1982	< 1992	< 2002
Paluma (unique area)	14.31%	74.35%	74.35%	88.03%	100.00%
Beaches - Bohle to North / Hwy					
to Coast	0.00%	11.87%	24.92%	56.62%	72.93%
Inland - Bohle to North / Hwy to					
Inland Boundary	4.22%	33.27%	45.72%	72.63%	92.13%
Kirwan East - T'gowa Dr to East	16.67%	20.71%	73.56%	97.16%	99.74%
Kirwan Mid - T'gowa Dr to Kern					
Dr	0.00%	0.04%	20.56%	38.73%	96.02%
Kirwan West - Kern Dr to Bohle					
river	0.00%	0.00%	6.04%	22.10%	67.40%
Condon Rasmussen	2.67%	9.47%	31.82%	55.58%	85.89%
Kelso	0.00%	4.93%	40.59%	66.51%	90.70%
Total	3.80%	20.24%	39.12%	64.60%	86.79%

#### Table 3-11: Age of Buildings

The construction of roads is an integral part of urban development. Figure 3.3 below show the kilometres of roads built each decade. The figure shows that the majority of development has occurred from the 1970's onwards.



Figure 3.3 Study area development progression

The comments made in the initial report on the types of buildings and standard of subdivisions applies equally to the construction within the former Thuringowa area.

## 3.8 VULNERABILITY OF LIFELINE INFRASTRUCTURE

The design and construction standards used for roads, drainage, water supply, sewer networks etc have varied over the period of development within this area. As a longer time record of natural hazards events has been maintained then the standards have changed to cope with these events. The result has been that the older developed areas are potentially more exposed to risk, especially flooding and wind loadings, than the newer areas.
The comments made in the initial study report with respect to the vulnerability of roads, railways, airfields, port, power supply, water supply and sewerage, stormwater, telecommunication and logistic facilities equally applies to this study area.

With respect to the high pressure **natural gas pipeline**, the supply pipeline is buried for its entire length and where it crosses a water course it has been concrete encased. The pipeline has been design to resist the natural hazards discussed in this study. The biggest risk posed to the pipeline is from an earthquake or accidental rupture by machinery. The pipeline material is polypropylene and is resistant to some differential movement of the earth. The pipeline easement is, at present, clearly marked and the owners are expected to maintain these markers in good order.

The **reticulated natural gas** system is based on above ground tanks ("bullets") in strategic locations with a local reticulation network. The tanks are refilled by tankers as required.

## 3.9 VULNERBILITY OF PEOPLE

The measurable quantities obtained from the ABS census 2006 data and used by IID (2009) in the initial report to illustrate the vulnerability of the people were adopted for this study.

The assessment is based on the following census attributes:

Physical Vulnerability

- % population under 5 years
- % population over 64 years
- % population over 64 years and living alone
- % population disables

Social and Economic Vulnerability

- % population unemployed
- % population renting
- % population on low income
- % population not volunteering for community activities
- Mobility Vulnerability
  - % households with no car
  - % single parent households
  - % large family households

Awareness Vulnerability

- % new residents in area
- % population with none or poor English
- % households with no internet access

These indicators were measured at the CCD level and then combined to the risk assessment zone level. All the indicators were then combined to give an overall community vulnerability index.

## 3.9.1 Physical Vulnerability

To assess the vulnerability of the population it was decided to divide the population into groups per CCD :

Under 5 years old, between 5 and 65 years old and over 64 years old. This demographic is shown at the risk zone level in table 3.12 and illustrated at the CCD level in figures 3.4, 3.5, 3.6 and 3.7

It was considered that the first and last age groups were more dependant on assistance to escape or recover from a natural disaster than the middle age group.

The average age of the former Thuringowa population was 32.68 years based on the 2006 census data over the 89 CCDs. The maximum average age for a CCD is 71.05 years and is situated in Condon and understandably the same CCD also has 74.36% of the population over 64 years. This high age is attributed to a large retirement village complex in this CCD.

The minimum average age is 20.43 years in a CCD in the suburb of Kirwan. This CCD is in a rapidly expanding new urban growth area which has attracted young families.

As discussed in the initial report, the young under 5 years, and the elderly, 65 years and over, are the more likely to be susceptible to natural disaster. At the 2006 census there were 4959 children under 5 or 8.38% of the former Thuringowa population. The proportion of children varied across the study area from a low of 6 in Paluma (4.17%) to a high of 874 (9.73%) in the Condon Rasmussen risk zone. At the CCD level the number varies from 0.0% in the Condon CCD mention above to 181 (12.23%) in a Kirwan CCD. This indicates that the distribution of children varied more than in the former Townsville area where the population of children varied between 3.6% and 12%. This is understandable as Thuringowa had a higher growth rate reflected in a younger average population.

The elderly population (65 and over) is 6.75% (3994) of the total population. At the CCD level this ranges from less than 2% in four CCDs in the Kirwan area to a high of 74.49% in Condon. The Condon CCD is the same as above which contains a large retirement village. At the risk assessment zone level, the highest number of elderly is in the Condon Rasmussen zone with 936 residents and the lowest in Paluma with 23 residents over 64.

The disabled population is more susceptible to the impact of disasters than any other group. There is a total of 2012 (3.40%) disabled persons within the former Thuringowa area with a maximum number of 180 (24.43%) in a Kirwan CCD and a low of 0 in two other Kirwan CCDs. At the risk zone level the highest numbers at 455 (5.47%) occurs in the Kirwan East area and a low of 7 (4.86%) in the Paluma zone.

	<u> </u>					
Zone	%<5	%>64	%>64 living	% disabled		
			alone	albabied		
Paluma	4.17	15.97	30.43	4.86		
Nth Beaches	7.83	7.96	17.10	3.41		
Inland	7.02	6.52	15.40	2.89		
Kirwan East	6.77	10.36	24.25	5.47		
Kirwan mid	9.73	3.68	14.18	2.78		
Kirwan west	9.20	3.38	26.54	1.87		
Condon/Rasmussen	8.88	9.51	19.66	3.75		
Kelso	9.61	4.69	12.25	3.43		
Totals	8.38	6.75	18.98	3.40		

#### Table 3-12: Study area age distribution by risk zone



Figure 3.4: Urban area percent of population under 5 years (ABS, 2006 data)



Figure 3.5: Urban area percent of population under 64 years and over (ABS, 2006 data)



Figure 3.6: Urban area percent of population over 64 years and living alone (ABS, 2006 data)



Figure 3.7: Urban area percent of population with disability (ABS, 2006 data)

# 3.9.2 Social and Economic Vulnerability

This demographic is shown at the risk zone level in table 3.13 and illustrated at the CCD level in figures 3.8, 3.9, 3.10 and 3.11.

Of the total population there were 30,307 or 51.22% of the population stated that they were employed or actively looking for work. Of this number, 1373 or 4.53% stated they were unemployed. The percentage looking for work varied from a high of 44 (12.39%) in a Condon CCD to a low of 0.00% in CCDs in Toomulla, Bohle Plains and Bushland Beach. At the risk zone level, the highest unemployment was 251 in Kirwan east (5.99%) and Condon Rasmussen (5.49%) zones with the highest percentage of 5.99% in Kirwan east. The lowest level of 4 occurred in the Paluma zone with the lowest percentage of 3.26% occurring in Kirwan west.

At the 2006 census there were a total of 5706 households that were renting, out of a total of 22,199 homes. The highest number was 249 or 54.4% in a CCD in Kirwan and the lowest at 0 in another CCD in Kirwan and a CCD in Mt Low.

At the risk zone level the highest number of households renting was 1160 or 31.32% in the Condon Rasmussen zone and the lowest number at 5 in the Paluma zone.

There are 673 households with an income below \$350 pw. The highest concentration of low income households is 173 (4.67%) in the Condon Rasmussen zone and the zone of lowest concentration is 6 households in Paluma and a lowest percentage of 1.27% in the Kirwan west zone. At the CCD level there are 38 (12.1%) of low income households in a Rasmussen CCD and a low of 0 households in 17 other CCDs across the area.

There were 51307 people over 14 and of those 33688 (65.66%) answered that they did no volunteer work in the previous 12 months. Of the 17619 adults that indicated they did volunteering work there is a high of 482 in a Kirwan CCD and a low number 47 at Paluma but the % of volunteers is reasonably consistent across the zones.

Zene	%	%	% Low	%Not
Zone	Unemployed	Renting	Income	Volunteering
Paluma	4.65	7.81	7.81	62.40
Nth Beaches	3.90	17.68	2.32	67.30
Inland	4.08	12.40	3.30	67.49
Kirwan East	5.99	31.73	3.49	66.06
Kirwan mid	3.28	30.15	1.86	65.32
Kirwan west	3.26	35.90	1.27	66.49
Condon/Rasmussen	5.49	31.32	4.67	63.94
Kelso	5.64	24.19	3.42	63.29
Totals	4.53	25.70	3.03	65.66

#### Table 3-13: Study area physical vulnerability by risk zone



Figure 3.8: Urban area percent of population unemployed (ABS, 2006 data)



Figure 3.9: Urban area percent of population renting (ABS, 2006 data)



Figure 3.10: Urban area percent of population on low income (ABS, 2006 data)



Figure 3.11: Urban area percent of population who do not volunteer (ABS, 2006 data)

# 3.9.3 Mobility Vulnerability

This demographic is shown at the risk zone level in table 3.14 and illustrated at the CCD level in figures 3.12, 3.13 and 3.14

There were 744 (3.35%) households that did not have access to their own vehicle. At the zone level this ranges from 198 households with no access to a vehicle in Kirwan East and Condon Rasmussen to a low of 0 households in Paluma and from 18.1% in Bohle to a low of 0% in Bluewater Park. At the CCD level there is a high of over 30 in 3 CCDs in Condon and Kirwan and a total of 18 CCD that had a 100% access to vehicles.

There were 2535 single parent households giving and average of 11.42% of all the households in the city. At the CCD level this ranges from 91 (28.0%) in Condon to less than 1% in Beach Holm and in an adjacent Condon CCD (contains the retirement village). At the risk zone level the highest number is 536 in Condon and a high percentage of 15.86% in Kirwan east to a low of 6 in Paluma and 6.95% in the Beaches zone.

There are a total of 1640 (7.39%) families of 3 or more children. The highest numbers of large families are in Condon with 55 (16.92%). The CCDs with the lowest number are Balgal Beach, Toomulla and a Condon CCD with zero. At the risk zone level the highest number is in Kelso with 304 (9.9%) and is also the highest percentage. The risk zone with the lowest number is Paluma with 3 large families.

Zone	% No Car Households	% Single Parent	% Large Households
Paluma	0.00	9.38	4.69
Nth Beaches	2.16	6.95	5.56
Inland	1.85	8.89	7.22
Kirwan East	6.01	15.86	6.31
Kirwan mid	1.57	8.77	7.83
Kirwan west	1.66	9.11	7.23
Condon/Rasmussen	5.35	14.47	7.86
Kelso	4.13	14.03	9.90
Totals	3.35	11.42	7.39

Table 3-14: Study area population mobility by risk zone



Figure 3.12: Urban area percent of households with no car (ABS, 2006 data)



Figure 3.13: Urban area percent of families with 3 or more children (ABS, 2006 data)



Figure 3.14: Urban area percent of one parent family (ABS, 2006 data)

# 3.9.4 Awareness Vulnerability

This demographic is shown at the risk zone level in table 3.15 and illustrated at the CCD level in figures 3.15, 3.16, and 3.17

The number of new residents is based on the numbers who have been at their present address less than 5 years. There are a total of 5378 (9.09%) of residents who are in the category. The risk zone with the highest number is Kirwan West with 1133 (14.74%) new to the area and the lowest is 10 (6.94%) in Paluma. The CCD with the highest number of new residents is in Kirwan West at 275 (21.42%) and the lowest is in a Bohle Plains CCD at 0.

There are a total of 228 residents (0.39%) who have no or poor English as their first language. The risk zone with the highest number at 50 (0.54%) is Kelso and the lowest number is 0 in Paluma. The CCD with the highest number at 12 (2.83%) is in Kirwan mid and there are 41 CCDs through out the area with 0 residents with poor English.

Internet access is another gauge of residents' awareness. A total of 6210 (31.28%) of households do not have access to the internet. At the risk zone level the highest number of households is in Kirwan Condon Rasmussen at 1136 (30.67%). The lowest level is 20 (31.25%) in Paluma. The CCD with the highest number of households with no internet is in Kirwan Rasmussen with 198 (55.15%) and there are 2 CCD with 12 households in Inland and again in the Northern Beaches with the lowest number.

Zana	% New	% Poor	% No
Zone	Residents	English	Internet
Paluma	6.94	0.00	31.25
Nth Beaches	10.02	0.12	29.52
Inland	7.06	0.2	30.10
Kirwan East	6.71	0.58	34.00
Kirwan mid	11.96	0.49	19.13
Kirwan west	14.74	0.35	19.96
Condon/Rasmussen	7.52	0.41	33.67
Kelso	7.28	0.57	28.42
Totals	9.09	0.39	27.97

Table 3-15: Study area population awareness by risk zone



Figure 3.15: Urban area percent of population new to area (ABS, 2006 data)



Figure 3.16: Urban area percent of households with poor English (ABS, 2006 data)



Figure 3.17: Urban area percent of households with no internet (ABS, 2006 data)

# 3.9.5 Community Vulnerability Index

The indices are combined in the same fashion as the original study.

- the value of each index is divided by the largest index value for that vulnerability category so that the indexes are a ratio of one (1) with 1 being the largest index.
- These indexes are summed across all the zones and divided by the number of categories (14) then multiplied by 100.
- The risk zone with the highest number is regarded as the most vulnerable.

The results of this calculation are shown in table 3.16 below. The risk zone of Kirwan East has the highest vulnerability index and Inland zone has the least vulnerability.

	/
Zone	Community Vulnerability Index
Paluma	62.07
Nth Beaches	57.38
Inland	56.54
Kirwan East	82.44
Kirwan mid	62.10
Kirwan west	63.15
Condon/Rasmussen	77.76
Kelso	72.85
Average	66.79

Table 3-16: Relative community vulnerability measures by risk zone

At the CCD level, the most vulnerable CCD is in Condon and the least vulnerable is at Rangewood. Figure 3.18 shows the relative vulnerability of each CCD.



Figure 3.18: Community vulnerability index at CCD level

#### 3.10 VULNERABILITY INTANGIBLES

The comments on the intangibles and the increasing reliance of the population on emergency services also applies to the former Thuringowa area.

## 3.11 INSTITUTIONAL VULNERABILITY

The amalgamation of the two Councils occurred in March 2008 and at the time of presentation of this addendum report, the new Council is fully integrated in respect to staff and most information.

The integration of GIS information between the two former councils is partly complete but access to all the information is not widely available. Information seems to be stored in numerous locations instead of a central server and made available to staff.

For example, computer modelling has predicted which major access roads would flood for a particular flood event of known Average Recurrence Interval (ARI) and rainfall intensity. This information is not available on the GIS.

A number of specific emergency management layers have been included on the GIS. These layers should be extended to include flooding etc.

A number of the generic strategies, concerning Council, recommended in the risk treatment plan for the original study have been finalised but some still remain outstanding. These are summarised in appendix B of this report.

#### 3.12 ECONOMIC VULNERABILITY

The comments on the economic vulnerability also applies to the former Thuringowa area.

## 3.13 ENVIRONMENTAL VULNERABILITY

The comments in the original study concerning the flora and fauna of the area applies equally to the former Thuringowa area.

## 3.14 EXPOSURE TO SEVERE STORMS

The degree of exposure to severe winds was assessed under the same criteria as detailed in the initial report namely:

- Within 1 km of the coast
- Located on slopes > 10%
- On land parcels greater than 5000 sq m

The former Thuringowa City area numbers of dwellings and commercial and industrial buildings with a heightened exposure to wind damage for each assessment zone are shown in the following table 3.17.

Zone	Dwellings			Commercial and Industrial		
	Exposed	Total	%	Exposed	Total	%
Paluma	232	232	100.00	1	1	100.00
Nth Beaches	4086	5478	74.59	8	21	38.10
Inland	1850	5003	36.98	4	30	13.33

#### Table 3-17: Dwellings with heightened wind exposure

Zono	Dwellings			Commercial and Industrial		
	Exposed	Total	%	Exposed	Total	%
Kirwan East	4	2829	0.14	2	163	1.23
Kirwan mid	9	2309	0.39	10	134	7.46
Kirwan west	26	3326	0.78	1	37	2.70
Condon/Rasmussen	85	3478	2.44	12	91	13.19
Kelso	336	3740	8.98	0	5	0.00
Totals	6628	26395	25.11	38	424	7.88

This shows that a larger % of the former Thuringowa City is in a more exposed category and is a reflection of the population residing along the coastline.

The modelling undertaken by CTS and SEA (2003) included the majority of the former Thuringowa City with the exception of the Paluma, Rollingstone, Balgal and Toomulla suburbs. The conclusions reached in the CTS and SEA (2003) report applies equally to this adjacent area.

The area the former Thuringowa City has the same exposure as the former Townsville City and the comments concerning the exposure of other above ground facilities such as power supply, telecommunications and Council infrastructure applies equally to this study area.

## 3.15 EXPOSURE TO FLOODS

A number of flood model studies have been undertaken in the study area but they do not cover the whole area. The models have concentrated mainly on the more densely populated areas.

The latest study was completed in early 2010 and includes the area bounded by the Bohle and Black Rivers. The study includes the current and proposed future urban areas within this area and the outputs are flood depths, velocities, road and property inundation for various rainfall events.

Further studies are underway to reassess and combine the flood studies previously undertaken in the former Townsville area and carry out broader flood plain analysis. The study will be required to investigate the impact of the various flooding scenarios on the community and infrastructure elements and include a risk analysis approach to flooding. The localities and infrastructure at risk of flooding will be identified allowing mitigation options to be investigated. These mitigation projects will then be included in Council's future capital works programs.

Flood studies have also been undertaken in the Purono Park and Toolakea areas and again were limited to flood heights etc. Future studies are required to study the risk exposure of the various communities and the mitigation projects needed to reduce these risks.

The Bohle Plains flood study has been received. Table 2.2 of this report has been extracted from that report and indicates the major access routes within the former Thuringowa area that will be inundated at various ARIs.

Tables 3.18, 3.19 and 3.20 show the numbers of dwellings, commercial/industrial and road segments inundated by flood in each risk zone for a 50 Year ARI. The initial Townsville LGA study included data on 100 yr ARI and PMF events but this information was not available for the whole Thuringowa LGA, only the Bohle Plains study area, and was omitted.

Zone	50 yr ARI	% 50 yr ARI	100 yr ARI	% 100 yr ARI	PMF	% PMF
Paluma	0	0.00%				
Nth Beaches	1237	39.27%				
Inland	560	15.27%				
Kirwan East	75	2.27%				
Kirwan mid	10	0.40%				
Kirwan west	215	7.77%				
Condon/Rasmussen	162	4.37%				
Kelso	704	22.92%				
Totals	2963	13.35%				

Table 3-18: Study area dwellings exposed to inundation under three flood scenarios

Table 3-19: Study area commercial and industrial building exposed to inundation under three flood scenarios

Zone	50 yr ARI	% 50 yr ARI	100 yr ARI	% 100 yr ARI	PMF	% PMF
Paluma						
Nth Beaches	2	9.52%				
Inland	7	33.33%				
Kirwan East						
Kirwan mid						
Kirwan west						
Condon/Rasmussen	2	9.52%				
Kelso						
Totals	11	52.38%				

Table 3-20: Study area road lengths exposed to inundation under three flood scenarios

Zone	50 yr ARI	% 50 yr ARI	100 yr ARI	% 100 yr ARI	PMF	% PMF
Paluma	2.45	8.24%				
Nth Beaches	92.97	60.57%				
Inland	87.52	39.33%				
Kirwan East	2.92	6.00%				
Kirwan mid	0.08	0.24%				
Kirwan west	12.71	25.15%				
Condon/Rasmussen	24.10	42.37%				
Kelso	33.51	48.21%				
Totals	256.26	38.50%				

# 3.16 EXPOSURE TO STORM TIDE

The depths above the Highest Astronomical Tide (HAT) of storm tide inundation at various locations along the coastline within the former Thuringowa area are shown in table 2.3.

Tables 3.21, 3.22 and 3.23 show the numbers of dwellings, commercial/industrial and road segments inundated by a storm tide event in each risk zone for a 50 Year ARI, 100 Year ARI, 10,000 Year ARI

	50 yr	% 50 yr	100 yr	% 100	10,000	%
Zone	ARI	ARI	ARI	yr ARI	yr ARI	10,000
						yr ARI
Paluma		0.00%		0.00%	5	7.81%
Nth Beaches	100	3.17%	164	5.21%	2411	76.54%
Inland	16	0.44%	16	0.44%	70	1.91%
Kirwan East		0.00%		0.00%		0.00%
Kirwan mid		0.00%		0.00%		0.00%
Kirwan west		0.00%		0.00%	2	0.07%
Condon/Rasmussen		0.00%		0.00%	1	0.03%
Kelso		0.00%		0.00%		0.00%
Totals	116	0.52%	180	0.81%	2489	11.21%

Table 3-21: Study area dwellings exposed to inundation under three storm tide	Э
scenarios	

Table 3-22: Study area commercial and industrial buildings exposed to inundation under three storm tide scenarios

Zone	50 yr ARI	% 50 yr ARI	100 yr ARI	% 100 yr ARI	10,000 yr ARI	% 10,000 yr AR		
Paluma								
Nth Beaches	4	19.05%	4	19.05%	8	38.10%		
Inland	4	19.05%	4	19.05%	5	23.81%		
Kirwan East								
Kirwan mid								
Kirwan west								
Condon/Rasmussen								
Kelso								
Totals	8	38.10%	8	38.10%	13	61.90%		

Table 3-23: Study area road lengths exposed to inundation under three storm tide scenarios

Zana	50 yr	% 50 yr	100 yr	% 100	10,000	%
Zone	ARI	ARI	ARI	yr ARI	yr ARi	10,000
						yr AR
Paluma		0.00%		0.00%	12.68	42.66%
Nth Beaches	20.23	13.18%	40.13	26.15%	142.33	92.73%
Inland	4.73	2.13%	11.66	5.24%	31.67	14.23%
Kirwan East		0.00%		0.00%		0.00%
Kirwan mid		0.00%		0.00%		0.00%
Kirwan west		0.00%		0.00%	4.73	9.36%
Condon/Rasmussen		0.00%		0.00%		0.00%
Kelso		0.00%		0.00%		0.00%
Totals	24.96	3.75%	51.79	7.78%	191.41	28.76%

# 3.17 EXPOSURE TO LANDSLIDE

Pells Sullivan Meynink were commissioned by Council to undertake a Landslide Hazard Study of the former Thuringowa area. The sites within this area were

- Paluma Village;
- Toomulla;
- Mount Low;
- Mount Kilburn and
- Deeragun

The study also investigated emergency access routes to Paluma and Hervey Range as well as the Bruce Highway at Rollingstone. The study did not include uninhabited or grazing areas (mountain ranges from Paluma to Hervey Range) and areas outside currently proposed urban development zones.

The study concluded the following:

"Category 1 study areas (including Paluma Village, Toomulla, Mount Low, Jensen, Deeragun, and Alligator Creek/Mount Low) are all potential Townsville growth areas and include a mix of high and low density residential development and Council infrastructure (roads, above ground pipelines, above ground sewer pipes, water tanks and radio masts). This study has shown that the Category 1 areas are typically impacted (where instability occurs) only by shallow slope instability and rock roll and localised rock fall. No deep-seated or large-scale slope instability was identified, nor were areas affected by potential debris flows identified. On the basis of these findings, we conclude that the Category 1 areas have a very low and low landslide risk.

According to the Australian Geomechanics Society (2007), very low and low landslide risks have the following implications (Table 9.1) (Reference 26)." Refer to the following table 3.24.

RISK LEVEL	EXAMPLE IMPLICATIONS
Low risk	Usually acceptable to regulators (that is, without any treatment). Where treatment has been required to reduce risk to this level, ongoing maintenance is required.
Very low risk	Acceptable. Manage by normal slope maintenance procedures.

Table 3-24: Landslide Risk Level Implications

The study also identifies drainage paths that are of concern during large storm or cyclone events but are a hydraulic concern not a debris flow concern.

As a result there are no areas with the study area where the built environment is threatened by high or moderate landslides.

Evacuation or emergency access routes to Paluma and Hervey Range are of concern and it was concluded that further engineering evaluation of culvert capacity, retaining walls and road shoulder stability should be undertaken.

## 3.18 EXPOSURE TO BUSHFIRE

Council commissioned C & R consulting to undertake a bushfire assessment of the Townsville region utilising the State Planning Policy 1/03 (SPP 1/03) and AS3959-2009 methodologies. The following figure 3.19 (C&R 2010) give the High, Medium and Low buffered zones within the whole Townsville City LGA. (It was recognised that there was no recent bushfire risk assessment maps were available for the whole LGA and this study was extended to cover the whole area as well as the former Thuringowa area.)

The area shown as high includes a 100 m buffer zone as required by SPP 1/02 and it is noted that there are no Extreme hazard areas within the LGA.

The flowing table 3.25 shows the number of dwellings exposed to high and low bushfire hazard potential.

Table 3-25: Former Thuringowa dwellings exposed to bushfire hazard potential.								
Risk Zone	High Fire	% High Fire	Medium Fire	% Medium Fire				
Paluma	43	18.53%	41	17.67%				
Nth Beaches	81	1.48%	1827	33.35%				
Inland	168	3.36%	1403	28.04%				
Kirwan East								
Kirwan mid								
Kirwan west								
Condon/Rasmussen	16	0.46%	53	1.52%				
Kelso	13	0.35%	458	12.25%				
Totals	321	1.22%	3782	14.33%				



Figure 3.19: Buffered Bushfire Hazard Assessment of the Townsville LGA based on SPP 1/03 methodology

Fire response and management maybe undertaken by the Queensland Fire and Rescue Service (QFRS) urban and rural units. The is one QFRS urban and 14 QFRS rural units within the former Thuringowa area. The rural brigades are listed in table 3.26. The brigade for different areas maybe viewed at the following web site.

http://mapping.dcs.qld.gov.au/external/firewardenfinder/

A mapping layer of the brigade boundaries is also maintained on Council's GIS system.

Table 3-26	Former	Thuringowa	OFRS	rural	brigades
	I UIIICI	muningowa		Turai	Dilgaues

<b>J</b>
Brigade Name
Alice River
Black River
Bluewater
Bluewater Estate
Crystal Creek
Hervey Range
Ollera Creek
Paluma
Purono
Rangewood
Rollingstone
Round Mountain
Rupertswood
Saunders Beach
Toolakea

## 3.19 EXPOSURE TO EARTHQUAKE

Council commissioned the Centre for Earthquake Research in Australia (CERA) to investigate the earthquake potential and vulnerability of the former Thuringowa area. They were not required to undertake a detailed investigation of the ground type underlying the area but rather to estimate the potential effect an earthquake may have, given the information available at this time.

The following table 3.27, from their report, gives a suburb by suburb guide to the potential hazards caused by an earthquake and the secondary hazards that may occur. The potential for ground failure, ground shaking, amplification and seiche is based on the known geological condition at these locations.

Table 3-27: A G	uide To Potential Earthquake Hazards In The Former City Of
Thuringowa - By	/ Suburbs

SUBURBS	PR	IMAF	RY HA	ZAR	DS	SECONDARY HAZAR			RDS		
	GROUND FAILURE	<b>GROUND SHAKING</b>	AMPLIFICATION	LIQUEFACTION	SEICHE	LANDSLIDE	FIRE	POLLUTION	FLOODING	PUBLIC HEALTH	RESTRICTED ACCESS/EGRESS
URBAN AND RURAL RESIDENTIAL											
ALICE RIVER	Х	Х	Х	Х		Х			Х		
BALGAL BEACH	Х	Х	Х	Х			Х				
BLACK RIVER	Х	х	х	Х		Х		Х	Х		
BLUEWATER	х	х	х	х							
BLUEWATER PARK	Х	х	х	Х		Х					
BOHLE PLAINS	Х	Х	Х	Х			Х				
BURDELL	Х	Х	Х	Х		Х	Х		Х		
BUSHLAND BEACH	Х	Х	Х	Х			Х			Х	Х
CONDON	Х	Х	Х	Х			Х			Х	
DEERAGUN	Х	Х	Х	Х		Х	Х			Х	
JENSEN	Х	Х	Х	Х			Х		Х		
KELSO	Х	Х	Х	Х	Х		Х		Х	Х	
KIRWAN	Х	Х	Х	Х			Х		Х	Х	
MOUNT LOW	Х	Х	Х	Х		Х					
MUTARNEE	х	Х	Х	х		Х					
PALUMA	х	х				Х					Х
RASMUSSEN	х	Х	Х	х			Х		Х		
ROLLINGSTONE	х	Х	Х	х		Х					
SAUNDERS BEACH	Х	х	Х	Х							
SHAW	Х	х	х	Х				Х	Х		
THURINGOWA CENTRAL	Х	Х	Х	Х			Х			Х	
TOOLAKEA	Х	Х	Х	Х							
TOOMULLA	Х	Х	Х	Х							
YABULU	Х	Х	Х	Х			Х	Х	Х	Х	
RURAL											
HUNAL											
BEACH HOLM	Х	Х									
BLUE HILLS	Х	Х				Х					
CLEMANT	Х	Х				Х					

SUBURBS		PRIMARY HAZARDS SECONDARY HAZARD							ARDS		
	<b>GROUND FAILURE</b>	<b>GROUND SHAKING</b>	AMPLIFICATION	LIQUEFACTION	SEICHE	TANDSLIDE	FIRE	POLLUTION	FLOODING	PUBLIC HEALTH	RESTRICTED ACCESS/EGRESS
CRYSTAL CREEK	Х	Х			Х	Х			Х		Х
GRANITE VALE	Х	Х				Х					Х
GUMLOW	х	Х	Х	х				Х			
HERVEY RANGE	Х	Х				Х					Х
LYNAM	Х	Х				Х					
PINNACLES	Х	Х	Х	Х	Х						
RANGEWOOD	Х	Х	Х	Х						Х	

The following table gives the number of dwellings exposed to these hazards in each of the suburbs and are then summarised into the risk zones. Note: A number of the suburbs cited above are not shown in the following table as this table 3.28 has been compiled from census data and the census collection districts (CCDs) do not coincide with suburbs boundaries.

Table 3-28: Number of Dwellings in each suburb.

Suburb	Dwellings
Alice River	263
Balgal Beach	365
Beach Holm	70
Black River	280
Bluewater	290
Bluewater Park	365
Bohle Plains	160
Burdell	322
Bushland Beach	893
Condon	2129
Crystal Creek	64
Deeragun	924
Granite Vale	170
Jensen	731
Kelso	3072
Kirwan	7800
Lynam	107
Mount Low	438
Rangewood	373
Rasmussen	1575
Rollingstone	186
Saunders Beach	205
Thuringowa Central	741
Toolakea	87

Suburb	Dwellings
Toomulla	89
Yabulu	500
Total	22199

The following table 3.29 summarised the dwellings in each risk zone.

Table 3-29:	Dwelling	per	risk	zone
	Dwennig	per	1131	20110.

Risk Zone description	Risk Zone	Total Dwellings
Paluma (unique area)	1	64
Beaches - Bohle to North / Hwy to Coast	2	3150
Inland - Bohle to North / Hwy to Inland Boundary	3	3668
Kirwan East - T'gowa Dr to East	4	3297
Kirwan Mid - T'gowa Dr to Kern Dr	5	2478
Kirwan West - Kern Dr to Bohle river	6	2766
Condon Rasmussen	7	3704
Kelso	8	3072
		22199

The CERA (2010) report concluded that because of the importance of Thuringowa (as part of the new Townsville City) as a regional centre and other factors that the

## EARTHQUAKE VULNERABILITY is MEDIUM - HIGH

## 3.20 CONCLUSIONS

A workshop was undertaken by the SAG to assess the applicability of the former Townsville City Risk Register, developed in the initial study, to the Thuringowa LGA. It was agreed by the SAG that the initial risk register applies equally to this study area and that no new risks were identified.

# 4. ANALYSIS OF RISKS

## 4.1 BACKGROUND

In order to maintain a consistent risk analysis approach across both former Council areas the frequency, consequence, risk ratings and background discussions in this section of the initial study report we reviewed by the Study Advisory Group (SAG) set up to oversee this study and accepted without change.

To undertake a risk analysis that the various hazards pose to the elements identified in the report requires that tables of exposures developed in chapter 3 be reduced to a common base. The initial Townsville report utilised vulnerability percentages in its risk analysis but it was felt that actual numbers of effected elements are a better reflection in the hazard analysis. The ratio of the actual number of elements affected to the total effected elements was calculated.

Weightings were then applied to the exposure ratios to highlight their relevant importance. If a critical element in a risk assessment zone (e.g. residents) is zero then the risk analysis for that zone is zero (e.g. if the number dwelling exposed to a storm tide in a zone is zero, then the risk analysis result for that zone is zero regardless of the score for the other exposed elements.

The analysis model can be summarised as:

- Critical element = 0 then zone analysis = 0
- Ratio of exposed elements to sum of exposed elements for all zones
- Apply weighting to each exposure ratio
- Add weighted exposure ratios
- Highest score indicates the highest risk

## 4.2 TROPICAL CYCLONES AND SEVERE THUNDERSTORMS RISKS

## 4.2.1 Severe Storm Risk Overview

Severe Storms occur as frequently in the study area as they may do in the initial study and hence the same comments and risk ratings occur.

The information source and weighting used to develop the risk index are:

•	Nos residential buildings within heightened exposure zone	3
•	Nos of building constructed before 1982	2
•	Community yulporability index	1

Community vulnerability index 1
Maximum Score 6

Figure 4.1 and table 4.1 indicated the wind risk index based on the above weightings.



Figure 4.1: Relative wind risk by risk assessment zone

Risk Zone description		Risk
Paluma (unique area)		4.31
Beaches - Bohle to North / Hwy to Coast	2	37.56
Inland - Bohle to North / Hwy to Inland Boundary		24.00
Kirwan East - T'gowa Dr to East		10.14
Kirwan Mid - T'gowa Dr to Kern Dr		3.72
Kirwan West - Kern Dr to Bohle river		2.89
Condon Rasmussen		7.07
Kelso	8	10.30

Risk zones 1 has the highest index as it is at the top of the Paluma range, risk zone 2 is the next highest with the majority of houses within 1 km of the coast. Risk zone 3 has a high index as it is a more rural area and has a longer fetch distance for cyclonic winds. The Kirwan East zone has a high index due to the majority of residential building being constructed prior to 1982.

The discussion in the initial IID report concerning **Secondary Hazards, Climate Change, Analysis and Assessment** applies equally to this study area.

## 4.3 FLOODS RISKS

## 4.3.1 Flood Risk Overview

Flooding in the various catchments within the former Thuringowa area is a common event and the majority of the urbanised catchments have had flood modelling undertaken. The risk ratings included in the initial IID (2009) report have been accepted for this study.

The information source and weighting used to develop the flood risk index are:

•	Nos. residential buildings in the 100 year ARI zone	3
•	Nos. commercial/industrial buildings in the 100 year ARI zone	2
•	Nos. roads in the 100 year ARI zone	1
•	Nos. buildings of construction post 1982	3
•	Community vulnerability	1
	Maximum score	10

Figure 4.2 and table 4.2 indicated the flood risk index based on the above weightings.



Figure 4.2: Relative flood risk by risk assessment zone

Table 4-2: Flood risk index b	y risk assessment zone
-------------------------------	------------------------

Risk Zone description		Risk
Paluma (unique area)	1	0.00
Beaches - Bohle to North / Hwy to Coast	2	28.43
Inland - Bohle to North / Hwy to Inland Boundary		27.99
Kirwan East - T'gowa Dr to East		3.77
Kirwan Mid - T'gowa Dr to Kern Dr		4.53
Kirwan West - Kern Dr to Bohle river		9.44
Condon Rasmussen		11.97
Kelso	8	13.87

The discussion in the initial IID report concerning Secondary Hazards, Climate Change, Analysis and Assessment applies equally to this study area.

#### 4.4 **STORM TIDE RISKS**

- Nos. residential buildings in 100 yr ARI storm tide zone 3 .
- Km. of roads in the 100 yr ARI storm tide zone 1 • 3
- Nos. of construction post 1982 •

Community vulnerability
Maximum score

Figure 4.3 and table 4.3 indicated the storm tide risk index based on the above weightings.



Figure 4.3: Relative Storm Tide risk by risk assessment zone

	<b>T I I I I</b>	
Table 4-3: Relative Sto	orm lide index by r	isk assessment zone.
	,	

Risk Zone description		Risk
Paluma (unique area)		0.00
Beaches - Bohle to North / Hwy to Coast		80.17
Inland - Bohle to North / Hwy to Inland Boundary	3	19.83
Kirwan East - T'gowa Dr to East		0.00
Kirwan Mid - T'gowa Dr to Kern Dr		0.00
Kirwan West - Kern Dr to Bohle river		0.00
Condon Rasmussen		0.00
Kelso	8	0.00

## 4.5 LANDSLIDES RISKS

No residential buildings or water supply networks were identified as being within a debris flow areas or within a high or medium landslide risk area.

Sections of the Paluma and Hervey Range Roads were identified as being within debris flow and slumping hazard areas.

The development of a landslip risk index model for a landslide event is not considered necessary.

The discussion in the initial IID report concerning **Secondary Hazards**, **Climate Change**, **Analysis and Assessment** applies equally to this landslide study.

# 4.6 BUSHFIRES RISKS

•	Nos. of dwelling exposed to high bushfire risk	3
•	Nos. of dwelling exposed to a medium bushfire risk	1
•	Community vulnerability	1
	Maximum score	5

Figure 4.4 and table 4.4 indicated the bushfire risk index based on the above weightings.



Figure 4.4: Relative Bushfire risk by risk assessment zone

Risk Zone description	Zone	Risk
Paluma (unique area)	1	9.63
Beaches - Bohle to North / Hwy to Coast	2	32.60
Inland - Bohle to North / Hwy to Inland Boundary	3	43.10
Kirwan East - T'gowa Dr to East	4	0.00
Kirwan Mid - T'gowa Dr to Kern Dr	5	0.00
Kirwan West - Kern Dr to Bohle river	6	0.00
Condon Rasmussen	7	5.76
Kelso	8	8.91

## Table 4-4: Relative Bushfire index by risk assessment zone.

## 4.7 EARTHQUAKES RISKS

## 4.7.1 Earthquake Risk Overview

As stated in section 2.7.2 above, no reliable ground site classification information is available and as a result the whole area should be regarded at the same classification. There is some obvious areas that may be classified as Class A (strong rock) or Class B (rock) but these areas are small compared to the remaining developed alluvial plain.

This then infers that the earthquake risk index, as developed in the initial IID (2009) report cannot be assigned to the various risk zones in the former Thuringowa area.

The report also questioned the risk rating scale shown in the initial Townsville study. The comment is based on the consequence of a MMVI class earthquake and the report comments are as follows:

#### "Section 4.7.1 – Earthquake Risk Overview:

This is based solely on intensity (MM) – a qualitative dement – with NO mention of magnitudes (ML). In IID (2009) Table 4.13, under "Consequences", the word "minor" is equated to MM VI. By whatever intensity scale, MM VI is where damage to the built environment occurs and is hardly "minor". For example – in the 1989 Newcastle earthquake, and indeed others in Australia since then, building damage (MM V1) was quite severe and significant. It is considered that "minor" should be changed to "moderate". This whole sub-section appears to be related to the insurance industry needs rather than to the broad spectrum of risk management for which Townsville City Council has responsibility."

As a result of the comments above the revised Earthquake risk rating is shown in table 4.5.

FREQUENCY	CONSEQUENCES	RISK LEVEL
Likely	Nil: Small intensity shaking to MM IV. Little if any damage.	No risk
Possibly	Insignificant: Small intensity shaking to MM V. Little if any damage.	Low
Unlikely	<b>Moderate</b> : Moderate intensity shaking to MM VI. Moderate damage to poorly constructed buildings possible. Injuries unlikely. Some damage to the more fragile in-ground infrastructure possible.	Low
Rare	<b>Major:</b> Strong intensity shaking to MMVII. Damage to older masonry and poorly constructed buildings likely. Some serious injuries likely and some fatalities possible. Some dislocation of in-ground infrastructure likely. Secondary hazards such as fire possible.	Low

## Table 4-5: Earthquake risk ratings

The CERA (2010) report includes

- inventory the of the built, human and natural environments for the urban, rural, costal and off shore precincts (CERA report table 14).
- vulnerability table of critical facilities, infrastructure and community services based on its importance, vulnerability to earthquakes and the impact of potential damage (CERA report table 20)
- interdependence matrix for infrastructure (CERA report table 21)

A priority order for recovery is then presented in table 4.6 and follows table 22 in the CERA (2010) report.

INFRASTRUCTURE TYPE	IMPORTANCE	DEPENDENCE	PRIORITY	
Transport - Road	44	44 17		
Communications – Telephone	38	17	55	
Fuel Supplies – Petroleum/Diesel	34	20	54	
Electricity – Mains	42	11	53	
Electricity – Standby	36	12	48	
Communications – Telemetry	29	14	43	
Evacuation Centre	0	41	41	
Communications – Emergency	23	17	40	
Media – Broadcasting – Radio	18	17	35	
Water	12	20	32	
Food Supplies	6	25	31	
Media – Newspaper	11	20	31	
Transport – Rail	13	17	30	
Media – Broadcasting – Television	5	19	24	
Sewerage System	4	19	23	
Fuel Supplies – Gas	4	16	20	
Septic System	3	14	17	
Drainage Stormwater	6	4	10	
Refuse	0	5	5	

Table 4-6: Summary In Priority Order Per Interdependence Matrix

The Earthquake Risk Assessment undertaken by CERA (2010) has concluded, in qualitative terms, that the risk is:

## EARTHQUAKE RISK ASSESSMENT is MEDIUM - HIGH

The comments in the initial IID (2009) report concerning

- Secondary Hazards;
- Climate Change;
- Earthquake Analysis and
- Earthquake Assessment

applies equally to the former Thuringowa area.

## 4.8 THE RISKS COMPARED

The initial IID (2009) report contains comment on comparing the risk of the hazards being considered and develops a multi risk rating across these hazards.

The comments are equally relevant to this study areas and the rating table in included for information in table 4.7.

HAZARD	SCENARIO RISK	MANAGE	AWARE	URGENCY	GROWTH	OUTRAGE	TOTAL
Destructive wind	6	3	2	2	3	3	19
River flood	5	3	2	3	2	4	19
Storm tide	5	3	3	3	3	4	21
Landslide	5	2	3	2	2	3	17
Bushfire	5	1	2	1	2	2	13
Earthquake	4	4	4	2	2	1	17

#### Table 4-7: Comparative multi-factor risk rating

On this assessment of total risk IID considers storm tide to pose the greatest threat to the Townsville community, with destructive winds and riverine flood a close second. Bushfire poses the lowest overall level of risk.

# 5. TREATING THE RISKS

## 5.1 INTRODUCTION AND GUIDING PRINCIPLES

The same focus on developing strategies to reduce or eliminate emergency risks were applied to the former Thuringowa City area.

The risk assessment criteria agreed to by the Study Advisory Group formed for the initial study were agreed to and adopted by the Study Advisory Group formed for this study. For completeness these criteria are repeated here from the initial report:

- 1. "reduce, and preferably eliminate, the risk of death or injury to emergency workers engaged in responding to any hazard impact;
- 2. reduce, and preferably eliminate, the risk of death or injury to the general population;
- 3. reduce, to an acceptable level, the risk of destruction or damage to public infrastructure and facilities;
- 4. reduce, to an acceptable level, the risk of destruction or damage to private property;
- 5. manage the impact of natural hazard impacts on cultural heritage and the natural environment to the extent that loss of heritage is minimised and the biodiversity of flora and fauna is maintained;
- 6. minimise the long-term impact on the local economy."

The guiding principles and statements made in this section of the initial report were applied to the treatment of the risks identified under this study.

Since the initial IID NDRM study report (2009), a number of the strategies identified have been completed or are in the process. The strategies presented here are those specifically identified in the reports commissioned for this study and those identified in subsequent workshops and public consultation.

A summary of the initial IID report (2009) strategies and their current status is included in Appendix B.

## 5.2 GENERIC RISK REDUCTIOIN STRATEGIES

Townsville City Council's corporate plan 2009 – 2014 has identified Disaster Management as a local and regional issue and the plan contains the following statements:

## **"DISASTER MANAGEMENT**

The focus of Council's Disaster Management Program, as required by the Disaster Management Act 2003, is on minimising the effects of hazards on our local community, by ensuring a coordinated approach within the community. This process requires the development and maintenance of planning partnerships at local and state levels.

Council has representation on the Queensland District Disaster Management Group. It takes a whole of government approach to disaster management arrangements and ensures cooperation between the various agencies that play a role during disasters. Our Local Disaster Management Group is responsible for developing disaster management arrangements and establishing and maintaining a local emergency service. Council oversees the operation of the Local State

Emergency Service Group and contributes to the maintenance of the State Emergency Service headquarters.

It also supports the SES and the Rural Fire Brigade established in the rural and remote areas of the city."

A further commitment is also contained in Goal 3: Social Sustainability

"Efficient disaster management

The strategy we will implement in order to achieve this outcome is:

3.14 Minimise the effects of and achieve Council's response to natural disasters."

Council's Operational Plan also contains the following strategies:

#### "Desired Outcome - Effective disaster management

**Strategy 3.14** - Minimise the effects of and coordinate Council's response to natural disasters

3.14.1 Provide operational support, reconnaissance and coordination of resources as required by the City's Disaster Management Plan and play a key Role in the response and recovery phases of natural disasters.

3.14.2 Review, implement and test council's plans and procedures to deal with disaster events.

3.14.3 Manage the Townsville Local Disaster Management Group processes and plans.

3.14.4 Provide infrastructure, maintenance and operational support to local SES Groups.

3.14.7 Communicate and educate residents on Council's role during disaster events and the community's responsibilities in living in a disaster-prone region.

3.14.10 Undertake hazard studies identifying areas / infrastructure at risk and mitigation measures for natural disasters."

The above statement indicates that the amalgamated Council has a strong commitment towards disaster management and the generic strategies recommended in the initial Natural Disaster Risk Management study report.

Hence the generic strategies, included in the initial study report, apply equally to this study area.

These strategies are shown in Appendix B and includes implementation progress achieved to date.

No additional generic strategies were identified.

## 5.3 TREATING SEVERE STORM RISKS

The average age of dwellings in the former Thuringowa is lower than that for the former Townsville City as the urban population of Thuringowa is the result of suburban overflow from the larger Townsville City. The population of Thuringowa has grown from approximately 20,000 in 1976 to 63,000 at the

2006 census. This has resulted in the majority of the dwellings and urban infrastructure being designed and built to the latest design and building codes and all new urban suburb developments have been required to install underground power.

This consideration aside, no additional strategies for the severe storm hazard were identified for the former Thuringowa area.

## 5.4 TREATING FLOODS RISKS

As mentioned previously, there are large areas of the former Thuringowa area that are not within current flood models but these areas are largely undeveloped. Council is currently undertaking a flood modelling study of the Bohle Plains area and modelling will be expanded as the boundaries of urban development are extended.

The strategies developed in the initial Townsville report also apply to this study area and are shown in Appendix B. No additional strategies were identified.

## 5.5 TREATING STORM TIDE RISKS

The initial storm tide study was undertaken for both the former Townsville and Thuringowa areas. Hence the treatment outcomes identified in the initial Townsville report apply equally to this study area.

No additional strategies were identified.

## 5.6 TREATING LANDSLIDES RISKS

Landslide risk treatment strategies were recommended by Pells Sullivan Meynink (2010) as part of their investigation into landslide areas in the former Thuringowa LGA and are included in Appendix C.

## 5.7 TREATING BUSHFIRES RISKS

Bushfire risk treatment additional strategies were recommended by C&R Consulting (2010) as part of their investigation in Bushfire hazard and are included in Appendix C.

## 5.8 TREATING EARTHQUAKES RISKS

Earthquake risk treatment additional strategies were recommended by CERA (2010) as part of their investigation in Earthquake hazard and are included in Appendix C.

## 5.9 CONCLUSIONS

The conclusions reached in the initial IID (2009) report can be applied equally to the former Thuringowa area and are included here for completeness.

"The overall risks posed to the population of the study area are relatively small and infrequent. ....., with floods and storms representing the most significant threats to property.

The risk treatment strategies suggested here have been designed to meet the criteria established in the context stage (Chapter 1). This has been achieved by adopting the following broad objectives:

- 1. protecting emergency workers: ensure that emergency workers have the right information at the right time and in the right form; ensure that they have appropriate training; ensure that they have appropriate resources.
- 2. protecting the general public: ensure that the general public receive the right information at the right time and in the right form; ensure that they know how to use that information to maximise their own safety; foster community resilience.
- 3. protecting public assets: ensure that all public critical infrastructure is sited, constructed and maintained to ensure that it will be available during and immediately after a disaster impact; if it is damaged ensure that it can be rapidly restored.
- 4. protecting community property: ensure that future development is located in areas with minimal exposure to inundation and other hazards; ensure that owners of existing property are aware of their potential exposure to hazards so that they may take steps to minimise their risk.
- 5. protecting the environment and heritage: ensure that all development is ecologically sustainable even under extreme conditions; ensure that heritage assets (including archives, historic buildings and cultural sites) are adequately protected.
- 6. protecting the economy: if all of the previous criteria are met the economy will largely look after itself.

By adopting these strategies the New Townsville City Council will go a long way to reducing the risks posed by natural hazards to a level that is as low as reasonably practicable in all but the most extreme events. Their adoption will also make Townsville City a safer and more sustainable community." IID (2009)

# REFERENCES

**2009 Victorian Bushfires Royal Commission**, 2010: *Final report summary, recommendations and Bushfire Safety Policy.* 

**AECOM**, 2009: *Bohle Plains Flood Planning Report*, consultant report for Townsville City Council by AECOM Australia Pty Ltd.

**BoM**, 2010: *Bureau of Meteorology Rainfall Data*, report collected off the BoM internet site on rainfall data.

**C&R**, 2010: *Natural Disaster Risk Management Study Bushfire Hazard Study*, consultant report for Townsville City Council by C & R Consulting

**CERA**, 2006: *Final report on earthquake risk assessment for the former City of Townsville*, consultant report for Townsville City Council by the Centre of Earthquake Research in Australia.

**CERA**, 2010: *Final report on earthquake risk assessment for the former City of Thuringowa*, consultant report for Townsville City Council by the Centre of Earthquake Research in Australia.

**Coffey Geoscience**, 2001: *Landslide hazard zoning study Townsville City area*, consultant report for Townsville City Council by Coffey Geoscience.

**CTS & SEA**, 2003: *Development of a cyclone wind damage model for use in Cairns, Townsville and Mackay,* Report TS582. James Cook University Cyclone Testing Station in association with Systems Engineering Australia P/L.

**DLGP/DES**, 2003: *State Planning Policy 1/03: Mitigating the adverse effects of flood, bushfire and landslide,* Department of Local Government and Planning and Department of Emergency Services.

**DLGP/DES**, 2003b: *State planning policy guideline: mitigating the adverse effects of flood, bushfire and landslide,* Department of Local Government and Planning and Department of Emergency Services, Brisbane.

**GHD and SEA**, 2007: *Townsville – Thuringowa storm tide study final report*, consultant report to Townsville and Thuringowa City Councils by GHD and Systems Engineering Australia P/L.

**GHD**, 2005a: *Ross River Dam upgrade study Part 3: design analysis inputs to risk analysis*, consultant report to TCC by GHD P/L.

**GHD**, 2005b: *Ross River Dam upgrade study Part 4: consequence analysis*, consultant report to TCC by GHD P/L.

**Granger K.**, 1997: 'Lifelines and the AGSO Cities Project', *The Australian Journal of Emergency Management*, Vol. 12, No. 1, pp. 16-18, Emergency Management Australia, Mt Macedon.

**IID**, 2009: *Townsville City Natural Disaster Risk Management Study Stage 1*, consultant report for the former Townsville City Council by the Institute for International Development.

**Maunsell McIntyre**, 2000: *Purono Park Flood Study,* consultant report to Thuringowa City Council by Maunsell McIntyre Pty Ltd

**Maunsell McIntyre**, 2001: *Bluewater Creek Flood Study,* consultant report to Thuringowa City Council by Maunsell McIntyre Pty Ltd

**Maunsell**, 2005b: *Townsville flood hazard assessment report: Phase 3 report vulnerability assessment and risk analysis*, consultant report to Townsville City Council by Maunsell Australia P/L.

**Maunsell**, 2008: *Toolakea Beach Flood Study*, consultant report to Thuringowa City Council by Maunsell Australia P/L.

Origin Energy LPG Ltd, Townsville – Thuringowa reticulated LPG mapping.

**PIFU**, 2010: *Information paper on forecast population growth from 2006 census to 2026.* Population Information Forecast Unit of the Office of Economic Statistical Research of Queensland Treasury.

**PSM**, 2010: *Townsville City Council-Natural Disaster Risk Management Study-Landslide Hazard Study*, consultant report for Townsville City Council by Pells Sullivan Meynink

**Rynn, J.M.W., Brennan, E., Hughes, P.R., Pedersen, I.S. and Stuart, H.J.,** 1992: *The 1989 Newcastle Australia, Earthquake – The Facts and the Misconceptions.* Bulletin of the New Zealand National Society for Earthquake Engineering, 25, 2, 77-44.

**SA/SNZ**, 1999: *Australia New Zealand Standard AS/NZS 4360:1999 Risk management,* Standards Australia, Homebush, and Standards New Zealand, Wellington.

**SA/SNZ**, 2004a: *Australia New Zealand Standard AS/NZS 4360:2004 Risk management,* Standards Australia, Homebush, and Standards New Zealand, Wellington.

**SA/SNZ**, 2004b: *HB436 Risk management guidelines: companion to AS/NZS 4360:2004*, Standards Australia, Homebush, and Standards New Zealand, Wellington

Zamecka A. and Buchanan G., 1999: *Disaster risk management*, Department of Emergency Services, Brisbane.
## **APPENDIX A: COMMUNITY CONSULTATION**

A requirement of the NDRM grant is that the public be consulted during the study.

The following consultation process was followed:

- 1. Emergency Management Queensland, Queensland Fire and Rescue and State Emergency Services participated on the Study Advisory Group (SAG)
- 2. A notice was placed in the Townsville Bulletin's Public Notices requesting public comment on the draft report and that it was available for viewing at the following locations:
  - Townsville City Council's web site
  - Townsville City Council's Libraries
  - Townsville City Council's customer service centres at the City and Kirwan
- 3. A following questionnaire was supplied:



There were 194 hits on Council's web site but only 5 actually completed the online survey form. A further 29 responses were received through Council's Libraries and Customer Service Centres.

A summary of the responses are as follows:

Q	Summary							
1	The majority selected Flooding, Cyclones and Storm Surge as							
	the major threat.							
	One response suggested that volcanoes be included.							
2	There were 16 yes replies and 17 negative.							
3	Only 9 respondents knew where their closest evacuation centre was located							
4	20 respondents wanted evacuation centres							
5	8 respondents agreed with the NDRM study strategies							
6	Additional comments were:							
	1.More community involvement;							
	<ol><li>Do not allow natural water courses to be blocked</li></ol>							
	during development;							
	<ol><li>Concern for the Black River residents;</li></ol>							
	<ol><li>Remove overhead power lines;</li></ol>							
	5. Inform the public; and							
	6. Ross and Bohle River flooding and Dam performance							
Comment 1 & 5 Part of the existing NDRM strategies; Comment 2 Included in Council's Town Planning development approv								

- Comment 2 Included in Council's Town Planning development approcess; Comment 3 Local disaster committee aware of this issue;
  - Comment 4 Ergon has this as an ongoing work program
  - Comment 6 This was a lengthy response and was considered by Council's drainage engineer. The recommendation was that there were no grounds for concern or the need for additional strategies.

Letters of thanks were sent to the all respondents where addresses were supplied.

The responses received were considered by the SAG and no additional strategies were included in the study report.

## **APPENDIX B: PROGRESS ON INITIAL RISK TREATMENT STRATEGIES**

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
	Generic						
1	When establishing its new Vision Statement & Corporate Plan the New TCC consider the inclusion of a clear commitment to maintain a safe & sustainable community, especially in relation to the potential impact of natural hazards.	Yes	Included 2009/14 Corporate Plan - released early 2009	Completed	-	-	-
2	At an early stage in the life of each Council the LDMG arrange a briefing for all elected councillors and senior executive on their roles & responsibilities for emergency risk management. An information package to support such a briefing should contain material such as the LGAQ/EMQ resource <i>Elected member's guide</i> <i>to disaster management.</i>	Yes	Annual presentation to be made to Councillors	In Progress	High	Executive Officer Emergency Management	November Annually
3	Council, through the LGAQ, request EMQ to task its legal advisors to compile & disseminate a statement of the legal, administrative & common law responsibilities of Qld local governments for emergency risk management.	Yes	State Disaster Management Act reviewed and released	Completed	-	-	-

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
4	In the process of re-designing the functional arrangements for its amalgamated structure Council review the subordination of the LDMG to maximise its effectiveness as a risk management body.	Yes	Disaster Management integrated with Corporate risk management process	Completed	-	-	-
5	At an early stage in the amalgamation process the New TCC promotes a policy that facilitates public access to details of potential hazard impact zones, especially those involving inundation hazards.	Yes	Hazard information available on Council's website.	Completed	-	-	-
6	Council commission a follow-up multi-hazard risk assessment, as Stage 2 of this study, to produce a disaster risk management strategy for the new TCC. That study should be based on updated City-wide hazard-specific studies for bushfire & earthquake (& possibly flood).	Yes	NDMP Project (Former Thuringowa area All Hazard Study) being actioned	In Progress	High	Executive Officer Emergency Management	Dec-10

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
	Council review its vegetation management strategies to manage remnant native trees & street tree planting to minimise		1. Vegetation management strategies part of Bushfire Officer's Management role	In Progress	Medium	Bushfire Management Officer - Integrated Sustainability Services	Mid 2011
7	their potential to do damage if brought down during storms or to provide bushfire fuel close to residents.	Yes	2. Bushfire Management Working Group to assess vegetation management strategies	In Progress	High	Bushfire Management Officer - Integrated Sustainability Services	June Annually
			3. Tree planting and road reserve to be assessed. (report on tree plantings noted by Council Aug 2010)	In Progress	Medium	Executive Officer Emergency Management/Parks/ Construction &Maintenance	2011
	The second group of generic strates Government's Natural Disaster Res	gies relate to the scop ponse & Recovery Arr	e of the study. This has been limited to co angements (NDRRA).	nsideration of the	ose natural haza	ards that are covered under the	Commonwealth
8	Council, through LGAQ, request EMQ and EMA to review the limitation of NDMP so that Qld local government can more effectively develop a genuine all- hazards approach to emergency risk management.	Yes	New Natural Disaster Resilience Program released by State Government	Completed	-	-	-
	Council seek future external funding to extend its multi-hazard risk assessment studies to		1. Former Thuringowa All Hazard Study in progress (NDMP Funding)	In Progress	Low	Executive Officer Emergency Management	Dec-10
9	address the full span of hazards, including heatwave, epidemics & anthropogenic hazards.	Yes	<ol> <li>NDRP Funding to be sought for hazards not covered by existing study</li> </ol>	In Progress	Medium	Executive Officer Emergency Management	2011
	The next group of generic strategies relate to the accumulation & recording of						

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
10	disaster information. The LDMG initiate discussions with the Townsville City Library, the Museum of North Qld and local history groups to document the community's experience of & response to emergencies.	Yes	Contact to be made with library and museum of North Queensland.	No Action	<del>Medium</del> Low	Executive Officer Emergency Management	2011
11	The LDMG incorporate into its Local Disaster Management Plan the requirement to undertake and/or fund post-event surveys & studies from which to accurately assess the consequences (physical, economic, personal) of all significant hazard impacts.	Yes	Impact assessment plan being prepared	In Progress	Medium	Executive Officer Emergency Management	Dec-10
12	The LDMG recommend to EMQ that guidelines be developed to standardise the conduct of post- event surveys & studies & incorporate those guidelines into the State Disaster Management Plan.	Yes	To be reviewed after procedures for new Disaster Management Act released	On Hold	Low	Executive Officer Emergency Management	Jun-11
13	The LDMG develop procedures & protocols by which to manage & coordinate post-event research by outside agencies following a major disaster.	Yes	To be reviewed after procedures for new Disaster Management Act released	On Hold	Low	Executive Officer Emergency Management	Jun-11

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
14	Council, through the LGAQ, recommend to EMQ that guidelines be developed & circulated to the scientific community relating to the conduct of post-event studies.	Yes	To be reviewed after procedures for new Disaster Management Act released	On Hold	Low	Executive Officer Emergency Management	Jun-11
15	The LDMG recommend to Council that as part of the amalgamation of the two council information systems that it commissions a review of its amalgamated information infrastructure & its capacity to fully support the planning for & response to a major emergency.	Yes	EMP Guidelines adopted	Completed	-	-	-
16	Council enter into discussions with the BoM to upgrade the Mt Stuart weather watch radar to a Doppler radar & to review the effectiveness of the current flood warning system.	Yes	<ol> <li>Follow up with BOM regarding Mt Stuart weather radar</li> <li>Evironmon flood warning system being reviewed and updated</li> </ol>	No Action In Progress	Medium Medium	Executive Officer Emergency Management Technical Services - Infrastructure Services	Dec-10 June 2011
	The next group of generic strategies are aimed at improving community resilience & awareness through improving risk communication.						

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
17	The LDMG recommend to Council the development of a comprehensive emergency risk communications strategy, in association with the response agencies, including the production of a comprehensive guide to the development of household emergency management plans. The guide should be included in the 'welcome' information pack provided to new residents.	Yes	Existing Community Awareness Plan being reviewed	In Progress	Medium	Executive Officer Emergency Management	August Annually
18	The LDMG, in conjunction with Council & response agencies engage with the local electronic media outlets to establish procedures to manage communications with the community, including messages in languages other than English, to provide authoritative information ahead of, during & after an emergency.	Yes	Existing Community Awareness Plan being reviewed	In Progress	Medium	Executive Officer Emergency Management	August Annually
19	The LDMG & Council establish a program of community awareness as to the importance of SEWS ahead of the annual bushfire & cyclone seasons.	Yes	Feedback received from LGAQ Disaster Management Conference June 2010. BoM advised LDMG and DDMG of outcome.	Completed	-	-	-

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
20	Council use the current high degree of media interest in issues relating to climate change to promote messages of the linkage of climate & natural hazards both new & into the future.	Yes	Existing Community Awareness Plan being reviewed	In Progress	Medium	Executive Officer Emergency Management	August Annually
21	Before the start of each cyclone season Council run a community education program aimed at building community resilience & self reliance. To provide focus to that campaign Council could consider adopting a slogan along the line of 'your safety is our concern, but your responsibility'.	Yes	Existing Community Awareness Plan being reviewed	In Progress	Medium	Executive Officer Emergency Management	August Annually
	The final group of generic strategies	are aimed at improvi	ng the response & recovery activities that	will be required f	ollowing the imp	act of a major hazard.	
22	The LDMG consider activating the local LDCC in response to the more frequently occurring lower- level emergency situations to expand the experience of members & their agencies.	Yes	LDCC Exercise held annually.	In Progress	Medium	Executive Officer Emergency Management	November Annually
23	The LDMG recommend to EMQ that model sub-plans be developed to provide guidance on planning for infrastructure recovery, business recovery & community welfare activities during & following an emergency.	Yes	State Recovery Policy released, BCM Planning for business released.	Completed	-	EMQ	-

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
24	Council, through the LGAQ recommend to EMQ that it publish guidelines for the establishing, coordination & administration of public disaster appeals.	Yes	Follow up with State Government	On Hold	Low	Executive Officer Emergency Management	2011
25	Before the onset of each cyclone season the LDMG should review & update the evacuation sub-plan of the Local Disaster Management Plan to take account of the risks identified in this study & to take account of best-practice evacuation planning methods.	Yes	TLDMP and some plans reviewed annually	In Progress	High	Executive Officer Emergency Management	December Annually
26	Townsville SES Unit investigate the development of a retirement village emergency & evacuation plan based on that operated by the Maroochy (Sunshine Coast Region) SES Unit.	Yes	Emergency Management Section to follow up with SES	No Action to Date	<del>Ongoing</del> Medium	Executive Officer Emergency Management	Dec-10
27	Council & the LDMG Welfare Committee examine the need & suitability of using 'off the shelf' software to support the registration & tracking of evacuees.	Yes	Responsibility of QPS/Red Cross	Completed	-	-	-

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
28	Council establish a dialogue with the public & private proprietors & operators of critical infrastructure to ensure that they understand their role in the local disaster management process & to encourage their support for the work of the LDMG.	Yes	Existing information and processes to be reviewed prior to consultation with critical infrastructure owners and operators	No Action to Date	<del>Medium</del> High	Executive Officer Emergency Management	Dec-10
29	The LDMG & EMQ commission specific research & analysis of the full range of critical infrastructure, especially in areas identified as information gaps in this study. Liaise with Geoscience Australia to ensure that this research is modelled on the approach employed in Commonwealth-led Critical Infrastructure Protection, Management & Analysis (CIPMA) program so that the information developed could be exchanged between the two systems.	Yes	Existing information and processes to be reviewed prior to consultation with critical infrastructure owners and operators	No Action to Date	<del>Medium</del> High	Executive Officer Emergency Management	Dec-11

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
30	The LDMG establish an arrangement with the local members of Wireless Institute Civil Emergency Network (WICEN) to provide communications support in the event of extended outages of telephone & other communications system.	Yes	Current loose agreement with SES to be formalised	In Progress	Medium	Executive Officer Emergency Management	Dec-10
	Severe Storm						
1	Council maximise the likelihood that all new buildings conform to wind loading standards under the BCA by incorporating into the Townsville City Plan wind loading and corrosion line mapping based on the provisions of AS 1170.2- 2002, As 4550-2006 and BCA Table 3.3.3.1.	Yes	BCA set wind loading standards. Council supports research by JCU Cyclone Testing Station	Completed	-	-	-
2	Council encourage owners & builders to ensure that renovations &/or repairs to houses built before 1989 are upgraded to meet current wind load conditions in line with SAA HB 1321 ( <i>Structural upgrading of</i> <i>older houses part 2 : cyclone</i> <i>areas</i> ).	Yes	BCA set wind loading standards. Council supports research by JCU Cyclone Testing Station	Completed	-	-	-

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
3	Council run annual information sessions for private certifiers, builders & architects on the requirements of AS 1170.2 & the desirability of applying the retrofit strategies of H 1321.	Yes	To be incorporated into Community Awareness Plan	No Action to Date	Medium	Executive Officer Emergency Management	2011
4	Council require operators of caravan parks to install tie down points for caravans & provide information to all caravan owners on caravan safety in high winds.	Yes	Review Council's Local laws regarding public safety	In Progress	High	Executive Officer Emergency Management	Jun-11
5	Council maintain a plan for the management of broken fibro & other asbestos-based products following storm damage. Identify appropriate disposal sites.	Yes	Existing guidelines for handling asbestos in place, disposal sites identified by Waste Management	Completed	-	-	-
6	Council continue to ensure that power supply in all new subdivisions is placed underground & establish a program with Ergon of placing power supply underground in areas of high exposure &/or frequent damage.	Yes	Policy in place for residential development, doesn't cover industrial	Completed	-	-	-
	Flood						
1	Council to review the detailed flood risk treatment strategies identified by consultants Maunsell Australia in their 2005 report for inclusion in a new City floodplain management strategy.	Yes	Townsville Flood Study	In Progress	Medium	Strategic Planning	2012

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
2	Council establish a rolling program to review & update flood modelling at ten or preferably five- year intervals, in urban areas & rural areas where significant development is planned to take place. Continue research & computerised flood impact modelling to support emergency management planning & operations.	Yes	Townsville Flood Study	In Progress	Medium	Strategic Planning	2012
3	Council investigate the need to undertake an updated flood management study to take account of the upgrade of the Ross River Dam & to incorporate the NQ Water operational procedures for managing flows through the dam into the local disaster management plan.	Yes	Townsville Flood Study	In Progress	Medium	Strategic Planning	2012
4	If indicated by the outcomes of Flood Strategy 3 Council investigate the installation of a siren warning system for properties immediately downstream of the dam to be used when flood waters are to be released from the dam.	Yes	To be discussed with BOM and EMQ	No Action	<del>Medium</del> Low	Executive Officer Emergency Management	Mid-11

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
5	LDMG ensure that local SES and QPS staffs are made familiar with management arrangements for local flood issues, conduct on-site briefings on the management of the flood threat at identified flash flooding hotspots, especially where road closures are required.	Yes	To be reviewed after completion of Townsville Flood Study	On Hold	Medium	Executive Officer Emergency Management	2012
6	Council records flood inundation information from major events in order to build up a database of records that can be used in responding to future flood events in flood prone areas.	Yes	Townsville Flood Study	In Progress	Medium	Strategic Planning	2012
7	Recommend to LGAQ that they negotiate with EMQ and DLGP a review of SPP 1/03 guidelines relating to flood with the particular suggestion that guidance be included on an appropriate resolution for DEM used in flood modelling.	Yes	SPP Guidelines reviewed by State Government, Part of City Plan Project	Completed	-	-	-
	Storm Tide						
1	Council establish a rolling program to review & update storm tide modelling at ten or preferably five-year intervals. Continue research & computerised inundation impact modelling to support emergency management planning & operations.	Yes	To be reviewed in line with City Plan Review (10 Years)	On Hold	Low	Strategic Planning	2015

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
2	The LDMG establish a program to encourage residents in potentially exposed locations to develop household emergency response plans for storm tide based on the existing modelling & storm tide warning system.	Yes	Part of Community Awareness Program, Community Messaging System implemented Oct 2009	Completed	-	-	-
3	LDMG to maintain specific evacuation plans for communities in storm tide-prone areas such as Cungulla & parts of South Townsville based on scenarios developed from the modelling.	Yes	Evacuation sub-plan being prepared	In Progress	Medium	Executive Officer Emergency Management	2011
	Landslide						
1	Stabilise potentially problematic batters or slopes on Council- controlled roads, or erect protective structures (such as mesh fences or bunds) & encourage DMR to undertake similar work on State-controlled roads.	Yes	To be reviewed upon completion of current landslide study	On Hold	<del>Ongoing</del> Medium	Infrastructure Services	Mid 2011

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
2	Given the uncertainty that exists regarding the potential risks posed by rock falls from Castle Hill being initiated by a close earthquake of moderate or greater magnitude, Council, in conjunction with relevant State agencies, commission specific research to establish an appropriate management strategy.	Yes	To be reviewed upon completion of current landslide study, Castle Hill EMP also in progress	On Hold	<del>Ongoing</del> Medium	Infrastructure Services	Mid 2011
3	Council maintain an ongoing community education program warning about rock falls from Castle Hill & landslides from other steep slope areas such as Mount Louisa.	Yes	To be reviewed upon completion of current landslide study	On Hold	<del>Ongoing</del> Medium	Infrastructure Services	Mid 2011
4	Recommend to LGAQ that they negotiate with EMQ and DLGP to review the SPP 1/03 guidelines relating to landslide with the particular suggestion that the 'default' landslide threat zone of 15% slope be revised to require specific reference to the litholgy.	Yes	SPP Guidelines reviewed by State Government, Part of City Plan Project	Completed	-	-	-
5	Council investigate technical options for monitoring areas of Castle Hill that have been identified as posing a particular threat from rock falls from steep rock cliffs.	No	Part of Castle Hill EMP process, Environmon rain gauge station installed	In progress	<del>Ongoing</del> Medium	Infrastructure Services	Mid 2011

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
6	Council establish a MOU with the State Government as to their potential liability should major damage or injury result from a rock fall or landslide from Council- managed State land on Castle Hill.	Yes	To be reviewed upon completion of current landslide study, Castle Hill EMP also in progress	In Progress	<del>Ongoing</del> Medium	Infrastructure Services	Mid 2011
7	Council commission City-wide landslide hazard potential mapping to SPP 1/03 standard. Council's GIS staff could undertake most of the work with guidance from an external consultant.	Yes	Landslide Report completed - as part of this study.	Completed	-	-	-
8	Incorporate the updated landslide potential hazard mapping done to SPP 1/03 standard into the new Townsville City Plan.	Yes	SPP Guidelines reviewed by State Government, Part of City Plan Project	Completed	-	-	-
	Bushfire						
1	Council commission an updated bushfire hazard mapping program to cover the New Townsville City area. Council's GIS staff has the necessary technical skills to undertake this work under the supervision of an external consultant that is skilled in bushfire hazard mapping.	Yes	Bushfire Report completed as part of this study	Completed	-	-	-

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
2	Incorporate the updated bushfire hazard potential mapping, done to SPP 1/03 standards, into the new Townsville City Plan.	Yes	Bushfire Study Report forwarded to City Plan Unit	In Progress	High	Executive Officer Emergency Management	2012
3	Council consider the immediate appointment of a Fire Management Officer to undertake the duties suggested by the 1994 State Bushfire Audit & to oversee the implementation of the bushfire management strategy for the study area.	Yes	Bushfire Management Officer incorporated in Integrated Sustainability Services	Completed	-	-	-
4	Council adopt as policy for managing fuel on council- controlled land: (a) the fire management principles & practices identified by the FABC & QPWS which seek to strike a balance between community safety & preserving biodiversity; (b) recognition of the principle that the need for fuel reduction to improve community safety will take precedence over consideration of smoke pollution from prescribed burning.	Yes	To be assed by Bushfire Management and Bushfire Management Working Group	In Progress	Medium	Bushfire Management Officer	Mid 2011
5	Conduct an annual audit of fuel conditions on Council-controlled land.	Yes	To be assessed by Bushfire Management Officer and Bushfire Management Working Group	In Progress	Medium	Bushfire Management Officer	Mid 2011

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
6	Based on the results of those audits, allocate adequate human & equipment resources, including QFRS support, to initiate a sustainable program of fuel management on Council- controlled land, with the land with the greatest level of hazard being treaded as soon as possible.	Yes	To be assessed by Bushfire Management and Bushfire Management Working Group	In Progress	Medium	Bushfire Management Officer	Mid 2011
7	Council, QPWS & Department of Defence, in conjunction with QFRS, adopt a maximum desirable fuel loading in bushland interface areas within the study area (e.g. 12 t/ha). Develop strategies to monitor & maintain that loading level, especially in areas adjacent to critical infrastructure & the urban interface.	Yes	To be assessed by Bushfire Management and Bushfire Management Working Group	In Progress	Medium	Bushfire Management Officer	Mid 2011
8	Consider formation of the Townsville City Fire Management Committee with representation from QFRS, QPWS, Defence, Powerlink & Ergon as sub- committee of the LDMG.	Yes	Bushfire Management Group formed within Council	Completed	-	-	-

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
9	Draw to the attention of building certifiers & developers operating in the City the existence of the <i>natural hazard management area</i> <i>(bushfire)</i> mapping & the responsibility they bear to ensure that the provisions of AS 3959 with regard to design & construction standards within those areas designated as being fire-prone, together with appropriate subdivisional design & sitting principles identified by CSIRO & others, are complied with.	Yes	Process to be formalised with Planning Department	On Hold	Low	Executive Officer Emergency Management	Mid 2011
10	QFRS promote bushfire safety program in study area suburbs & localities with an identified fire threat. Households in those areas are to be encouraged to develop household fire plans.	Yes	QFRS household fire safety planning advertising commenced mid 2010	Completed	-	-	-
11	QFRS consider installing & maintaining prominent 'fire danger' signage in urban interface areas to improve community awareness in periods of elevated fire danger.	Yes	Part of Household Fire Safety Program	Completed	-	-	-

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
12	Recommend to LGAQ that they negotiate with EMQ and DLGP to review the SPP 1/03 guidelines relating to bushfire with the particular suggestion that guidance be included on an appropriate resolution for modelling in interface area. It would also be advantageous to publish more appropriate weights for aspect to reflect wind direction in local fire weather events & a more comprehensive list of hazard potential scores vegetation or ecosystem types than is currently available.	Yes	SPP Guidelines reviewed by State Government, Part of City Plan Project	Completed	-	-	-
	Earthquake						
1	Commission a detailed site class study of the urbanised area to improve the resolution & accuracy of the class zones suggested in this study. From that analysis identify specific building types that may be exposed to amplified earthquake shaking.	Yes	Strategy to be reassessed	On Hold	Low	Technical Services Infrastructure Services	2011

NO	STRATEGY	FORMER THURINGOWA AREA REPORT	ACTION	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
2	Ensure all new buildings comply with the BCA earthquake loading code (AS1170.4) as modified by the revised acceleration factors. Encourage owners of existing buildings to upgrade their properties to current standards when undertaking structural renovations or extensions.	Yes	<ol> <li>BCA set building standards, private certifiers enforce standards</li> <li>Upgrade of existing buildings to be reviewed with Planning and Development</li> </ol>	Completed On Hold	- Low	- Executive Officer Emergency Management	- 2011
3	Conduct an audit of all Council buildings & where appropriate retrofit all those deemed to be potentially unsafe in an earthquake or Richter magnitude 5.0 or greater.	Yes	Project to be considered in conjunction with Property Services	On Hold	Low	Executive Officer Emergency Management	2012
4	Educate the public about what to do in an earthquake.	Yes	Incorporated within Community Awareness Plan, EMA brochures available	In Progress	Medium	Executive Officer Emergency Management	Dec-11

## APPENDIX C: ADDITIONAL RISK STRATEGIES IDENTIFIED IN THURINGOWA REPORTS

	STRATEGY	COMMENT	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
	Landslide					
1	All areas identified as being within a Landslide area, need to be subject to a site specific geotechnical investigation at the time of a development / building application.	Process to be developed		Medium	Executive Manager Strategic Planning Planning and Development	2011
2	Identify an emergency access / evacuation route for Paluma or implement remedial / stabilisation works on Paluma Road. Negotiate with Dept. Transport and Main Roads for appropriate outcome.	Undertaken with cooperation from the Department of Transport and Main Roads		Medium	Technical Services	2011
3	Current Townsville Landslide overlay maps be updated in accordance with Australia Geomechanics Society, 2007 procedures.	Updated mapping procedure released		Low	Technical Services	2011
4	Australian Geoguides be adopted by Council for use on hillside development.	Geoguides LR3, LR4, LR5, LR6, LR8 and LR9 to be adopted.		Medium	Executive Manager Strategic Planning Planning and Development	2012
5	The current Planning Scheme Landslide Hazard code be amended to reflect the outcomes of this study report.	Draft planning code available		Medium	Executive Manager Strategic Planning Planning and Development	2012
6	<ul> <li>The Local Disaster Management Plan be amended to: <ul> <li>identify landslides as a weather related hazard</li> <li>Identify evacuation routes for Paluma and Mt Elliot</li> <li>Include the Dept of Main Roads and Transport as partly responsible for the road network</li> <li>Reference the landslip report in updated Plan.</li> </ul> </li> </ul>	Recommendation to be included at time of next review of the LDMP		High	Executive Manager Emergency Management	2011
	Bushfire			·		

	STRATEGY	COMMENT	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
1	Council adopt the Bushfire Hazard Map developed under the current SPP 1/03.	Bushfire Map completed as part of this study		High	Executive Manager Strategic Planning Unit	Dec-10
2	Incorporate the updated bushfire hazard potential mapping, done to SPP 1/03 standards, into the new Townsville City Plan.	Bushfire Study Report forwarded to City Plan Unit		High	Executive Manager Strategic Planning Unit	Dec-10
3	When the new SPP 1/03 is announced revise the Bushfire Hazard Map to meet any new requirements.	Bushfire Mapping to be revised		Medium	Executive Manager Strategic Planning Unit	Jul-11
4	When an amendment is made to AS3959- 2009 the bushfire prone mapping to be reviewed.	Bushfire Mapping to be revised		Medium	Executive Manager Strategic Planning Unit	Jul-11
5	When the Victorian Bushfires Royal Commission final report is released, its recommendations be reviewed and any changes incorporated into Council's new Planning Scheme.	To be assessed by Bushfire Management Officer, Bushfire Management Working Group and City Plan Unit.		High	Executive Officer Emergency Management and Executive Manager Strategic Planning Unit	Apr-11
6	When the Victorian Bushfires Royal Commission final report is released, its recommendations be reviewed and any changes incorporated into Council's Disaster Management Plans	To be assessed by Bushfire Management Officer, Bushfire Management Working Group and City Plan Unit.		High	Executive Officer Emergency Management	Apr-11
7	Local Law No 12, Safety and Convenience be amended to include provision of notices to land owners that do not appropriately manage their property in accordance with SPP 1/03, AS3959-2009 and the City Planning Scheme. Penalties to apply if an owner does not comply with the notice within the prescribed time period.	Revise Local Law No 12		Medium	Exec Manager Integrated Sustainability	Jan-11
8	Council's to inspect and monitor properties to ensure the appropriate bushfire mitigation measures are adopted and maintained and to enforce Local Law No 12.	Inspection and Monitoring to be included in the position description for Council's Bushfire Management Officer.		Medium	Exec Manager Integrated Sustainability	Jan-11

	STRATEGY	COMMENT	STATUS	PRIORITY	REPONSIBLE OFFICER	TARGET DATE
9	Before the start of each Bushfire season, Council run a community education program aimed at building community resilience & self reliance. To include: - Public education and awareness program - Advertising campaign - Pamphlets delivered to rural areas	Education and awareness program to be developed by BMWG and QFRS		High	Executive Officer Emergency Management	Mid 2011
10	Make an interactive DIY flowchart for owner builders available on Council's web site to assist in designing and building in bushfire prone areas.	To be assessed by Bushfire Management Officer, Bushfire Management Working Group and City Plan Unit.		Low	Executive Manager Strategic Planning Unit	2012
	Earthquake					
1	Identify additional open area evacuation sites (buildings may collapse)	Reviewed in conjunction with QFRS and Bushfire Neighbour Safety Places		Low	Executive Officer Emergency Management	2011
2	Evaluate structure stability of evacuation centres with regards to earthquake.	Centre to be able to survive an earthquake.		Medium	Executive Officer Emergency Management	2011
3	Train search and rescue personnel to current urban search and rescue procedures in collapsed buildings.	To be raised at next LDMG and DDMG???		Medium	Executive Officer Emergency Management	2011