

	drift), water or waves.
Wave Height	The vertical distance between a wave trough and a wave crest.
Wave Hindcasting	The estimation of wave climate from meteorological data (barometric pressure, wind) as opposed to wave measurement.
Wave Length	The distance between consecutive wave crests or wave troughs.
Wave Period	The time taken for consecutive wave crests or wave troughs to pass a given point.
Wave Rider Buoy	A floating device used to measure water level variation caused by waves. It is approximately 0.9m in diameter and is moored to the sea floor.
Wave runup	The vertical distance above mean water level reached by the uprush of water from waves across a beach or up a structure
Wave Setup	The increase in water level within the surf zone above mean still water level caused by the breaking action of waves.
Wave Train	A series of waves originating from the same fetch with more or less the same wave characteristics.
Wind Setup	The increase in mean sea level caused by the “piling up” of water on the coastline by the wind.
Wind Waves	The waves initially formed by the action of wind blowing over the sea surface. Wind waves are characterised by a range of heights, periods and wavelengths. As they leave the area of generation (fetch), wind waves develop a more ordered and uniform appearance and are referred to as swell or swell waves.
Windborne Sediment Transport	Sand transport by the wind. Sand can be moved by the processes of suspension (fine grains incorporated in the atmosphere), saltation (medium grains “hopping” along the surface) and traction (large grains rolled along the surface).

Glossary of Acronyms

Source: Tweed Coastline Management Plan (Umwelt, 2005)

CCA	Comprehensive Coastal Assessment
CHA	Coastal Hazards Assessment
CL Act	Crown Lands Act
DCP	Development Control Plan
DECC	Department of Environment and Climate Change
DGRs	Director General's Requirements
DIPNR	Department of Infrastructure, Planning and Natural Resources
DLWC	Department of Land and Water Conservation
DL	Department of Lands
DPI	Department of Primary Industries
EMP	Estuary Management Plan
EP& A Act	Environmental Planning and Assessment Act
ESD	Ecologically Sustainable Development
HAT	Highest Astronomical Tide
LAT	Lowest Astronomical Tide
LGA	Local Government Area
MHWS	Mean High Water Spring
MLWS	Mean Low Water Spring
NRCMA	Northern Rivers Catchment Management Authority
PWC	Personal Water Craft
SEPP	State Environmental Planning Policy
TCMP	Tweed Coastline Management Plan
TLEP	Tweed Local Environmental Plan
TSC	Tweed Shire Council

Executive Summary

VDM Consulting Belleng have been engaged by Leighton Properties Pty Ltd to prepare a Coastal Hazard Assessment (CHA) for the proposed eco-tourism resort development at Lot 490 on DP1095234, Part of Lot 489 DP47021 and Part of Lot 500 DP727470 Casuarina Way, Kingscliff.

The subject site is located at Casuarina Way, South Kingscliff, within the Tweed Shire of NSW. The site is bound by Cudgen Creek to the north and west, to the northwest by Tweed Coast Way and to the east the Pacific Ocean. The northern boundary of the Salt development is located immediately adjacent to the south of the site. The site is currently undeveloped however was subject to sand mining until the early 1980s and as a result is highly disturbed.

This report identifies the following potential coastal hazards to be associated with the development proposal:

- Beach Erosion;
- Shoreline Recession;
- Coastal Entrance Instability;
- Vegetation Degradation and Sand Drift;
- Coastal Inundation;
- Climate Change; and
- Stormwater Erosion.

The *Tweed Coastline Hazards Management Plan* (WBM, 2001) details the coastal processes and details and hazards which affect the coastline of the Tweed Shire. The report provides an assessment of the projected landward limit of the backbeach erosion escarpment and cumulative hazards zones for nominated planning periods. The report defines a number of management zones for the coastline based on coastal features. The development is located within the 'Norries Head to Sutherland Point Beach Unit' Area of the report. The information contained within the report previously formed the basis for a hazards assessment of the subject site (section 3 of this report).

However, since preparation of the first and second issues of this report, the New South Wales Government has adopted the *NSW Sea Level Rise Policy Statement* (October 2009) which adopted new planning benchmarks with respect to sea level rise.

Tweed Shire Council subsequently engaged a consultant to update the hazard lines for Tweed Shire in accordance with the NSW Government *Draft Coastal Risk Management Guide: Incorporating sea level rise benchmarks in coastal risk assessments*.

The results of the assessment have shown that the development still complies with all relevant planning instruments in NSW, and that the setbacks provided are still greater than the revised hazard zones provided by Tweed Shire Council in August 2010.

Of the hazards identified; the most significant issues were deemed to be the potential for coastal erosion and foreshore recession.

Whilst the *Tweed Shire Coastline Hazard Definition Study* proposed that less than the full 7(f) zone Environmental Protection (Coastal Lands) as depicted in the *Tweed Local Environmental Plan 2000* (Tweed Shire Council) is required for hazard mitigation purposes over the 50 and 100 year planning periods, retention of the 7(f) buffer is considered to provide long-term protection from coastal erosion and other hazards for the management of undeveloped lands (Umwelt, 2005).

1. Introduction

VDM Consulting Belleng has been engaged by Leighton Properties Pty Ltd to prepare a Coastal Hazard Assessment for the proposed eco-tourism resort development at Lot 490 on DP1095234, Part of Lot 489 DP47021 and Part of Lot 500 DP727470 Casuarina Way, Kingscliff.

The NSW Government Department of Planning has issued the Director-General's Environmental Assessment Requirements (DGR's); which provides a detailed list of further investigations required to properly assess the development. These requirements have been undertaken in consultation with relevant government agencies including Tweed Shire Council (TSC).

This report has been prepared to address the key issue of Coastal Hazards; as identified in the DGRs extract below:

6. Hazard Management and Mitigation	
Coastal Processes	
6.1	Address coastal hazards and the provisions of the Coastline Management Manual. In particular consider impacts associated with wave and wind action, coastal erosion, sea level rise and more frequent and intense storms.

The report identifies all potential coastal hazards associated with the development proposal, provides an evaluation of the development against the relevant planning instruments, and determines mitigation measures where required.

Following preparation of the first and second issues of this report, the New South Wales Government promulgated the *NSW Sea Level Rise Policy Statement* (October 2009) which adopted new planning benchmarks with respect to sea level rise.

Tweed Shire Council subsequently engaged a consultant to update the hazard lines for Tweed Shire in accordance with the NSW Government *Draft Coastal Risk Management Guide: Incorporating sea level rise benchmarks in coastal risk assessments*.

This report has been amended in September 2010 following comments from Tweed Shire Council, Department of Planning, Department of Environment, Climate Change and Water, and the Land and Property Management Authority with respect to this assessment, and receipt of revised hazard line mapping from Tweed Shire Council in August 2010.

1.1. Scope and Objectives

Decision making in the coastal zone requires requires an understanding of the environmental processes that are constantly shaping the coastline, and to quantify the sometimes significant risks which to life, property and the environment itself.

Specifically, this CHA is structured as follows:

- Section 1 - An overview of the subject site and development;
- Section 2 - A description of the coastal management framework;
- Section 3 - Identification and assessment of all potential individual coastline hazards associated with both the coastline and Cudgen Creek related to:
 - Beach Erosion including dune slope instability and storm bite;
 - Shoreline Recession;
 - Coastal Entrance behavior;
 - Sand Drift;

- Stormwater Erosion;
- Oceanic Inundation;
- Climate Change including sea level rise and frequent and intense storms; and
- Mitigation Measures proposed as part of the development;
- Section 4 - An evaluation of proposed development against applicable policies of relevant Planning Instruments in the context of coastal hazard assessment and management;
- Section 5 – Conclusions; and
- Section 6 – References.

The objectives of this report are:

- To accurately describe and assess all coastal hazards associated with the proposal in the context of the *Coastline Management Manual*, *Tweed Coastline Hazard Definition Study*, and *Tweed Shire Coastal Management Plans*;
- To evaluate the development against all other relevant planning instruments in the context of coastal hazard assessment and management;
- Ensure that the type, scale and location of the development reflects the level of risk posed by coastal hazards; and
- To describe mitigation measures where required.

1.2. Description of Subject Site

1.2.1. General

The subject site is located at Casuarina Way, South Kingscliff, within the Tweed Shire, NSW. The site is bound by Cudgen Creek to the north and west, to the northwest by Tweed Coast Way and the Pacific Ocean to the east. The northern boundary of the Salt development is located immediately adjacent to the south of the site. The site is currently undeveloped however was subject to sand mining until the early 1980s and as a result is highly disturbed.

Address	Lot 490, Casuarina Way, Kingscliff
Real Property Description	Lot 490 DP47021 Part of Lot 489 DP47021 Part of Lot 500 DP727470
Area	The total area of the site encompassing Lot 490 and parts of Lot 500 and Lot 489 is 43.4 ha of which 11.77 ha will be subject to development.
Land Tenure	Crown Land to be developed under lease agreement.
Zoning-Tweed Local Environmental Plan	The bulk of Lot 490 is designated as 2(f) Tourism Zone with portions of Lot 490 adjacent to Cudgen Creek zoned as 7(a) Environmental Protection (Wetlands and Littoral Rainforests). The parts of Lot 489 and 500 which fall within the subject site are designated as 7(f) Environmental Protection (Coastal Lands).
Topography & Stormwater Conveyance	The subject site slopes from the southeast to the northwest at a grade of approximately 2%. Levels across the site range from a maximum of 8 m AHD to a minimum of 1m AHD. Stormwater flows north through the centre of the site into an existing wetland and through culverts located under Tweed Coast Way to discharge into Cudgen Creek and finally into the Pacific Ocean.
Rainfall	The climate of Kingscliff is considered sub-tropical having relatively warm wet summers, mild winters and a high rainfall average. A rainfall study was undertaken for 6-minute interval data obtained from the Bureau of Meteorology (BOM) for station 058158 (Murwillumbah). A data set with rainfall recordings for the year 1978 (average rainfall year) was applied to the MUSIC modelling performed as part of a Stormwater Management Plan prepared by Belleng VDM which indicates the mean annual rainfall is 1648 mm.

Soils	Previous geotechnical studies have indicated soil types are a mixture of sand, loam, and sandy-clay. Fine sands near the surface exhibit typical permeability of 2.5 m/day. Exposure of acid sulfate soil has been identified as a potential issue during earthworks.
Vegetation Communities	Vegetation on site consists of highly degraded vegetation communities dominated by environmental weed species. Some isolated stands of native regrowth vegetation dominated by <i>Banksia</i> and <i>Casuarina</i> species are present.

1.2.2. Coastal Features

The subject site is located adjacent to a section of South Kingscliff Beach, which extends from Norries Head in the south, to Sutherland Point in the north, approximately 8 km in length. It is composed of clean fine sand across its width; from the extensive dunal system seaward to deep water (Umwelt, 2003).

The South Kingscliff Beach profile shows slight embayment between the two controlling headlands, with the southern end showing more indentation in a crenulate planform, which is typical of a beach characterised by south to north net longshore transport in the nearshore zone (TSC, 2001).

The following is an extract from the Tweed Shire Coastline Hazard Definition Study Final Report prepared by WBM Oceanics Australia (2001) which describes the features of South Kingscliff Beach:

"The main dune system is extensive and relatively high at typically 6-10 m above Mean Sea Level (MSL), the higher dunes being in the central beach area. It has been recountoured after sand mining to a more or less even grade in most areas, sloping seawards from the Kingscliff-South Kingscliff road which runs along a back barrier dune ridge at an elevation 10-15 m at its western extremity, some 250-300 m from the beach.

Erosion reportedly in 1974, although possibly in 1967, created a distinct scarp in the main dune which persists today. In the central beach area, the top of this scarp is some 10-12 m above MSL, while to the north and south it reaches to a height of about 5-6 m. A well developed foredune exists seaward of the toe of the scarp in the main dune.

To the west of the road, the barrier slopes down to low lying wetlands and the Cudgen Lake/Cudgen Creek System. The system flows out of Cudgen Lake towards the north behind the barrier dunes and discharges at Kingscliff, adjacent to the northern side of Sutherland Point.

Inspections and surveys over the past 20 years show this foredune to extend up to 50 m wide, is typically well vegetated with the sand binding spinifex grass, and is wind formed to a peak height of about 4-5 m. At some locations, this foredune is separated from the main dune erosion scarp by a swale in which thick vegetation, both native and exotic (e.g. bitou bush), is prevalent.

The subject site does not differ markedly from this description; with a relatively high dune system present in the central beach area of Lot 500 with a typical foredune height of approximately 7 m. The dunal system has reasonable vegetative cover in an open forest structure; comprised of a mix of native and exotic species including *Casuarina equisetifolia* and *Acacia sophorae* (Warren, 2008).

As the site is bound by Cudgen Creek to the north and west, and the creek is also considered as being part of the defined NSW coastal zone (as declared under the *Coastal Protection Act 1979*), coastal hazards associated with both the creek and ocean are considered in this report. The Cudgen lake and creek are a coastal lake and creek system with a waterway area of 1.4 km² and catchment of 66 km² (NSW Government-Department of Natural Resources, 2008). Cudgen Lake is a shallow (1-2 m deep) perched tidal lagoon of approximately 160 ha, which drains into Cudgen Creek (NSW Government-Department of Natural Resources, 2008). Cudgen Creek maintains a meandering, mostly northerly 9 km course to its entrance at Kingscliff.

The entrance is north of Lot 489 on the northern side of Sutherland Point and is open, with the installation of breakwalls in 1967. A relatively high littoral transport rate of about 500,000 m³/yr discharges from the entrance from south to north.

The section of creek which bounds the north and western portions of the site is in relatively good condition however some sections have minor bank erosion evident. Two SEPP 14 Wetland areas identified as 43c and 43d respectively adjoin the creek on the western boundary of the subject site.

Figure 1-1 and Figure 1-2 illustrate the location and nature of the subject site.



Figure 1-1.Site Locality Plan

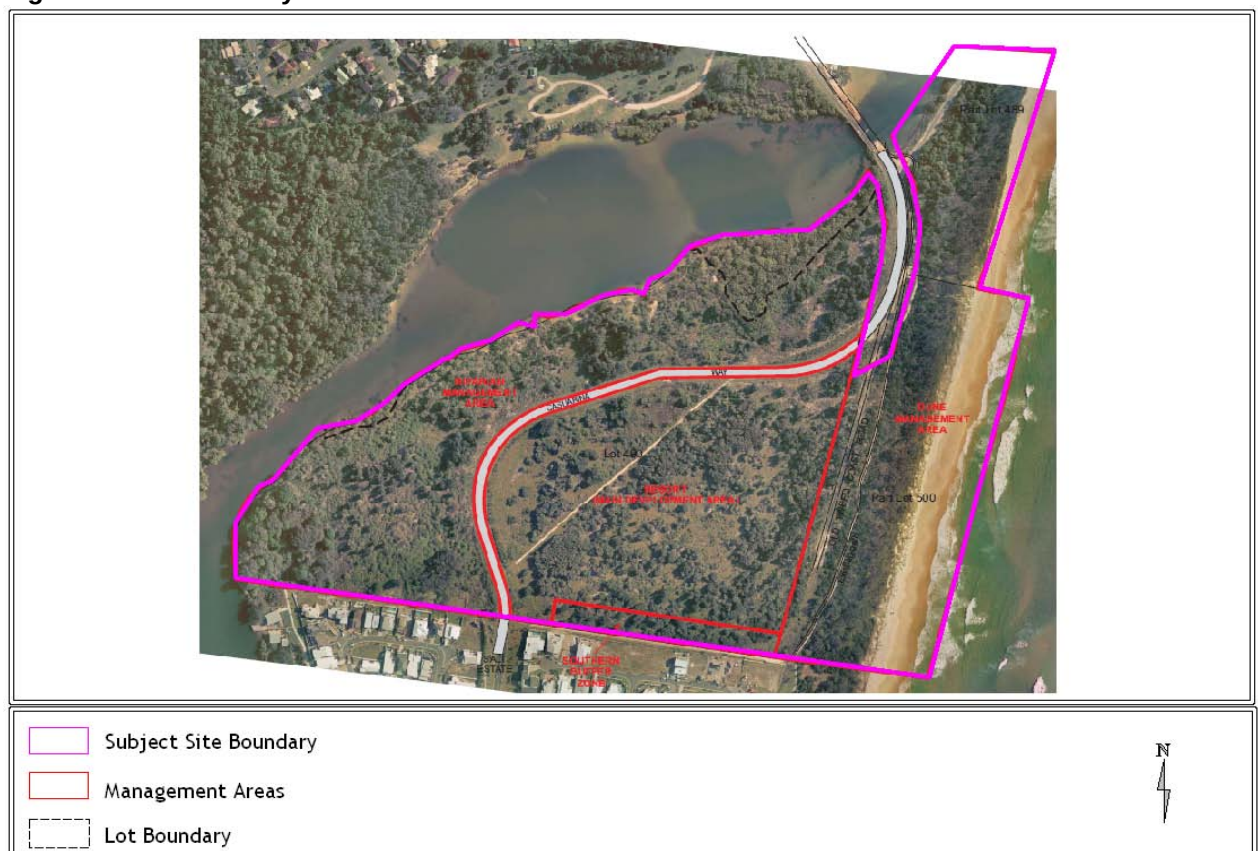


Figure 1-2. Aerial Photography (source: James Warren and Associates, 2008)

1.3. Description of Development Proposal

Leighton Properties have acquired a Development Lease with the NSW Department of Lands for the development of an ecotourism resort; to be compliant with the *Lot 490 Management Plan* (NSW Department of Lands, 2005). The Kingscliff Resort Concept Plan prepared by Leighton Properties Pty Ltd states that the development is to be:

"A quality eco-tourism development in a natural setting combining a range of passive and active recreational opportunities and economic benefits to the local community while ensuring protection and enhancement of the site's environmental values"

The 'Kingscliff Resort' will include the following:

- 84 low rise units and 96 bungalows;
- Internal road network;
- Resort facilities including reception, restaurant, bar, conference area, retail, pool and spa;
- Interpretive facilities;
- Park, playground facilities;
- Nature trails and circuit training;
- Picnic shelters;
- Beach access and car parking;
- Beach Public amenities (change rooms, toilets and showers);
- Car parking;
- Pontoon;
- and
- Rehabilitation and revegetation works.

The portion of the site designated for the resort development forms 11.77ha of Lot 490. The remaining part of the site (part of Lots 490, 489 and 500) is to be maintained by the tenant in accordance with the requirements of the lease and will include ancillary public facilities including road and car parking, public amenities block, picnic shelters, play ground and circuit training facilities and access to the creek, beach and bush.

Setbacks are proposed to coastal features including a setback of variable width to Cudgen Creek, which is 80 m at its narrowest band width, and an approximate 150 m setback to the Pacific Ocean which forms the width of Lot 500. Some non-critical infrastructure is located within these setbacks; including road and car parking, public amenities block, picnic shelters, play ground and circuit training facilities and beach and estuary access.

Figure 1-3 presents the revised master plan for the site. It is noted that some minor changes have been made to the layout since the previous issues of this report however these generally relate to siting of dwellings and infrastructure. It is anticipated that the project will be developed in two stages with the northern half of the development being developed first.

LEGEND

- Resort internal circulation lanes
- On ground pedestrian and cycling pathways
- Suspended walkways
- Fully accessible bungalows
- Asset Protection Zone
- Landscape Visual Buffer
- Unit Pod
- Fully Accessible Unit Pod
- 2 Bedroom Bungalow
- 2 Bedroom Fully Accessible Bungalow
- 3 Bedroom Bungalow
- Beach Side Bungalow
- Maintenance Area



AMENDMENTS

REV.	DATE:	DESCRIPTION:	ISSUED BY:
G	13.08.10	RELODGEEMENT	GH
H	26.08.10	REVISED LAYOUT FOR RFI RESPONSE	GH
i	14.09.10	Surf life saving storage, Caraparking at entry	GH

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NOTES:

Verify all dimensions on site before the commencement of any new construction work, alterations or shop drawings - take measured dimensions in preference to any scaled dimensions

Comply to the following or any other relevant codes:
- Building Code of Australia
- Local Authorities Rules and Guidelines
- covenants manual
- Apply all applicable AUSTRALIAN STANDARDS where relevant, including:
- Termite Barrier AS 3660
- Access and Mobility Codes AS 1428.1 & 1428.2
Larger Scale Drawings Take Precedence to smaller scale

Kingscliff Resort
DEVELOPMENT



LEIGHTON PROPERTIES

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CLIENT. LEIGHTON PROPERTIES
JOB THE KINGSCLIFF RESORT
LOCATION CASUARINA WAY KINGSCLIFF 2487
PROPERTY DESCRIPTION

JOB No. 1040
DATE. OCT 09
SCALE. 1:1000@A1
1:2000 @ A3
DRAWN. GH
CHECKED JMA Architects

DRAWING SET MASTER PLAN
DRAWING TITLE SITE PLAN
DRAWING No: 1040 MP-01-3
ISSUE i
PRINT DATE 14/09/2010

FOR SUBMISSION

2. Coastal Management Framework

In June 2001 the NSW Government announced a Coastal Protection Package to protect the State's beaches, headlands and other coastal features for future generations. As part of the package, planning and development within the NSW coastal zone (as declared under the *Coastal Protection Act 1979*) is now subject to a Ministerial direction for coastal protection, *NSW Coastal Policy*, *State Environmental Planning Policy (SEPP) 71 - Coastal Protection*, and the *Major Projects SEPP* (which identifies coastal development that will need the approval of the Minister for Planning).

2.1. NSW Coastal Policy

The *NSW Coastal Policy 1997* is a document which identifies the State's various management policies, programs, and standards as they apply to the NSW coastal zone.

The coastal zone as declared under the *Coastal Protection Act 1979* is defined as:

- Three nautical miles seaward of the mainland and offshore islands;
- One kilometre landward of the open coast high water mark; and
- A distance of one kilometre around:
 - All bays, estuaries, coastal lakes, lagoons and islands;
 - Tidal waters of coastal rivers to the limits of mangroves, as defined by NSW Fisheries (1985) maps or the tidal limit whichever is closer to the sea.

The subject site therefore falls within the NSW coastal zone. The *NSW Coastal Policy* is an attempt by State government to better coordinate the management of the NSW coastline by providing a framework to manage the coast's physical, ecological, cultural and economic assets. The policy is therefore a summary of many programs and policies managed and implemented by a variety of statutory and non-statutory parties, under an overarching ideology for coastal zone management.

The primary objective of the policy is to ensure that the coast is managed in an ecologically sustainable fashion.

Following a review of the policy, the relevant objectives as they would apply to this proposal include:

- To manage the coastline and estuarine environments in the public interest to ensure their health and vitality;
- To give the impacts of natural processes and hazards a high priority in the planning and management of coastal areas; and
- To development land use and management plans which ensure the sustainable development and use of resources.

The key roles and implementation methods are illustrated in Figure 2.1 below, which is reproduced from the *Coastal Policy 1997*.

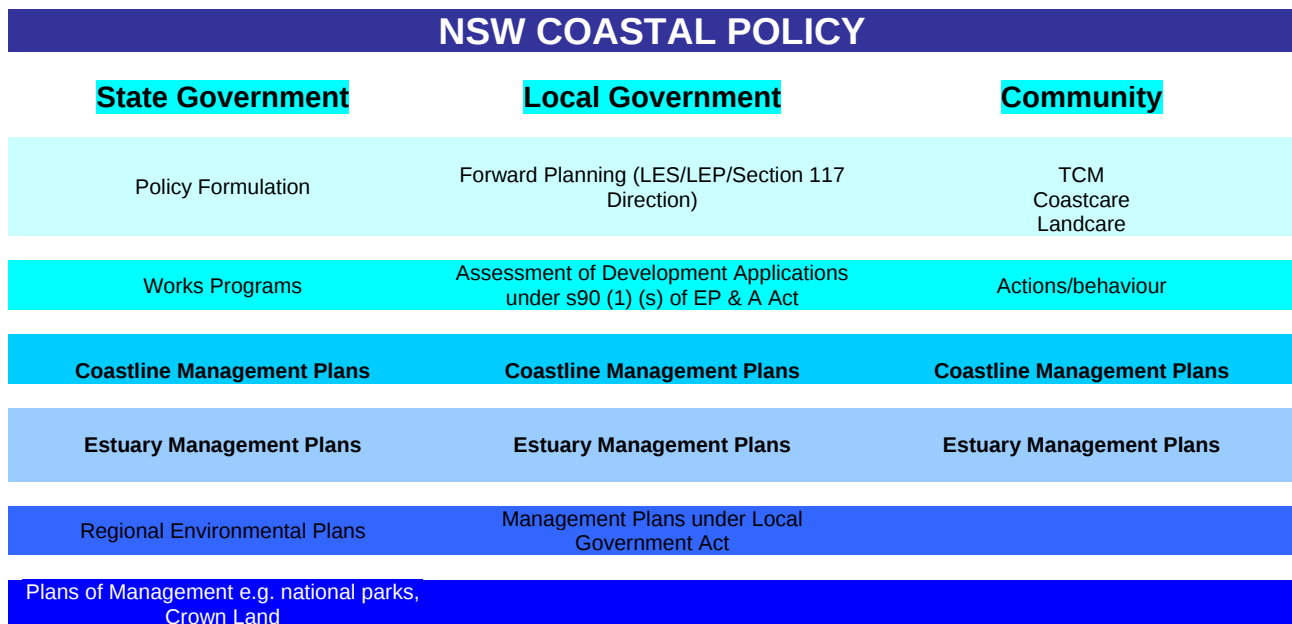


Figure 2-1 Coastal Policy-Key Roles and Implementation Mechanisms

As shown in Figure 2.1 above, Coastal Management Plans and Estuary Management Plans form two of the central planks of NSW Coastal Policy and are implemented through State and Local Government bodies and the community. The following sections provide further detail on the relevant policies and strategies contained within the Coastal Policy framework.

2.2. Coastline Management Manual

In 1988 the NSW Government introduced the *Coastline Hazard Policy* which brought forth a suite of planning and structural measures to ensure the balanced management of the coastline. The implementation of this policy in 1990 resulted in the publication of the ***Coastline Management Manual*** (NSW Government 1990). The manual outlined a system whereby local government authorities might strive to achieve better coastal management outcomes through an integrated management system. This system involves adoption of a management framework that requires planning factors such as social, economic, recreational, aesthetic and ecological issues be considered with coastline hazards and beach amenity requirements when assessing coastal management and development.

This management system is defined through implementation of six strategic steps:

1. Formation of a Coastal Management Committee;
2. Preparation of a Coastal Process/Hazard Definition Study;
3. Preparation of a Coastline Management Study;
4. Preparation of a Coastline Management Plan;
5. Review of the Management Plan; and
6. Implementation of the Management Plan.

TSC's adoption of this approach resulted in the preparation of the following plans of management:

- ***Tweed Shire Coastline Hazard Definition Study*** Final Report prepared by WBM Oceanics Australia (October 2001);
- ***Tweed Shire Coastline Management Study Stage 2, Management Objectives*** prepared by Umwelt Environmental Consultants (February 2005); and
- ***Tweed Coastline Management Plan*** (May 2005) prepared by Umwelt Environmental Consultants.

Sections 2.3.1 - 2.3.3 provides a description of these plans of management.

2.2.1. Tweed Shire Coastline Hazard Definition Study

This study details the coastal processes and hazards which affect the coastline of the Tweed Shire. The information has been used to provide an assessment of the projected landward limit of the backbeach erosion escarpment and cumulative hazards zones for nominated planning periods. The report defines a number of management zones for the coastline based on coastal features. The development is located within the 'Norries Head to Sutherland Point Beach Unit' Area of the report. The information contained within the Tweed Coastline Hazard Definition Study has formed the basis of this CHA (section 3 of this report).

Of the hazards identified; the most significant issues were deemed to be the potential for coastal erosion and foreshore recession.

2.2.2. Tweed Shire Coastline Management Study Stage 1 & Stage 2

The Tweed Coastline Management Study Stage 1 - Values Assessment (Umwelt, 2005) provided an assessment of values and issues attributed to the Tweed Coastline. The assessment was the culmination of the results of extensive community consultation effort, consideration of Council and regional policies, and discussion with relevant Council and State agency representatives.

In order to address the issues raised in Stage 1 of the study, Stage 2 of the assessment provides a range of management options for consideration. Broadly, these management options fell into two categories, being:

1. those required for the management of coastal hazards; and
2. those required to achieve sustainable use of the coastline and to provide for the ongoing protection and management of recreational amenity, ecological values, heritage values and social and economic well being.

The management options were subject to extensive consultation with statutory and community stakeholders in order to determine the most appropriate management options and move forward to the production of the Tweed Coastline Management Plan.

2.2.3. Tweed Coastline Management Plan

The Tweed Coastline Management Plan (TCMP) prepared by Umwelt in 2005 presents the culmination of the preceding Tweed Coastline Studies detailed in sections 2.2.1 and 2.2.2 above. The TCMP provides Tweed Shire Council with an integrated planning framework for management of the Shire's 37 km coastline. In order to improve coastline facilities and infrastructure, implementation of prioritised strategic actions within the plan will occur over time. The plan aims to strike a balance between maintaining access, functionality, access, and conservation outcomes. The plan also seeks to ensure that coastal hazards are planned and mitigated for where required. Management objectives as stated in the TCMP include relevant to this CHA include:

Objective	Secondary Objective
To recognise and accommodate natural processes and climate change	• To reduce the impact of coastline hazards on existing developed areas and to reduce the private and public losses resulting from damage by coastal forces • To ensure that future coastline development and land-use is compatible with coastline hazards, including the potential effects of climate change • To ensure that local emergency action plans are in place that deal with the threat, onset and aftermath of large coastal storms
	Kingscliff-South Kingscliff Area Management Actions • Management of Cudgen Creek entrance in accordance with revised Estuary Management Plan • Retain 7(f) Zone within Tweed LEP 2000 on current alignment • Enforce recommendations within the existing management plans for 7(f) zoned lands.

Section 3 provides an assessment of coastal hazards pertaining to the proposed development, based on the information provided in the Tweed Coastline Management Plans detailed in sections 2.2.1 - 2.2.3 above.

Additionally, the development has been assessed against the relevant coastal hazard management provisions of other relevant planning instruments in section 4 of this CHA.

2.2.4. Tweed Coast Estuary Management Plan 2004-2008

An Estuary Management Program is administered by the NSW Department of Natural Resources; which enables local communities to help develop and implement plans of management to restore and protect estuaries. The program forms an implementation component of the NSW Government's *River and Estuaries Policy* (1993). The intended outcomes of the program are to improve the health and function of an estuary whilst maintaining the aesthetic, recreational, environmental, and economic values of the estuary.

Estuary Management Plans have been prepared for three estuaries in the Tweed Shire (including Cudgen) in order to carefully manage, maintain and conserve the natural resources which are under pressure from urban development and recreation. The management plans for each of these creeks considers habitat enhancement and conservation, urban development, water quality, bank stability and increased recreational use. A 50 m minimum setback from the banks is proposed in the EMP for developments adjacent to Cudgen Creek.

3. Coastal Hazards

Coastal hazards are defined in the *Coastline Management Manual* as “*Detrimental impacts of coastal processes on the use, capability and amenity of the coastline*”. Whilst these hazards are attributable to naturally occurring coastal processes; these processes may lead to loss of amenity of the coastline.

Beyond impacts on the use and amenity of the coastline; a number of hazards are associated with development in the coastal zone which can place human life and property on the coast at risk. Therefore, knowledge of coastline hazards and their potential impacts on amenity and development is required in order to effectively manage the coastal zone.

The *Coastline Management Manual* has identified seven (7) hazards along the NSW coastline:

- Beach Erosion;
- Shoreline Recession;
- Coastal Entrance Instability;
- Vegetation Degradation and Sand Drift;
- Coastal Inundation;
- Slope and Cliff Stability; and
- Stormwater Erosion.

Of these seven (7) hazards identified, the *Tweed Coastline Hazard Definition Study* has identified that with the exception of Slope and Cliff Stability, all of these hazards apply to the Tweed Coastline. Hazard Management Options as defined in the *Coastline Management Manual* broadly correspond to four (4) categories; environmental planning, development control conditions, dune management and undertaking engineering works.

Additionally, the DGRs make specific reference to the following hazards: wave and wind action, coastal erosion, sea level rise and more frequent and intense storms.

The *Coastline Management Manual* states:

Coastline hazard conservation and management aims to achieve a balance between the use of the coast to meet human needs and desires on the one hand, and the financial loss and social disruption associated with hazard events on the other. This is done by attempting to ensure that hazards are avoided in the first instance and otherwise ensuring that the damage potential of properties is consistent with that risk.

Definition of hazards and their potential impacts in the coastal zone is subject to inherent uncertainties, which arise from the complex and interrelated nature of coastal processes, gaps in data sets in coastal processes, and lack of full understanding of these processes. Therefore any study which seeks to quantify these hazards must take into account the inherent uncertainties associated with coastal processes, and be able to respond to future uncertainties associated with them.

The coastline hazards and associated coastal processes affecting the Tweed Shire coastline were previously identified in the *Tweed Shire Coastline Hazard Definition Study* (WBM, 2001). However, in order to be able to take into account revised planning benchmarks for sea level rise adopted by the New South Wales Government in their *NSW Sea Level Rise Policy Statement*, Tweed Shire Council commissioned revised hazard mapping for the Tweed Coastline in 2010.

The previous coastal hazard zones as defined in the *Tweed Shire Coastline Hazard Definition Study* represented an assessment of the setback lines required, when taking into consideration *all* applicable coastal hazards.

The study depicts the landward extent of hazard zones for the **immediate, 50 year and 100 year** planning timeframes, as defined below: