



LOT 490 CASUARINA WAY,
KINGSCLIFF
FOR
LEIGHTON PROPERTIES

REV.	DESCRIPTION	APPR.	DATE
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REVISIONS



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DRAWING TITLE :

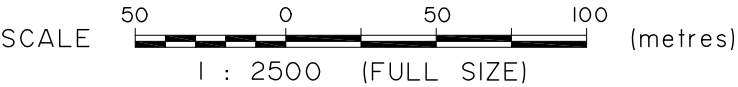
FIGURE 3.2
SUBJECT SITE SHOWING
HAT, MHWS FOR CUDGEN CREEK
AND PACIFIC OCEAN

DEVEL. APPLIC. No. :	DATE : 16.09.10
PROJECT LEADER : BRAD COMLEY	
DESIGNER : MICHAEL HOWE	
DRAFTSPERSON : MICHAEL HOWE	
CHECKED : KRISTINA ENTWISTLE	
APPROVED FOR AND ON BEHALF OF BELLENG VDM	

R.P.E.Q. No. :		
SCALE : 1:2500	DATUM :	FULL SIZE : A3
PROJECT No. : 00-3655	DRAWING No. : SK02	REVISION : B

LEGEND

- HAT
- MHWS
- MLWS
- LAT



3.1. Tweed Coastline Processes

Coastal processes associated with Tweed beaches as defined in the Hazard Study prepared by WBM (2001) are as follows:

- Wave-induced longshore transport of sand, with a strong net transport to the north;
- Onshore/offshore movements of sand associated with relatively short term storm-related erosion and subsequent rebuilding of the beach and foredune;
- Wind-induced transport of sand from the beach to the back-beach dune system;
- Effects of stream entrance movements and/or movements of beach sand into lower tidal estuary areas under the influence of tidal and flood flows; and
- Most likely some past shoreline retreat resulting from sea level rise in recent decades, expected to accelerate significantly in the future.

Coastal hazards and how they apply to the development site are described in detail in the following sections. Climate change, which may exacerbate all coastal hazards; is also included with reference to specific hazards associated with climate change. The following sections provide a description of the hazard, a local context, how the development is in accordance with the provisions of the *Tweed Shire Coastline Hazard Definition Study*, *Tweed Coastline Management Plans* and *Tweed Coast Estuaries Management Plan* and mitigation measures if required.

3.2. Erosion and Shoreline Recession

Sandy beaches are dynamic sedimentary systems that naturally experience phases of erosion and accretion that operate over a range of time intervals (Thom & Hall, 1991).

Beach deposits predominantly consist of sand particles that can be easily eroded by waves. These deposits comprise terrestrial sediment delivered to the coast by rivers, sediment produced by the erosion of coastal landforms by waves, and marine sediment that has been reworked from offshore deposits onto the coast. Sand derived from a terrestrial source is usually dominated by resistant minerals such as quartz. Marine sediments, however, comprise resistant minerals and biogenically-produced calcium carbonate (OzCoasts, 2008).

Visible erosion on the beach berm following storms is generally the result of both short and long term storm demand and long term losses of sand. Sand transported cross-shore from the beach or dune to the nearshore profile which is recoverable over time constitutes short term demand. Long term losses are mostly attributable to an imbalance in the overall sediment budget. Long term losses will induce shoreline recession.

Severe erosion to sandy beaches can be caused by large waves, elevated water levels and strong winds. As a rule, the eroded sand is gradually returned to the beach berm and the beach is rebuilt through the process of accretion during calmer periods.

Human activities which may accelerate beach erosion include inappropriate development in the coastal zone, modifications to the shoreline configuration such as breakwaters and retaining walls which disrupt natural sediment pathways, climate change triggering an increase in the frequency of storms and/or rise in sea level and removal of dune vegetation. The following sections 3.2.1 – 3.2.4 provide an assessment of hazards related to erosion and recession for both Cudgen Creek and the Pacific Ocean.

3.2.1. Short Term Erosion (Storm Bite)

Short term erosion of the beach berm and foredunes, is a result of wave attack associated with increased wave heights and elevated water levels during severe or a series of storms in succession. The volume transported offshore during such events is the 'storm bite'. A best estimate of regional storm bite as stated in the Hazard Study (WBM, 2001) put this at approximately 200 m³/m of sand removal from the foredune. This is presented as the 'immediate hazard' line on Figure 3-1. This immediate hazard line is located

approximately 30 m from the existing erosion scarp, and is located well within the Lot 500 setback provided as part of the development. As such short term erosion is not considered a major constraint to the development with adequate setbacks provided to allow for the natural processes to continue.

3.2.2. Shoreline Recession

Shoreline recession is defined by the *Coastline Management Manual* as “the progressive landward shift of the average long term position of the coastline”. The gradually receding coastline creeps landward, and may threaten existing buildings or infrastructure. Shoreline recession is caused by the constant loss of sediment and/or an increase in sea levels.

The following table is an extract from the *Coastline Hazard Definition Study* which illustrates for the beach section closest to the subject site (Sutherland Point), the lower, best and upper estimates of shoreline recession, taking into account inherence uncertainties and all available data.

Beach Section	Assessed Long Term Shoreline Recession Rate (m/yr)		
	Lower Estimate	Best Assessment	Upper Estimate
Norries Head to Sutherland Point Sutherland Point	0.04	0.05	0.10

The table shows that for the subject site, adoption of the upper estimate results in 0.10 m/yr of recession. For the adopted 100 year planning period (for undeveloped land) this would result in 10 m. The setback proposed of approximately 150 m to the Pacific Ocean provide ample room to accommodate projected rates of shoreline recession, and are in excess of the shoreline hazard lines delineated on Figure 3-1.

3.2.3. Dune Slope Instability

The typical form of a sandy beach in its accreted state consists of a beach berm, a grassed incipient dune, a higher frontal dune, and hind dunes. A severe storm event may cause erosion of the berm and frontal dune, leaving a pronounced erosion escarpment. The landward advance of erosion is significantly affected by dune height. In general terms, the higher the dune, the lesser the landward advance of the erosion escarpment (NSW Government, 1993). An erosion escarpment which is formed during a storm event may have an almost vertical profile. As the sand dries, the dune may ‘slump’ forming a lower angle of repose. The slumping process defines a zone of ‘slope readjustment’ in which structures are at danger of collapse (zone of reduced bearing capacity).

A zone of reduced bearing capacity (landward of the erosion scarp) is nominated in Figure 3-1. No structures are proposed within this zone of reduced bearing capacity.

3.2.4. Bank Erosion

Bank erosion of tidal waterways is a naturally occurring process. Over time, the profile of a bank will change in response to the processes of erosion and accretion. Severe erosion may result in ‘undercutting’ of the bank. Erosion may be exacerbated through anthropogenic factors such as trampling of vegetation on the banks and boat wash.

Minor bank erosion has been documented as occurring along the southern bank cutting of the estuary in the vicinity of the subject site. This appears to be predominantly natural, likely caused by a combination of factors including rising and falling tides, boat wash, wind generated wave action, and pedestrian access to the estuary (Australian Wetlands, 2005). The bank appears to be eroding relatively slowly due to the vegetation stabilising parts of the bank.

The *Estuary Management Plan* (EMP) for Cudgen, Cudgera and Mooball Creeks (EMP) prepared by Australian Wetlands states that:

“Bank erosion management should be based on the principle of allowing natural bank erosion to proceed where it does not impact on infrastructure, private property or high conservation value vegetation”.

A 50 m minimum setback from the banks is proposed in the EMP for developments adjacent to Cudgen Creek. A setback to non-critical infrastructure is provided in the development, which at its narrowest width

is 80 m. However, it is acknowledged that some non-critical infrastructure will be located within the setback including a pontoon, tennis court, basketball court, and picnic shelters.

For this particular section of the creek, the EMP recommends that new developments be conditioned to construct formal access points to the creek, and to revegetate the banks in order to reduce erosion and improve visual amenity. In line with this plan, revegetation of the riparian corridor and formal access points (i.e. the pontoon) will be provided.

3.3. Coastal Entrance Behaviour

A variety of hazards are associated with coastal entrances, both trained and natural. Training works, whilst temporarily stabilising the location of an entrance, may also cause changes to the estuary and adjacent beaches. Entrances left in their natural state often migrate along the beach in the direction of the longshore sand transport as a result of coastal storms and freshwater flooding events.

Hazards of untrained entrance can include breakthrough, scour, infilling and closure. Hazards of trained entrances can include changes to the hydraulic regimes of estuaries, alteration to sediment transport processes, littoral transport rates and tidal ranges.

A 'hydrodynamic alteration' refers to any modification to the entrance or shoreline which can influence the volume, frequency, and duration of flow of water that enters (flood tides) or exits (ebb tides) the waterway (NSW Department of Natural Resources, 2006).

The EMP prepared by Australian Wetlands discussed the Cudgen Creek entrance:

The entrances of Cudgen Creek are shaped by the prevailing coastal processes of tides, waves, floods and the longshore sand transport that flows along the coast in a predominantly northerly direction. The entrance training walls at Cudgen creek has stabilised or fixed the entrance and were constructed in the 1960s to alleviate flooding in the lower reaches of the estuary.

The training walls have the effect of moving the entrance bar to the end of the walls or slightly offshore. They also tend to create a deeper channel between the walls as flows are concentrated along them. The stability of the entrance or its tendency to remain open to oceanic flows is a function of the estuary's tidal prism and the longshore sand transport rate. All three Tweed coastal estuaries have relatively small tidal prisms (~500, 000 cubic metres) with entrances on a high longshore transport coastline (~500, 000 m³/year). This means that the entrance bar is very shallow and consequently navigation is extremely difficult.

As the entrance is trained, breakthrough and closure are not thought to apply. Hydraulic regimes have been considered in the hydraulic analysis undertaken by Belleng VDM. Elevated water levels are discussed in section 3.6 of this CHA. Erosion of creek banks is considered in section 3.2.4. No other hazards were identified in the EMP prepared by Australian Wetlands.

3.4. Sand Drift

Sand drift is a naturally occurring process common to all beach systems, and is defined as windborne sediment transport. Whilst often a gradual and ongoing process, episodic periods of strong wind can result in a relatively large volume of sand being moved elsewhere. Sand drift is a major problem in NSW (NSW Government, 1993) and can create a number of hazards including burial of infrastructure such as roads, structural damage to infrastructure and buildings, abrasion, and at its worst; the permanent loss of sand from a beach system and the overwhelming of coastal developments.

Sand drift is usually a result of the degeneration or destruction of native dunal vegetation protecting the foredune. Causes of this degradation can include pedestrian and vehicle access of dunes or illegal vegetation removal (often undertaken by landholders to provide a better view to the ocean). Sand which is blown inland is then permanently lost to the beach system.

As with all Tweed Coast beaches, the dunes of the subject site are reasonably well vegetated, with a combination of native and introduced species, and sand drift losses are not apparent (WBM, 2001). All vegetation in the coastal zones, both adjacent to Cudgen Creek and the Pacific Ocean is to be retained, with revegetation works undertaken as part of the development. Access to the beach will be formalised, preventing trampling and damage to existing vegetation over large areas. This will minimise the potential of sand drift becoming a hazard at the subject site.

3.5. Stormwater Erosion

In some 'backbeach' locations, stormwater runoff is discharged into coastal waters by semi-perennial small creeks that cross the beach berm. Major runoff events to such creeks may cause scouring and erosion to the beach berm and point of discharge. This can allow larger waves to attack the creek entrance, which if already unstable may migrate along the beach (NSW Government, 1993). Stormwater erosion potential is directly correlated to the intensity of urban development in the catchment area, the manner in which it is treated and how and where it is discharged.

As per the Stormwater Management Plan prepared by Belleng VDM (2008), stormwater has been designed to discharge into an existing drainage line and into Cudgen Creek and as such will not result in any additional breaks in the shoreline or creek bank. No stormwater will leave the site by concentrated surface flow onto the beach (which can potentially lead to scouring and acceleration of erosion). Therefore the hazard of stormwater erosion is not deemed applicable to the subject site.

3.6. Oceanic Inundation (Flooding)

Oceanic inundation is the flooding of coastal lands by ocean waters (NSW Government, 1993). On the NSW coast, there are many low lying areas which are subject to coastal inundation, including the foreshores of estuaries and low lying land. The inundation of these areas is caused by large waves and elevated water levels associated with severe storms (NSW Government, 1993). Flood waters from coastal sources may also interact with fresh water flooding, however in general flooding in areas within close proximity to the coast is dominated by coastal water levels (NSW Government, 1993).

No areas of oceanic inundation were defined or mapped in the Tweed Coastline Hazard Definition Study (Umwelt, 2005). However, the study identified that some sections of dune along the coast may be subject to over topping during extreme storm events (WBM, 2001). The TCMP states that areas identified as at potential risk from oceanic inundation include some areas around north and south Kingscliff.

For a 1 in 100 year event, the assessed peak Storm Tide Level (mAHD) was 1.85 m, and Wave Setup (mAHD) was 3.01 m (WBM, 2001). Dune wave runup levels have been assessed as at approximately RL 5.0 - 5.5 n (AHD) for the 100 year design wave event for the open beaches (WBM, 2001). Dunes may be

overtopped in locations wherever they are lower than this height, however top of dune is between 7-8 m at the site and therefore this is not anticipated to become a problem.

Moreover, in light of the precautionary approach taken to setbacks as a result of the TCMP, the >150 m setback to the Pacific Ocean is considered adequate to prevent the likelihood of oceanic inundation.

Flooding from Cudgen Creek however may occur within a 100 year planning timeframe. A +500mm freeboard over the designated flood level will be adopted for all residential development within the floodplain, as per Tweed Shire Council (TSC) requirements. This freeboard includes provisions for climate change and any potential increase in flooding risk associated with Cudgen Creek. Filling within the subject site will be limited to the high level access roads as part of the overall flood risk management plan. Individual house sites will not be filled and are proposed to be of pier and beam construction. TSC has further advised that no compensatory cut will be required due to the proximity to the ocean boundary.

3.7. Climate Change

Climate change, as opposed to climate variability, is the term used to describe changes in average weather over time periods ranging from decades to millions of years. Increasing concern over climate change has arisen from scientific research which suggests a detectable level of human influence on the global climate. The enhanced greenhouse effect, or global warming, is the impact on the climate from the additional heat retained due to increased amounts of carbon dioxide and other 'greenhouse' (heat-absorbing) gases that humans have released into the earth's atmosphere since the industrial revolution.

A significant body of research suggests that the increase of greenhouse gases in the earth's atmosphere has led to a warming of the global climate over the past century. In Australia, the average trend in annual mean temperature areas in Australia for the period 1950-2001 shows a 1°C increase in mean annual temperature since 1950 (Bureau of Meteorology, 2005).

Whilst rising sea level is most frequently discussed hazard of climate change in coastal areas, climate change may potentially affect all of the coastal hazards discussed in sections 3.1-3.6 above. Other impacts of climate change include variations to trends in rainfall, wind and wave action, and storm intensity and frequency. These issues are discussed in the following sections.

3.7.5. Sea Level Rise

Sea level rise is the result of an increase in the volume of water in the oceans due to the melting of glaciers, ice caps and ice sheets; and an expansion of seawater molecules as the temperature rises. Whilst projections of future sea-level rise may seem insignificant, in combination with severe storm events, vulnerable regions of the coastline (including estuaries) may become more vulnerable to attack by storm surge and waves.

The table below presents the latest low, mid (best) and high estimates of sea level rise from the Intergovernmental Panel on Climate Change IPCC (1996) for the years 2020, 2050 and 2100, relative to 1990 which were adopted in the *Tweed Shire Coastline Hazard Definition Study*:

Year	Low	Best Estimate	High
2020	0.05	0.10	0.20
2050	0.10	0.20	0.40
2100	0.15	0.50	0.95

However, the Department of Planning have subsequently advised that the sea level rise projections contained in their *NSW Sea Level Rise Policy Statement* (adopted in October 2009) should be used in this assessment. This draft statement identifies a rise of 40 cm to 2050 and 90 cm to 2100 for the NSW coastline.

Tweed Shire Council have subsequently revised their coastal hazard lines in accordance with the NSW Government sea level rise benchmarks and the revised hazard lines are shown in Figure 3-1. It is noted

that some public amenities are located seaward of the revised 2100 hazard line specifically road and car parking, public amenities block, picnic shelters, play ground and circuit training facilities and beach and estuary access. Given the non-critical and relatively minor nature of this infrastructure this incursion is considered acceptable provided the balance of Lot 500 is utilised for dune rehabilitation.

Elevated water levels in Cudgen Creek as a result of climate change are addressed in section 3.6.

3.7.6. Storm Surge

Severe meteorological events such as tropical cyclones are often accompanied by a temporary local rise in sea level known as storm surge (OzCoasts, 2008). This surge is usually caused by strong onshore winds exerting a stress on the sea surface, which causes water to accumulate against the coast. Additionally, the low atmospheric pressure within the cyclone can allow a small rise in water level (OzCoasts, 2008). As a cyclone moves into shallow coastal waters, the nearshore seabed and coastline shape modify the surge and may result in a substantial amplification of its height. When combined with the normally occurring astronomical tide, this phenomenon is referred to as storm tide (WBM, 2001).

The approximate level of HAT is delineated on Figure 3.3. This level is well below the setback provided (Lot 500); storm surge and storm tides are not predicted to affect the development.

3.7.7. Frequent and Intense Storms and Wind and Wave Action

Some predictive modelling has suggested that the intensity and frequency of storms may increase, owing to a southward movement of the cyclone belt; which would expose more of the NSW coastline to cyclones (NSW Government, 1993). Studies have drawn a correlation between the frequency of intense cyclones with increased water temperature (Webster et al, 2005). An increase in storm events as discussed above would result in a more severe wave climate i.e. larger waves would be more frequent. Modified storm patterns may also result in changes to the direction in which waves attack the coastline.

Effects associated with frequent and intense storms and associated wind and wave action are considered in sections 3.2 and 3.6. The hazard lines presented in Figure 3-1 have considered and incorporated the likelihood of more frequent and intense storms based on all available data. The hazard lines are seaward of the setback provided (Lot 500).

4. Assessment of Development against relevant Planning Instruments

Environmental Planning in NSW with respect to hazard management aims to ensure that the location and nature of development is consistent with the potential risks and impacts of the hazard. This in to ensure that the social and economic impacts of coastline hazards can be minimised or prevented.

The following sections provide a description of provisions of the relevant planning instruments and guidelines in NSW, and an evaluation of the development against these relevant coastal hazard management provisions.

4.1. Environmental Planning and Assessment Act 1979

Planning in NSW is carried out under the statutory control of the *Environmental Planning and Assessment Act (EP&A Act) 1979*. The NSW Department of Planning is responsible for the administration of this Act.

There are four tiers of planning instruments under the EP&A Act, being:

- State Environmental Planning Policies (SEPP's);
- Regional Environmental Plans (REP's);
- Local Environmental Plans (LEP's); and
- Development Control Plans (DCP's).

The objectives of the EP&A Act are:

- (a) To encourage:
 - (i) The proper management, development and conservation of natural and man-made resources, including agricultural land, natural areas, forests, minerals, waters, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment;
 - (ii) The promotion, provision and coordination of orderly and economic use and development of land;
 - (iii) The protection, provision and coordination of communication and utility services;
 - (iv) The provision of land for public purposes;
 - (v) The provision and coordination of community services and facilities; and
 - (vi) The protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities and their habitats; and
- (b) To promote the sharing of responsibility for environmental planning between the different levels of government in the state, and
- (c) To provide increased opportunity for public involvement and participation in environmental planning and assessment.

The following sections address the relevant SEPPs, REPs, LEPs and DCPS pertinent to the development.

4.1.8. State Environmental Planning Policy 71-Coastal Protection

State Environmental Planning Policy (SEPP) No. 71-Coastal Protection was introduced in 2002 under the *EP&A Act* and aims:

- (a) to protect and manage the natural, cultural, recreational and economic attributes of the New South Wales coast, and
- (b) to protect and improve existing public access to and along coastal foreshores to the extent that this is compatible with the natural attributes of the coastal foreshore, and

- (c) to ensure that new opportunities for public access to and along coastal foreshores are identified and realised to the extent that this is compatible with the natural attributes of the coastal foreshore, and
- (d) to protect and preserve Aboriginal cultural heritage, and Aboriginal places, values, customs, beliefs and traditional knowledge, and
- (e) to ensure that the visual amenity of the coast is protected, and
- (f) to protect and preserve beach environments and beach amenity, and
- (g) to protect and preserve native coastal vegetation, and
- (h) to protect and preserve the marine environment of New South Wales, and
- (i) to protect and preserve rock platforms, and
- (j) to manage the coastal zone in accordance with the principles of ecologically sustainable development (within the meaning of section 6 (2) of the *Protection of the Environment Administration Act 1991*), and
- (k) to ensure that the type, bulk, scale and size of development is appropriate for the location and protects and improves the natural scenic quality of the surrounding area, and
- (l) to encourage a strategic approach to coastal management.

Part 4 of SEPP 71 imposes the following restrictions on development in the coastal zone:

- Development must not impede or diminish public access to the coastal foreshore;
- Development involving non-reticulated effluent disposal must not have a negative effect on water quality; and
- Development must not involve discharge of untreated stormwater into the sea, a beach, estuary etc or onto a rock platform.

The development complies with the provisions of SEPP 71. Access to Cudgen Creek and the Pacific Ocean is provided through an open space network, road access and car parking, and formalised pathways to the estuary and beach. Stormwater has been designed to discharge into an existing drainage line and into Cudgen Creek and as such will not result in any additional breaks in the shoreline or creek bank. No stormwater will leave the site by concentrated surface flow onto the beach (which can potentially lead to scouring and acceleration of erosion). Based on the site characteristics and the range of available SQIDS, the SMP prepared by Belleng VDM has included detailed treatment measures that will satisfy the requirements of downstream environmental protection. All treatment is to occur within proposed swales and bioretention areas, thus minimising any potential water quality impacts on the existing wetlands and Cudgen Creek (Belleng VDM, 2008).

4.1.9. Coastal Design Guidelines for NSW

The *Coastal Design Guidelines for NSW* were prepared by the Coastal Council of NSW 2003. The Coastal Council is the NSW Government's advisory body on coastal zone management and planning issues. The guidelines have been prepared with reference to the *Coastal Policy 1997* and are complementary to the Government's Coastal Protection Package. The principles of ecologically sustainable development have been used as a basis for preparation of the coastal design guidelines.

Objectives of relevance to this report include the following:

- Areas adjoining freshwater estuarine, coastal habitats and the coastal edge are managed to reduce the land use impacts through setbacks that also supports the protection of properties from erosion, protection of sensitive ecologies, provision of public access along the foreshores and to natural areas, provision of visual amenity along the foreshore, protection of properties from the effects of sea level rise, improvement of water quality;
- Setbacks should also address coastal erosion hazards such as storm surge events and river flooding, long-term shoreline recession and sea-level rise, cliff retreat and catastrophic collapse, sand drift hazard, entrance stability, estuarine erosion and changes in tidal current positions;
- Setbacks are designed to protect ecosystems and reserves covered under SEPP 14 wetlands, SEPP 26 littoral rainforest, SEPP 53 koala habitat as well as salt-marsh and mangrove communities, riparian vegetation, frontal dunes and headlands, national parks, protected areas and reserves;
- For new developments the foreshore setbacks should be at least 50 m wide as a precautionary measure where possible;

- Setbacks need to be marked and their vegetation preserved. Setbacks should where possible be increased to 100 m or more where they are adjacent to ecologically sensitive areas or in situations where the coastal erosion hazard requires greater distance;
- Setbacks for redevelopment should consider a 100 year planning timeframe to address shore line retreat and sea-level rise.
- Coastal estuary planning for local areas must follow the guidelines in the coastal zone management manual;
- Development on frontal dunes is avoided; and
- Set new development back from the foreshore edges of the ocean, lakes and other waterways to protect visual amenity and create opportunities for public access.

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 is 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.

Setbacks have addressed coastal erosion hazards such as storm surge events and river flooding, long-term shoreline recession and sea-level rise, cliff retreat and catastrophic collapse, sand drift hazard, entrance stability, estuarine erosion and changes in tidal current positions as detailed in the *Coastline Management Manual*, *Tweed Coastline Plans of Management*, *NSW Government Sea Level Rise Policy Statement*, and *Estuary Management Plan*. The *Tweed Coastline Hazard Assessment* adopted a 100 year planning timeframe for undeveloped lands in order to address shore line retreat and sea-level rise.

Setbacks have been designed to protect ecosystems and reserves covered under SEPP 14 wetlands, as well as salt-marsh and mangrove communities, riparian vegetation, and frontal dunes and headlands.

4.1. Local & Regional Planning Instruments and Plans of Management

4.1.1. North Coast Regional Environmental Plan 1999

The *North Coast Regional Environmental Plan 1999* (North Coast REP) is a strategic planning document which provides policy direction for Local Environmental Plan (LEP) preparation in the NSW north coast region. LEPs which are prepared by local government must be in accordance with this Plan. Of relevance to this report, the North Coast REP Development Control 33-coastal hazard areas states:

Before granting consent to development on land affected or likely to be affected by coastal processes, the council shall:

- (a) take into account the *Coastline Management Manual*;
- (b) require as a condition of development consent that disturbed foreshore areas be rehabilitated; and
- (c) require as a condition of development consent that access across foredune areas be confined to specified points.

Setbacks have addressed coastal erosion hazards such as storm surge events and river flooding, long-term shoreline recession and sea-level rise, sand drift hazard, entrance stability, estuarine erosion and changes in tidal current positions as detailed in the *Coastline Management Manual*, *Tweed Coastline Plans of Management*, and *Estuary Management Plan*. The *Tweed Coastline Hazard Assessment* adopted a 100 year planning timeframe for undeveloped lands in order to address shore line retreat and sea-level rise.

All vegetation in the coastal zones, both adjacent to Cudgen Creek and the Pacific Ocean is to be retained, with revegetation works undertaken as part of the development. Access to the foredunes will be formalised, preventing trampling and damage to existing vegetation over large areas. This will prevent sand drift from becoming a hazard at the subject site.

4.1.2. Tweed Local Environmental Plan 2000

The Tweed Local Environmental Plan (Tweed LEP) is a statutory plan prepared under the *EP&A Act* to control and guide the future development of land in the whole of Tweed Shire. Lands within Tweed Shire are subject to various landuse zones which set out what development can occur in them.

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).

The primary objectives of Zone 7(f) Environmental Protection (Coastal Lands) as stated in the Tweed LEP are:

- To identify land susceptible to coastal erosion and protect it from inappropriate development; and
- To protect and enhance the scenic and environmental values of the land.

Land susceptible to coastal erosion was identified in the Hazard Assessment as discussed in previous sections and illustrated in Figure 3-1. Zone 7(f) covers the entire area of Lot 500 (see Figure 4.1 below). An approximate 150 m setback to the Pacific Ocean which is the width of Lot 500 is provided as part of the development, which exceeds the setback required in the Hazard Assessment. 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. The vegetation in this zone is to be retained and rehabilitated, further enhancing the scenic and environmental values of the land.

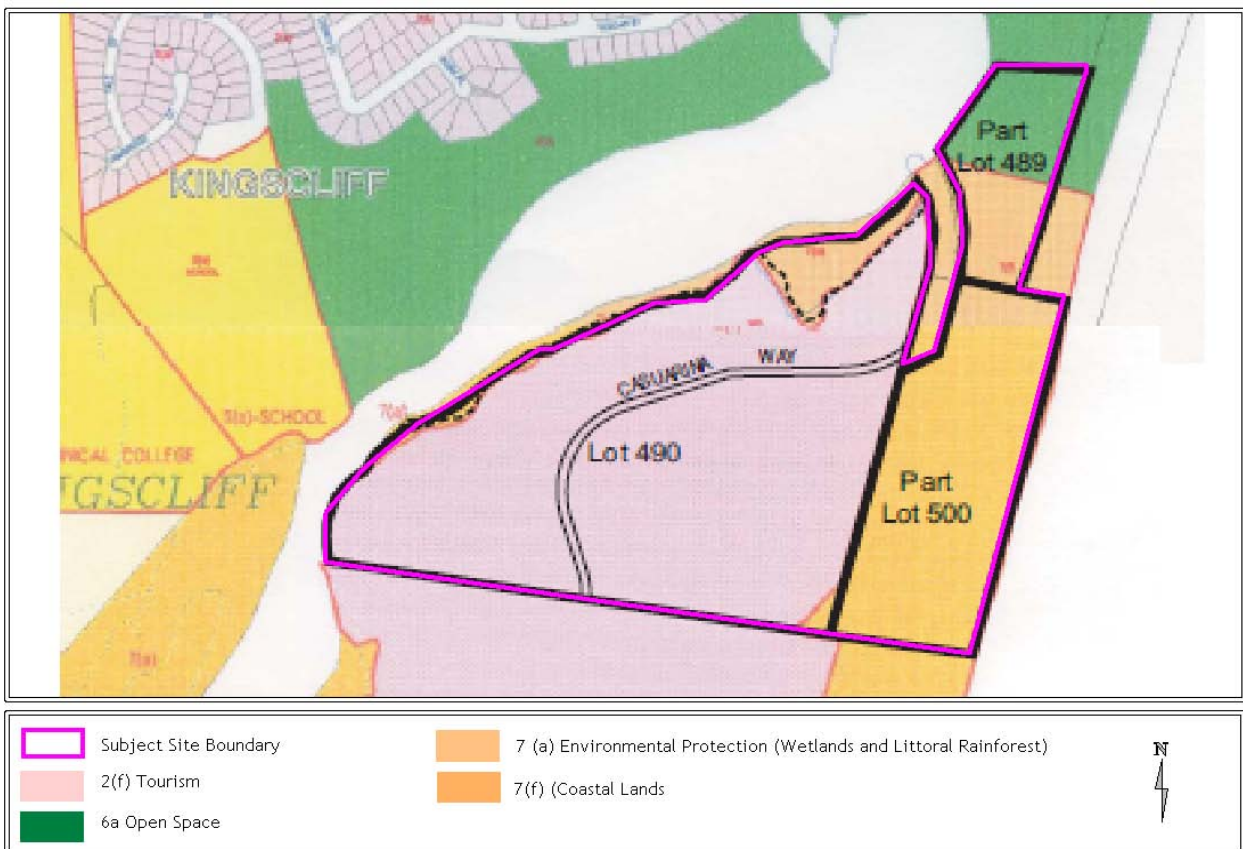


Figure 4-1 Tweed LEP Zoning Map

4.1.3. Tweed Shire Development Control Plan

The Tweed Development Control Plan (DCP) contains the development control policies for the Tweed Shire. Of relevance to this plan are conditions related to building setback, building types, dune protection, flood mitigation, emergency access and planned retreat. The development is in accordance with all relevant development control policies.

4.1.4. Lot 490 Plan of Management 2005

The *Lot 490 Draft Plan of Management* (NSW Department of Lands & NSW Department of State and Regional Development) has been prepared to guide future development of the site in order to ensure consistency with the sites community and environmental values.

The aims of this Plan of Management include:

- To ensure development is consistent with ecological, scenic, social, and cultural values of the site;
- To promote regeneration and restoration of sensitive yet degraded areas within the reserve and adjoining land; and
- To reflect the State significance of this coastal site, particularly in terms of environmental planning and management and urban design.

An extract from this plan shows proposed setbacks from Cudgen Creek and the ocean (Refer to Figure 2 Development Parameters below). The proposed setback from Cudgen Creek is a minimum of 50 m and the setback from the ocean comprises the entire width of Lot 500. Whilst some development does occur within the boundary of Lot 500; this is comprised entirely of non-critical infrastructure including road and car parking, public amenities block, picnic shelters, play ground and circuit training facilities and beach and estuary access. The development is in accordance with these setbacks and the provisions of the Lot 490 Plan of Management.

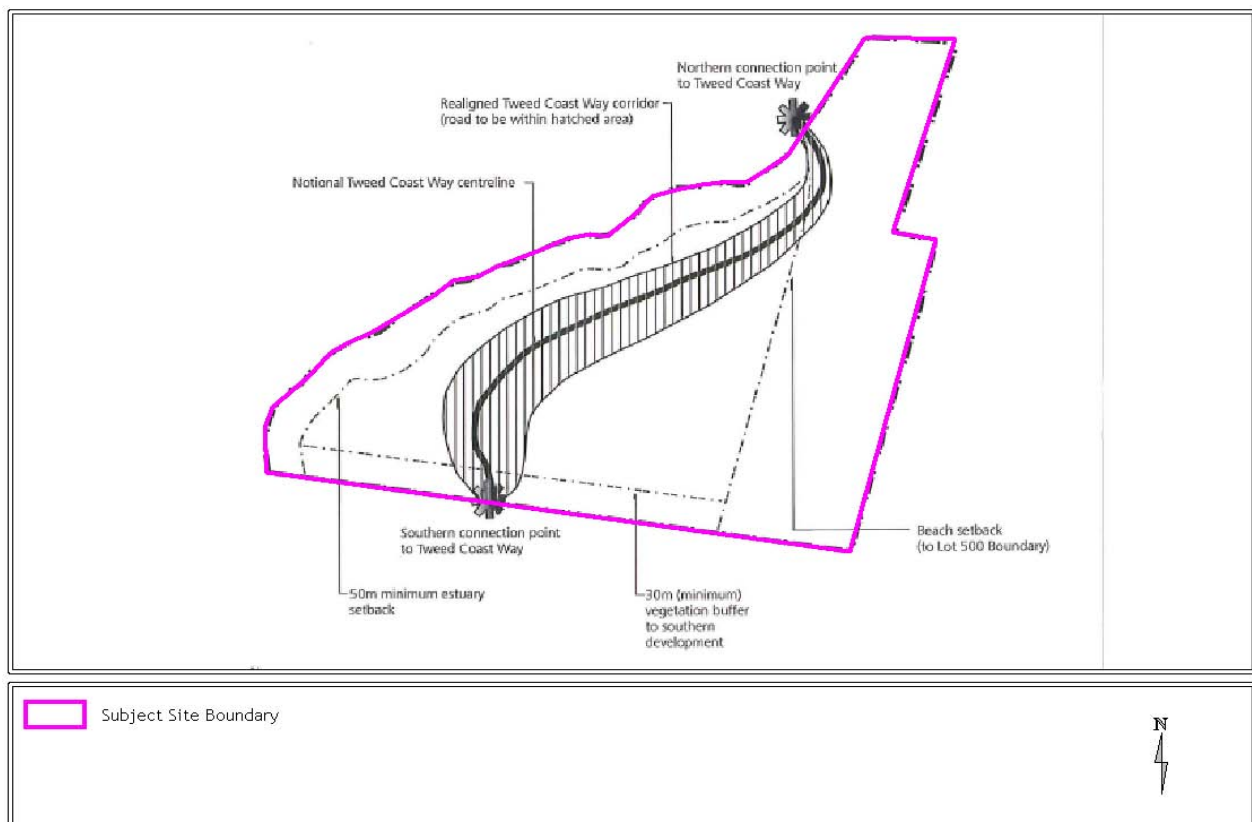


Figure 4-2 Development Parameters (source-Lot 490 Plan of Management, Department of Lands, 2005)

5. Conclusion

Figure 3-1 shows both the 2001 coastline hazard zones for the subject site as defined in the *Tweed Shire Coastline Hazard Definition Study*, and the revised 2010 hazard lines commissioned by Tweed Shire Council in response to the NSW Governments *Draft Coastal Risk Management Guide: Incorporating sea level rise benchmarks in coastal risk assessments* (2009). The revised 2010 hazard zones depicted represent an assessment of the setback lines required, when taking into consideration revised sea level rise planning benchmarks adopted by the NSW Government.

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

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, the revised hazard lines prepared in 2010 indicate that the 2100 and 2050 lines are now further landward than those estimated in 2001. The 2100 line is now approximately 20 m landward from the previous 2001 mapping and the 2050 line is approximately 9 m further landward.

The precautionary principle would dictate that a buffer of greater band width is preferable to one which is narrower. A greater setback also provides a greater degree of comfort in the longer term in the face of scientific uncertainty regarding the future possible effects of coastal hazards associated with climate change. The TCMP states:

The 7(f) zone on its current alignment provides a long term timeframe over which to accommodate coastline hazards as well as a natural buffer to enhance recreational (including long-term public foreshore access), visual amenity, ecological, and environmental values of the zone.

At South Kingscliff, 87% of adjoining lands have been developed, or planned for development with the 7(f) zone at its current alignment. There is little justification for realignment of the 7(f) zone for the remaining 13% of land.

Retention of the 7(f) buffer (Lot 500 boundary) is considered to provide long-term protection from coastal erosion and other hazards for the management of undeveloped lands (Umwelt, 2005). Zone 7(f) covers the entire area of Lot 500 (see Figure 4.1). This lot, which comprises an approximate width of 150 m from the MHWS is provided as a setback to the Pacific Ocean as part of the development. Some non-critical infrastructure is located within this setback; including road and car parking, public amenities block, picnic shelters, play ground and circuit training facilities and beach access in accordance with requirements of relevant policies requiring public facilities and access to the beachfront. The vegetation in this zone is to be retained and rehabilitated, further enhancing the scenic and environmental values of the land. The development has therefore exceeded the required setbacks for coastal hazards, as discussed in section 3.

The EMP recommends a minimum 50 m setback from the Cudgen Creek. This setback is provided in the development, which at its narrowest width is 80 m. The inherent risk of a development located adjacent to a tidal estuary (Cudgen Creek) and the ocean is acknowledged, however given the nature of the development, which is non-permanent residential development as opposed to permanent accommodation, the development is considered appropriate for the site.

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

6. References

- Australian Wetlands. 2005. *Tweed Coast Estuaries Management Plan 2004-2008*. Cudgen, Cudgera, and Mooball Creeks
- Belleng VDM. 2008. *Stormwater Management Plan*.
- Belleng VDM. 2008. *Hydraulic Analysis*.
- Coastal Council of NSW. 2003. *Coastal Design Guidelines for NSW*
- CSIRO. 2004. *Global sea-level rise*. CSIRO Marine Research, Australia. Retrieved from the internet from: <http://www.marine.csiro.au/LeafletsFolder/45slevel/45.html>
- IPCC. 2001. *Climate Change 2001: The Third Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. Cambridge UK
- IPCC. 2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK
- James Warren and Associates Pty Ltd. 2008. *Ecological Assessment for Leighton Properties Pty Ltd*.
- NSW Department of Lands & NSW Department of State and Regional Development. 2005. *Lot 490 Draft Plan of Management*
- NSW Government. 1997. *NSW Coastal Policy 1997*
- NSW Government. 1993. *Rivers and Estuaries Policy 1993*
- NSW Government. 2009. *Draft Policy Statement on Sea Level Rise 2009*
- NSW Government. 2009. *NSW Sea Level Rise Policy Statement*
- NSW Government-Department of Planning. 1979. *Environmental Planning and Assessment Act 1979*.
- NSW Government-Department of Planning. 1999. *-North Coast Regional Environmental Plan 1999*
- NSW Government. 1999. *State Environmental Planning Policy 71-Coastal Protection*
- NSW Government-Department of Natural Resources, 2008. *Estuaries in NSW, Cudgen Lake and Creek*. <http://www.naturalresources.nsw.gov.au/estuaries/inventory/cudgen.shtml>
- Thom, B.G. and Hall, W. 1991. Behaviour of beach profiles during accretion and erosion dominated periods. *Earth Surface Processes and Landforms* **16**: 113-127.
- Tweed Shire Council. 2000. *Tweed Local Environmental Plan 2000*.
- Umwelt Environmental Consultants. 2005. *Tweed Shire Coastline Management Study Stage 2, Management Objectives*
- Umwelt Environmental Consultants. 2005. *Tweed Coastline Management Plan*
- WBM Oceanics Australia. 2001. *Tweed Shire Coastline Hazard Definition Study Final Report*
- Webster, P.J., Holland, G.J., Curry, J.A., and Chang H.R. 2005. Changes in tropical cyclone number, duration and intensity in a warming environment. *Science* **309**: 1844-1846