KENMAR FARMS PTY LTD
ENGINEERING IMPACT ASSESSMENT

PROPOSED 13 LOT SUBDIVISION
Lot 4 DP 876253
Willow Avenue
Bogangar NSW

Revision Number: 1

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OPUS

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APPENDIX A

1. INTRODUCTION

Kenmar Farms Pty Ltd has commissioned Opus Qantec McWilliam to prepare a report on the engineering impacts of a proposed 13 lot residential subdivision at Willow Avenue, Bogangar. This assessment forms part of a Major Project Application No. MP08_0118 prepared by Darryl Anderson Consulting Pty Ltd and is to be read in conjunction with that application.

This report addresses the following issues outlined by the Director General's Environmental Assessment Requirements (DGEAR):

- Traffic Impact Study
- Hazard Management and Mitigation - Coastal Processes
- Hazard Management and Mitigation - Flood Risk Assessment
- Water Cycle Management
- Stormwater Management Plan
- Erosion & Sediment Control Plan and Construction Management Plan
- Infrastructure Provision

2. PROPERTY DESCRIPTION

The property description is Lot 4 DP 876253, in the Shire of Tweed. The total site area is approximately 11.37 hectares. The area of the proposed development is approximately 9428m^2. The portion of the site being developed is zoned part Low Density Residential 2(a) and part Environmental Protection (Habitat) 7(l) under Tweed Local Environment Plan 2000. Other areas within Lot 4 DP 876253 boundaries are zoned Rural 1(a) under Tweed Local Environment Plan 2000.

3. DEVELOPMENT LOCATION

The site is located at the southern end of Willow Avenue. The locality is shown in Figure 1.0. The location is bounded by allotments which front Tamarind Avenue to the north and east and a constructed canal to the south. Cudgen Lake is located at the end of Willow Avenue to the west. There is existing low-density urban residential development to the east, west and north of the site. The site is indicated in Photo Plate 1 with the proposed development area hatched.

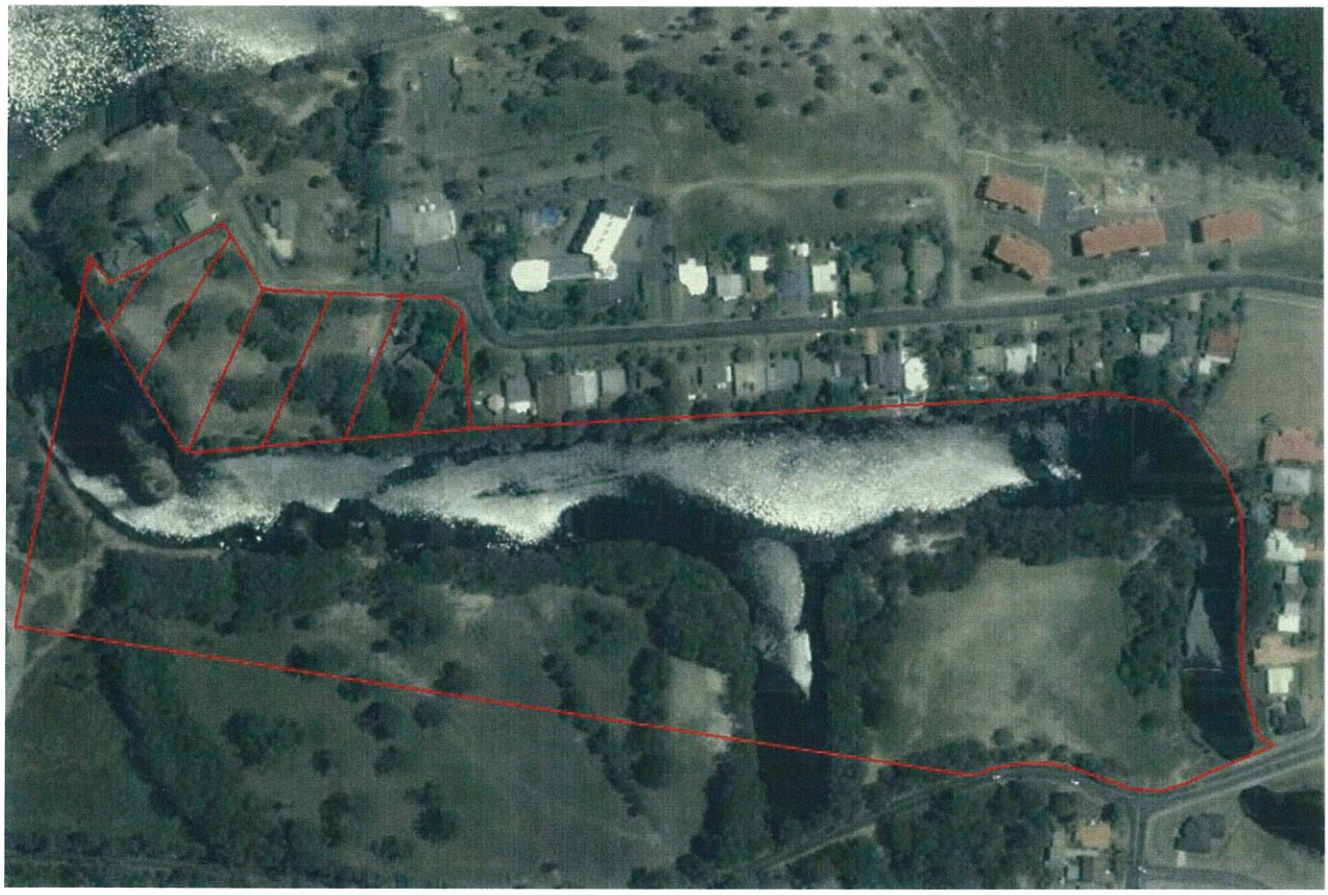

PHOTO PLATE 1

SITE – Source: Google Earth Pro

4. EXISTING SITE FEATURES

The site is currently vacant land. The development site is grassed, with scattered trees throughout and patches of densely populated vegetation along the northern and southern property boundary. The topography of the site is a flat with minor gradients within zone 2(a) sloping toward Willow Avenue at approximately 1% to 4%. The levels within the development area zoned 2(a) range from RL 3.67metres AHD at south-east section of the property to RL 2.99 metres AHD at the north-west section of the property. The land zoned 7(l) at the rear of the site grades at approximately 10% to 25% into the existing constructed canal.

The existing canal is located along the southern boundary of the development site. The canal is approximately 33 metres wide and discharges via a reduced channel width of approximately 10 metres into Cudgen Lake.

The existing features are illustrated in Figure 2.0. Photo Plate 2 shows Willow Avenue frontage to the site.

PHOTO PLATE 2

WILLOW AVENUE FRONTAGE TO SITE

5. DESCRIPTION OF PROPOSAL

The proposal is to create a twelve (12) lot residential subdivision of and a residue parcel becoming Lot 13. The twelve proposed residential lots vary in sizes from 569m^2 to 1065m^2 and the residue lot being 11.36 hectares. The proposed development is shown in Figure 3.0.

6. TRAFFIC, PARKING AND ACCESS

6.1 EXISTING TRAFFIC

6.1.1 EXISTING TRAFFIC ENVIRONMENT

The site is currently vacant and does not generate traffic.

6.1.2 ROAD NETWORK AND HIERARCHY

Access to Willow Avenue is solely from Tamarind Avenue. Both Tamarind Avenue and Willow Avenue are residential access streets. Clothiers Creek Road and Tweed Coast Road are the two possible access paths to Tamarind Avenue. Clothiers Creek Road is classified as an Urban Arterial and Tweed Coast Road a Rural Distributor, as defined in Tweed Shire Local Traffic Data Counts. From Tweed Coast Road commuters will

utilise Tamarind Avenue directly to Willow Avenue. Clothiers Creek Road merges into Rosewood Avenue at the intersection of Kauri Avenue. Rosewood Avenue is an Urban Distributor, as defined in Tweed Shire Local Traffic Data Counts. The shortest access to Willow Avenue from Clothiers Creek Road is via Rosewood Avenue through Poplar Avenue which intersects with Tamarind Avenue.

6.1.3 EXISTING ROAD GEOMETRY

There is existing barrier kerb and channel on the frontage of proposed allotments 10, 11 and 12. The width of the road section with kerb is nine (9) metres wide. The remainder of Willow Avenue is asphalt pavement with out kerb and has a reduced width of approximately 5.3 metres. The designated speed is 50 km/h. Willow Avenue has a minor gradient of approximately 0.2% in the direction of Tamarind Avenue to the east.

6.1.4 EXISTING TRAFFIC VOLUMES

Tweed Shire Council does not have any traffic data for Willow Avenue and Tamarind Avenue. Based on Table 7.1 – Tweed Shire Council, Tweed Road Contribution Plan, Section 94 (January 2009). An assessment of the existing approximate traffic volumes has been calculated using the number of existing residential dwellings and apartments identified by use of aerial photographs. The number of existing resort dwellings were obtained from their web-site. Traffic rates for the function centre were based on a restaurant type development as there is no specific rate for this type of development. The resulting estimated traffic volumes for Willow Avenue and Tamarind Avenue are summarised in Table 10.1.4 below.

Table 10.1.4 – Existing Traffic Volumes

Street / Road	Component	Rate	Number
		Daily vehicles	Daily vehicles
Willow Avenue			
	Existing 4 Dwelling Houses	9	36
	Existing Function Centre 200m^2	60 / 100m^2 GFA	120
	Willow Avenue Total		**156**
Tamarind Avenue			
	Existing 72 Dwelling Houses	9	648
	Existing 43 Resort Apartments	3/ Unit	129
	Tamarind Avenue Total		**777**

6.2 PROPOSED TRAFFIC ENVIRONMENT

6.2.1 TRAFFIC GENERATION

The proposed traffic generation is detailed in Table 10.2.1 and is expected to generate the following amount of annual average vehicles per day (vpd) based on Table 7.1 – Tweed Shire Council, Tweed Road Contribution Plan, Section 94 (January 2009).

Table 10.2.1 – Proposed Traffic Generation

Component	Rate	Number
	Daily vehicles	Daily vehicles
Proposed 12 lot residential subdivision	9	108

The proposed development is expected to increase the number of daily vehicle trips by 108.

6.2.2 ROAD OPERATING CAPACITY

The traffic volumes on Willow Avenue and Tamarind Avenue due to the proposal are detailed in Table 10.2.4 below.

Table 10.2.4 – Road Operating Capacity

	Road Class	Existing AADT	Design AADT	Increased AADT	Proposed AADT	% Increase
Willow Avenue	Access Street	156	1000	108	264	69.2
Tamarind Avenue	Access Street	777	3000	108	885	1.38

The proposal will not impact significantly on the main local or regional road network capacity. The increase in traffic is minor and is within Council's specified functional capacity for this class of road.

Table D1.7 of Tweed Shire Council Road Design Specification D1 (2004) indicates the maximum desirable traffic volume in a six metre wide access street is 1000 vehicles per day. The proposal will increase Willow Avenue traffic to 264 vehicles per day.

As part of the subdivision it is proposed to construct road widening to the Willow Avenue site frontage. Works in the road reserve would include provision for kerb and gutter along the site frontage only and underground drainage and the provision of water, sewer, power and telephone services to each lot. The construction of Willow Avenue will improve on the existing road operating capacity from 1000 vehicles per day to 3000 vehicles per day for an ultimate future width of 9.0 metres to match the existing kerbed section. Road widening to the opposite site frontage would be completed by others. The proposed Willow Avenue widening and kerb and channel on the frontage of the site is shown on Figure 4.0.

6.2.3 PROPOSED ACCESS

Proposed access to the each of the twelve (12) lots will be off Willow Avenue. The proposed access to the site is flat with minor gradients sloping toward Willow Avenue at approximately 1% to 4%. The proposed access and grades comply with Tweed Shire Councils Driveway Access to Property Design Specification, Part 1, June 2004.

6.2.4 CONSTRUCTION TRAFFIC

During the construction phase, heavy vehicle traffic could be expected. This would comprise of earthmoving equipment, construction plant equipment and builder's vehicles. Impacts resulting from the traffic generated by construction would be mitigated by the low existing traffic volumes and relatively short duration of works.

6.2.5 TRAFFIC IMPACTS AND MITGATING MEASURES

We conclude that the development does not have a significant impact on the existing traffic environment and the widening of Willow Avenue with kerb and gutter along the sites frontage will improve on the existing road operating capacity.

7. HAZARD MANAGEMENT AND MITIGATION – COASTAL PROCESSES

A study has been completed on the coastal process hazards for the Tweed Shire Council by WBM Oceanics Australia titled Tweed Shire Coastline Hazard Definition Study, (TCHDS 2001). The study has assessed the hazards identified by zones of land under threat from events such as climate change, sea level rise, wave action and wind action. Hazard bands have been delineated for each planning period of coastal inundation where elevated water levels occur from a combination of storm tide, wave setup, wave runup and sea water level rise. The hazard bands being the immediate / post storm, presently developed areas 50 years and future developments 100 years. Council has determined that for risks to existing developments a 50 year planning period was appropriate and undeveloped (and future developed) land a 100 year planning period appropriate, Tweed Shire Council, Tweed Shire Coastline Management Study Stage 2, Management Objectives, 2005. A 100 year planning period has been adopted for the proposed development site. Relevant topics impacting on the coastal hazards are addressed below.

7.1 WAVE AND WIND ACTION

Section 8.4.1 of the TCHDS has identified that wind transport losses are not presently significant at Bogangar Beach region as there is good coverage of vegetation. The location of the subject site and the considerable vegetation present on the existing canal banks and makes it unlikely for wind transport losses to occur. Table 4.3 of TCHDS contains storm tide and wave setup levels for the Tweed Coast region. The 100 year planning period as adopted for the proposed site is RL 1.85 m AHD for storm tide and RL 3.01 m AHD for wave setup level. The proposed site has levels ranging from RL 3.09m AHD to RL 3.67m AHD which is greater than the 100 year planning period for storm tides and wave setup levels. The distant location of the proposed site from the coastline will unlikely present any significant wave issues.

7.2 SEA LEVEL RISE AND COASTAL EROSION

Table 4.4 of TCHDS anticipates the future sea level rise for the years 2020, 2050 and 2100. The table estimates the latest low, mid (best) and high global mean sea level rise. The anticipated sea level rise for a 100 year planning period is 0.15m (low), 0.5m (best estimate) and 0.9m (high). The distant location of the proposed site from the coastline will unlikely present any significant wave issues.

The increase in sea level rise is likely to impact on the downstream Cudgen Lake level and canal water level adjacent to the site. The following flood modelling results and analysis in Section 8 have demonstrated the impacts do to global warming for all of the anticipated sea levels.

The location of the subject site in relation to the coast line means that coastal erosion impacts are not applicable in this instance.

7.3 FREQUENT AND INTENSE STORMS

Changes to the intensity of storms as a result of climate change are outlined in the Department of Environment and Climate Change (DECC) document Flood Risk Management: Practical Consideration of Climate Change. Increases in rainfall intensity as a result of climate change are suggested for flood modelling and analysis are detailed in the DECC document with respect to the 2030 and 2070 projections. The intensity impacts are as follows for the 2030 and 2070 cases respectively, -5, +5 % and 5%, 10%. The intensity increase is likely to increase flood levels and flood modelling discusses this impact.

7.4 CLIMATE CHANGE – SEA LEVEL RISE AND INCREASED RAINFALL INTENSITY

The sea level rise due to the enhanced greenhouse effect has the potential to affect coastal regions. Table 4.4 of Tweed Coastline Hazard Definition Study, 2001 anticipates the future sea level rise for the years 2020, 2050 and 2100. The table estimates the latest low, mid (best) and high global mean sea level rise. The anticipated sea level rise for a 100 year planning period is 0.15m (low), 0.5m (best estimate) and 0.95m (high).

8. HAZARD MANAGEMENT AND MITIGATION – FLOODING

The adopted Tweed Shire Development Control Plan (DCP), Section A-3 – Development of Flood Liable Land version 1.3 (2010) includes flood levels for the Bogangar area which are derived from the Tweed Byron Coastal Creeks Flood Study (2009 by WBM BMT). The Q100 flood level for Cudgen Lake adopted within the design is R.L 2.92 m AHD. Tweed Shire Council requires a minimum floor level for residential developments as of June 2010 to be at least 500mm above the 100 year ARI flood level. Flood modelling has been conducted (refer section 8.2) which details results of flood models calibrated to the BMT WBM study. A Q100 level at the site of R.L 2.94 m AHD has been determined. Therefore a freeboard level of R.L 3.44 m AHD was selected for the development. The proposed site has sections above the adopted design freeboard level of RL 3.44 m AHD but requires minor filling in the house pad locations to meet Tweed Shire Council standards.

In terms of probable maximum flooding (PMF), the Tweed Shire Flood Liable Land maps detailed in the DCP A-3 Revision 1.3 indicates a PMF level of RL 5.7m AHD would be applicable.

Section A3.2.6b of the policy outlines the Emergency Response Provisions for Habitable Developments in areas affected by PMF. A review of DCP section A3 and a telephone conversation with Council's Danny Rose has confirmed the site is classified as a new subdivision however the site area is less than 5 Ha (actual development area is 0.98 Ha) therefore a high level road evacuation route is not warranted. The flood design constraints for the site are therefore based on the local area constraints for Bogangar and the design floor level is required to be the Q100 + 0.5m Freeboard.

8.1 COASTAL RISK ASSESSMENT / FLOOD HAZARD PLAN

A coastal risk assessment has been conducted for the site based on the flood modelling in accordance with the draft Tweed Shire Council DCP Section A-3 Development of Flood Liable Land draft version 1.3 maps

which are based on the Tweed Byron Coastal Creeks Flood Study (2009 BMT WBM).Refer Figures 7.8 and 7.9 for the Coastal Risk Assessments if the site.

The assessment demonstrates that the site and proposed dwellings are within a coastal risk area as reffered to in Figure 5 of the Draft Coastal Planning Guideline: Adapting to Sea Level Rise (October 2009, NSW Department of Planning). Each proposed house pad is located within the 100 year ARI flood plus free-board zone requiring the development to be assessed against the TSC LEP and the Planning Criteria as outlined in the Draft Coastal Planing Guideline. The development is less than 5 Ha which requires the subdivision to provide a design floor level based on the Q100 + Freeboard scenario and does not warrant the provision of a design flood level to the Climate Change design flood level as stated in the DCP A3.
The development addresses the planning criteria outlined within the Draft Coastal Planning Guideline for development in coastal risk areas as follows;

- *The development avoids exposure to immediate coastal risk due to its location above tidal zones and Q100 flood levels.*
- *Locating the building pad above the Q100 flood level + 500mm freeboard provides for the safety of residents with regards to the risk of coastal processes.*
- *Flood modelling has determined that the proposed developments have no impacts on the safety of the public and property adjacent to or adjoining the site. Refer Section 8.2 for further details.*
- *Infrastructure services and utilities on site will not be affected due to the design level of the house site.*
- *The development is located at a level which will not interfere with and accommodates natural coastal processes.*
- *By employing Best Management Practices during construction and providing Water Sensitive Urban design elements such as rainwater tanks and infiltration / dispersal trenches during operation the development protects the Coastal ecosystem from an possible impacts. Refer section 9 for further details.*
- *The development does not impact public beach, foreshore of waterfront access and also maintains amenity.*

8.2 CATCHMENT BASED FLOODING

8.2.1 RUNOFF CALCULATIONS

There are two main catchment areas that discharge the canal stormwater at the rear of the site over flow into Cudgen Lake. The first catchment extends south to south west from the site along the surrounding peaks of Round Mountain. The second catchment extends to the south east draining a constructed canal and surrounding roads / allotments. The catchment areas and critical flow paths are shown in Figure 5.0. Catchment A is a rural type catchment and catchment B is an urban type catchment. The values obtained for the first catchment (Catchment A) calculation are based on the Probabilistic Rational Method (for rural NSW catchments) as this is considered the most appropriate for the catchment size as the method accounts for catchment variations in slope along the major flow path and QUDM methods only analyse on average slope for the total catchment. The time of concentration and coefficient of runoff used in the Probabilistic Rational Method are calculated based on the site area. The second catchment (Catchment B) calculation was conducted using the Rational Method as described in the Queensland Urban Drainage Manual, Tweed Shire Design Specification D5 and Australian Rainfall & Runoff, 2007 (AR&R, 2007). The Catchment B time of concentration was calculated based on a standard inlet time and stream flows from the top of the catchment to the entry point, the coefficient of runoff was based on the impervious fraction of the catchment. The peak runoff conditions for various recurrence interval storms are presented below in Table 12.1 and Table 12.2.

Table 8.1.1.1 - Stormwater Runoff Rates – Catchment A

Storm ARI.	Time of Concentration (hrs)	C_{ARI}	Intensity (mm/hr)	Catchment Area (km^2)	Q (m^3/s)
5yr	1.39	0.644	54.2	4.86	**70.09**
100 yr	1.39	0.742	89.30	4.86	**89.45**

Table 8.1.1.1 - Stormwater Runoff Rates – Catchment B

Storm ARI.	Time of Concentration (hrs)	C_{ARI}	Intensity (mm/hr)	Catchment Area (km^2)	Q (m^3/s)
5yr	0.75	0.76	96.13	0.42	**9.42**
100 yr	0.75	0.96	122.79	0.42	**13.75**

8.2.2 FLOOD MODELLING

Flood modelling was conducted using XP-Storm to provide a 1 dimensional / 2 dimensional analysis of the local flood hazard in the adjoining lots bordering the existing canal network. The model includes the following catchments which flow to the canal at the rear of the site: as shown on Figure 5.0 for the external catchments.

Table 8.1.2.1 –Catchments Contributing to XP-Storm Model

Catchments	Area (km^2)
A (Major)	*4.86*
B (Major)	*0.42*
F(Minor)	*0.18*
G(Minor)	*0.04*
H(Minor)	*0.03*

Table 8.1.2.2 - Stormwater Runoff Rates – Additional Minor Catchments

Catchment	Storm ARI.	Time of Concentration (hrs)	C_{ARI}	Intensity (mm/hr)	Catchment Area (km^2)	Q (m^3/s)
F(Minor)	5yr	0.28	0.665	123.04	0.18	**4.09**
	100yr	0.28	0.840	194.29	0.18	**8.16**
G(Minor)	5yr	0.25	0.665	130.15	0.40	**0.99**
	100yr	0.25	0.840	204.92	0.40	**1.96**
H(Minor)	5yr	0.25	0.760	130.15	0.30	**0.98**
	100 yr	0.25	0.960	204.92	0.30	**1.95**

The catchments were entered into the model with their corresponding characteristics of area, impervious fraction and time of concentration. Ground levels used in the model were based on detail survey; additional levels outside the detail survey area were estimated based on a site investigation. A 12D tin was created from the levels and incorporated into the 2D model.

8.2.3 MODEL RESULTS

Flows were calculated by the computer programme using hydrograph methods (flow varies with time) from AR&R rainfall hyetographs and intensities outlined in Tweed Shire Council Design Specification D5 Stormwater Drainage Design. The peak flows were calibrated against the peak flows calculated using the Rational Method outlined in AR&R to facilitate comparison of the results. The calculated difference between peak flows calculated from the model and the Rational Method ranged from + 14% to -9% for the minor catchments bordering the canal system. This variation in the possible input data has a direct effect on the output results in terms of absolute water levels. The effect of this potential error is reduced by comparing the difference in water levels before and after development. In that respect the absolute values of water levels shown in Figures 6 - 7 should not be considered as the definitive design flood level for the area under assessment.

Table 8.1.3.1 –XP-Storm Flows vs Rational Flows

Catchments	Rational Q100 Flow (m^3/s)	XPStorm Flow (m^3/s)	Difference (%)
A (Major)	*89.45*	*102*	*+14*
B (Major)	*13.75*	*12.5*	*- 9*
F(Minor)	*8.16*	*8.1*	*-0.7*
G(Minor)	*1.96*	*2.0*	*+2*
H(Minor)	*1.95*	*1.95*	*0*

Flood modelling was conducted for both the major (Q100) and minor (Q5) ARI flows. For minor flow modelling (Q5 year) the lake level was set to the Tweed Shire Council Q100 flood level of R.L 3.4m AHD which is outlined in the Tweed Development Control Plan – Development of Flood Liable Land - Section A3. The other flood scenario modelled was the major flow event (Q100) with the lake outlet at the R.L 1.0 m AHD.

The sensitivity of the model to various lake levels downstream of the site was also assessed. This analysis takes into account the potential impacts associated with sea level rises as a consequence of global warming. Lake levels of R.L 1.0m, 1.5m and 2.0m AHD were modelled. The increases to the lake level modelled conform with those suggested in the Department of Environment and Climate Change (DECC) document Flood Risk Management: Practical Consideration of Climate Change. Increases in rainfall intensity as a result of climate change were also modelled as detailed in the DECC document with respect to the and calibrated to the Tweed Coast Creeks Study with a 30% intensity increase and lake level of 3.4 m.

The recent Tweed Byron Coastal Creeks Flood Study(October 2009) conducted by BMT WMB for the Tweed Shire Council has indicated a Q100 flood level for the lake of R.L 2.92 m AHD. The study includes the regional affects of climate change and sea level rise. The 2100 year flood scenario within the study results in a lake level of R.I 3.4m AHD due to sea level rise. Two flood scenarios were modelled and calibrated to the BMT WMB study as follows; R.L 2.92m AHD lake level with 100 ARI storm within the upstream catchments; and a R.L 3.40m AHD lake level with 100 ARI Storm and 30% intensity increase within the catchments. These two scenarios were modelled for the existing and developed case's. The 30% intensity increase and R.L 3.40m lake level was modelled as a sensitivity analysis and serves to validate the selection of the Q100 + 0.5m freeboard as the future dwelling habitable design level. The sensitivity analysis was conducted in accordance with the Department of Climate Change: Practical Consideration of Climate Change (2007) guidelines.

To calculate the flows and flood elevations in the 2D model the 12D levels are converted to a grid. The computer model is sensitive to the size of the grid adopted for the calculations. Calculations were carried out using a 6m grid up to a 10m grid to investigate the affects. The larger grid sizes produced a more stable model with fewer warnings. The purpose of the assessment is to determine the impact of the development rather than the absolute water level. In that regard the 8 m grid pattern provided a more stable calculation. A 9m grid was required for model stability when the downstream outlet level was R.L 3.0m and greater. We have adopted the 8m grid for outlet levels < R.L 3.0m and a 9m grid for levels > R.L 3.0m.

The results of the various 1d/2d model calculations for all scenarios are presented in Figures 6 and 7. The figures provide calculated flood levels at various grid locations as well as flow vectors. The flow velocity vectors show the direction of flow. The length of the flow arrow is proportional to the magnitude of the flow velocity. The levels have a stated accuracy of +/- 0.15m. A summary of results is provided as follows.

Table 8.1.3.2 –XP-Storm Flood Elevations

	Q100 Flood Levels in Key Locations (R.L m A.H.D)							
Scenario	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Existing DSWL 1.0m	1.287	1.433	1.557	2.479	1.755	1.831	1.676	1.341
Proposed DSWL 1.0m	1.287	1.433	1.557	2.479	1.755	1.831	1.676	1.341
Existing DSWL 1.5m	1.811	1.928	2.043	2.479	2.278	2.335	2.207	1.841
Proposed DSWL 1.5m	1.811	1.928	2.043	2.479	2.278	2.335	2.207	1.841
Existing DSWL 2.0m	2.086	2.361	2.542	2.479	2.834	2.837	2.722	2.108
Proposed DSWL 2.0m	2.086	2.361	2.542	2.479	2.834	2.837	2.722	2.108
Existing DSWL 2.92m	2.929	2.928	2.939	2.940	2.942	2.942	2.942	2.928
Proposed DSWL 2.92m	2.929	2.937	2.940	2.942	2.942	2.942	2.942	2.928
Existing DSWL 3.4m + 30%	3.409	3.412	3.422	3.423	3.423	3.422	3.422	3.410
Proposed DSWL 3.4m + 30%	3.410	3.412	3.422	3.423	3.423	3.422	3.422	3.410

Note: Flood levels are provided for comparison between existing and proposed flood scenarios and are from the flood model. The values in the table may not correlate directly to the Figures as the number of displayed levels in the Figures has been reduced for clarity. The recorded flood level is the closest level adjacent to the locations detailed as follows. See Figures 6 – 7 for detailed flood elevation plans.

1) North west corner of proposed development site (at rear of proposed Lot 1)
2) South west corner of proposed development site (at rear of proposed Lot 4)
3) South east corner of proposed development site (at rear of proposed Lot 12)
4) North east corner of proposed development (at front of proposed Lot 11)
5) To rear of lots fronting Tamarind Avenue (approximately 200m east of proposed site)
6) To rear of lots fronting Tamarind Avenue (approximately 360m east of proposed site at bend in canal)
7) Center of canal intersection (south east of the site)
8) At channel constriction point (prior to outlet adjacent to location 1)

8.2.4 MODEL ANALYSIS

Our analysis and interpretation of the various calculated results reveal the following impacts.

- The three lake levels investigated (RL 1.0, 1.5 and 2.0 m) resulted in a maximum 1m difference in peak water levels upstream boundary of the model for the existing undeveloped case.
- For all major flow cases (Q100 flows) modelled with alternate lake levels due to sea level rise and intensity increase as a result of global warming there is no impact on neighbouring properties due to development. The development does not cause a noticeable increase in flows to the canal and flood levels are generally much lower than the site, therefore any obstructions on the site have no affect on overland flow paths and consequently flood levels.
- For minor flow cases (Q5 flows) modelled with Q100 downstream flood levels, inundation of the site is apparent in both the existing and design case. Filling of building pad sites to comply with council freeboard level requirements for the future buildings appears to have no affect on the flow in the channel however it does restrict flow from Willow Avenue to the canal causing increased flow in Willow Avenue and an increase in inundation area. The development reduces flows from Willow Avenue to the canal and flood levels are increased in the road. The increase is exaggerated as the size of the 2D grid (8m x 8m) blocks the area between house pads which is unobstructed and would allow flow between the houses. To mitigate the affects of the development on flood levels it is proposed to ensure that any fencing between lots to have high permeability with frequent openings to reduce restriction of flow from Willow Avenue to the canal. The calculated flood levels due to the average recurrence interval (ARI) increase are consistently higher for both the existing and design case. Flows within the canal are increased due to the increased intensity. The Increase in ARI causes an increase in flow however it does not affect the difference in flood levels.The flood scenarios calibrated to the BMT WBM study being; the lake level of R.L 2.92m AHD with a 100 year ARI storm in the catchments; and the lake level of R.L 3.4m AHD with a 100 year ARI storm plus a 30% intensity increase; both have no impact on flood levels in adjoining lots and public areas as a result of the proposed development. Refer Figures 6.6 and 6.7 and 7.6 and 7.7 for further details.
- The sensitivity analysis modelled as the lake level of R.L 3.4m AHD with a 100 year ARI storm plus a 30% intensity increase provided results which were 20mm lower than the Q100 event + freeboard scenario. This result validates the Q100 + freeboard level as a reasonable design level by demonstrating that with the most conservative estimate of climate change and sea level rise impacts the development freeboard level would not be exceeded.
- The proposed flood hazard plan has identified that all dwellings are within the extent of 100 year ARI + sea level rise (0.9) + freeboard scenario. As demonstrated on the proposed Flood Hazard Plan by undertaking minor filling to the building envelopes the flood planning area on the developed lots would be mitigated and the coastal risk reduced.
- In the worst case flood scenarios (the TSC DCP A3 Q100 and 2100 climate change scenarios) the flood impacts due to the development are non worsening. When the flood levels are at the Q100 levels and climate changes levels in accordance with TSC DCP A3 the development has no impact on flood levels in adjacent lots.

We conclude that the proposed development has no impact on water levels in the adjoining residential properties. The development slightly increases levels in Willow with no additional increase in flood levels in adjoining residential properties. The increase is insignificant as the model exaggerates the flow restriction in Willow Avenue with the 8m x 8m grid size. We are of the opinion that the increase has no practical significance as the model exaggerates the effect of the house pads with the 8m x 8m 2D grid. The majority of the site is already filled to the Council nominated flood level and the development has no effect on Q100 flood levels in adjoining properties.

9. SITE BASED STORMWATER MANAGEMENT & WATER CYCLE MANAGEMENT

9.1 EXISTING DRAINAGE

The existing drainage patterns are defined with the majority of overland flow from the site grading north to the Willow Avenue road reserve. The existing gully pits in Willow Avenue discharge stormwater via a 300mm diameter pipe to the north through Lot 618 DP508200 and into Cudgen Lake. The existing gully pits in Tamarind Avenue discharge stormwater via a 375mm diameter pipe to the south through Lot 641 DP216389 and into the existing canal.

Drainage calculations for the site catchments have been carried out using the Rational Method as described in the Queensland Urban Drainage Manual, Tweed Shire Design Specification D5 and Australian Rainfall & Runoff (1987) for a 5 year ARI minor storm event and a 100 year ARI major storm event.

The existing runoff conditions for the existing drainage in Willow Avenue for various recurrence interval storms are presented below in Table 14.1.1. The time of concentration in accordance with Queensland Urban Drainage Manual (QUDM) is 15 minutes for urban and residential areas where average slope is up to 3%. An existing fraction of impervious of 7.5% was determined from the detailed site survey information. Figure 4.1 illustrates the existing catchments and runoff rates.

Table 14.1.1 - Existing Stormwater from site and road reserve

Storm ARI.	f_i	C_{10}	I_{15} minute (mm/hr)	A (ha)	Q (L/s)
5 yr	0.075	0.715	130.15	1.36	336
100 yr	0.075	0.715	204.92	1.36	668

9.2 PROPOSED DRAINAGE NETWORK

Roof water runoff from the new allotments will be diverted into the canal at the rear of the site reducing the catchment to Willow Avenue by 1800m^2 (12 lots by 150m^2 , 150m^2 being the typical roof area as defined in the Tweed Shire Council DCP Section A5 Subdivision Manual) . The proposed development will increase runoff from the site however the increased stormwater from the development and road reserve will be mitigated by discharging roof water to the canal at the rear of the site, where the whole of the site runoff previously discharged to the street. The proposed development will increase the impervious site area from 0% to approximately 5% for proposed driveways. The proposed road widening will increase the impervious area from 24% to 39%. The combined site and road reserve impervious area will increase from 7.5% to 14%. Calculations presented in Table 14.2.1 are based on a 15 minute time of concentration respectively (reference Table 5.05.1 of QUDM).

Table 14.2.1- Proposed Stormwater Runoff Rates from site and road reserve

Storm ARI.	f_i	C_{10}	$I_{5\ minute}$ (mm/hr)	A (ha)	Q (L/s)
5 yr	0.14	0.728	130.15	1.18	297
100 yr	0.14	0.728	204.92	1.18	591

The proposed diversion of roof water reduces the stormwater runoff to the Willow Avenue road reserve such that there is no impact from the proposed development to the existing drainage infrastructure in the street. Thus the proposed development will reduce the stormwater flow into the existing Willow Avenue piped drainage by 39 l/s for a 5 year ARI minor storm event and 77 l/s for a 100 year major storm event. The proposed stormwater drainage and catchment calculations are illustrated in Figure 8.2.

9.3 STORMWATER QUALITY

Development of residential areas generally increases the concentrations of suspended solids, nitrogen and phosphorous in stormwater runoff compared to the existing undeveloped catchment if untreated. Pollutants from residential areas generally comprise of gross pollutants (trash and sediments) biological pollutants (decaying vegetable matter and animal excreta) and nutrients (nitrogen and phosphorus).

Tweed Shire Council specify deemed to comply stormwater treatment requirements in Tweed Shire Council Design Specification D7 – Stormwater Quality. A pollution control device, Gross Pollutant Trap, such as a Humeceptor or equivalent is generally suitable for treatment of surface runoff from road areas for a 3 month ARI storm event as required by Tweed Shire Council Design Specification D7.

The design provides for water sensitive urban design by directing the roofwater to a rainwater tank with overflows discharged to an infiltration trench. The infiltration trench overflows would discharge to the canal at the rear of the site. The works related to the site include only limited additional paved areas (driveways) causing a negligible contribution to pollutants which will be offset with the provision of treatment to roof water runoff. The provision of a GPT such as a Humeceptor is not physically feasible due the shallow construction of existing stormwater drainage within Willow Avenue and would be susceptible to backflow during large events dispersing a concentration of pollutants into the street and adjacent properties above events greater than the 20 year ARI. Water sensitive urban design options such as swales are not suitable as the road provides for numerous driveways for the frontage of the development as described in T.S.C Design Specification D7.

In conclusion due to the small area of pavement attributing to runoff the actual pollutants are may be viewed as minor. Roof water will be discharged to rainwater tanks and infiltration trenches in accordance with WSUD techniques.

10. EROSION & SEDIMENT CONTROL AND CONSTRUCTION MANAGEMENT

10.1 EXISTING SITE

The existing site is grassed, with scattered trees throughout and patches of densely populated vegetation along the northern and southern property boundary. The maximum grade on the development site is approximately 1% towards Willow Avenue.

10.2 PROPOSED EROSION CONTROL

A number of measures or best management practices (BMP) should be implemented to reduce soil erosion and achieve discharge water quality in compliance with Tweed Shire Council Design Specification D7 Stormwater Quality.

The best management practices should be implemented according to the Department of Housing Manual 'Managing Urban Stormwater, Soils and Construction' (2004 'Blue Book'). These measures include hay bales, silt fencing and diversion channels which should be placed in accordance with the proposed management plan during both the construction and re-vegetation phases. Disturbed areas should generally be controlled to drain to these features. There are no external catchment to the site. Disturbed areas will be limited to minor filling to provide building pads for flooding immunity.

The lot layout indicates that approximately 1800m^2 (12 lot by 150m^2) of disturbed area would be created by clearing of house pads. Design Specification D7 indicates that for disturbed areas of less than 1.0 ha, provision of silt fencing or other sediment traps/barriers is satisfactory treatment and a sediment basin is not required. Figure 9.0 shows the erosion control measures for the proposed development. The stabilised site entry will be located off Willow Avenue on the proposed driveway access footprint to the proposed Lot 3.

10.3 IMPACT OF EROSION CONTROL

The implementation and maintenance of erosion control measures would result in manageable impacts on the downstream water system. The impact of transported sediment would be ameliorated by utilising the proposed sediment traps/barriers around the site and a temporary stabilised site entry/exit.

11. WASTEWATER

11.1 EXISTING SEWER RETICULATION

There is an existing 150mm diameter gravity sewer main located within the Willow Avenue road reserve. The existing sewer discharges from the frontage of Lot 634 DP 216389 east along Willow Avenue and into a sewer pump station located in Tamarind Avenue at the frontage of Lot 636 DP 216389. A 100mm diameter sewer rising main transports waste from the sewer pump station along Tamarind Avenue east for approximately 400 metres into manhole number BBC/5. Figure 10.1 shows the existing sewer reticulation.

The existing sewer pump station currently serves four (4) residential lots,a function centre in Willow Avenue,twenty eight (28) residential lots and the Cabarita Lakeside Resort in Tamarind Avenue. Table 12.3 summarises the existing sewer demands.

11.2 PROPOSED WASTEWATER

The proposed development will increase the proposed sewer demands for the proposed twelve (12) lot residential subdivision .A new 150mm diameter sewer main will be constructed within the Willow Avenue road reserve to service Lots 3 to 10 (inclusive). The new sewer main is proposed in the road reserve to avoid impact to existing trees and vegetation on the site proposed to be retained. No other utility services will be impacted as overhead power and communications are located on the opposite road frontage and there is sufficient clearance to an existing adjacent 100mm diameter water main. The proposed main will connect into existing manhole BCB/4 and extend along the verge to the western boundary of proposed Lot 10. Lots 1, 2, 11 and 12 will utilise the existing 150mm diameter gravity sewer line for new house connections. House connections to the proposed new sewer main and existing reticulation will be located clear of trees to be retained where possible. Where this cannot be achieved, new services will be tunnel bored under trees to preserve the existing vegetation and limit future impact from the connection of house drainage. The proposed sewer reticulation is shown in Figure 10.2

11.3 EXISTING & PROPOSED WASTEWATER FLOWS

NSW Public Works Department's Manual (PWD) of Practice Sewer Design provides the calculations for determination of sewer loads. Tweed Shire Council's Revenue Policy Fees and Charges 2008/2009 specify 3.2 people per ET. Sewer load calculations have been undertaken for the existing case and proposed additional 12 residential lots. We have adopted the demand rate of 1.0ET for all existing dwellings, 0.45ET per room for the existing resort apartments and 0.048ET per m^2 floor area for the existing function centre. Sewer demands for the function centre were based on a takeaway / fast food type development as there is no specific rates for this type of development. Calculations were performed using PWD methods and Tweed Shire Council data. Table 12.3 summarises the existing and proposed sewer demands to the existing sewer pump station in Tamarind Avenue.

From Tweed Shire Council Design Guide D12 – Sewerage Systems.
1 EP (Equivalent People) = 240 litres/day (Average Dry Weather Flow)
1 ET (Equivalent Tenament) = 3.2 EP
1ET = 768 L/day

Table 12.3 – Proposed Sewer Pump Station Demands

Component	Quantity (Unit)	Equivalent Tenement per unit (ET)	ET per component
Existing Sewer Demands			
Existing Dwellings	28	1.0	28
Existing Function Centre (m^2)	200	0.048	9.6
Existing Resort Apartments	43	0.45	19.35
Total			**56.95**
Proposed Sewer Demands			
Proposed 12 Lot Residential Subdivision	12	1.0	12
Total			**12**
TOTAL ET			**68.95**

We estimate the Existing Development Flows as

ET = 56.95
Average Dry Weather Flow = 0.626 L/s
Peak Dry Weather Flow = 2.246 L/s
Peak Wet Weather Flow = 6.422 L/s

We have provided a storm allowance of 1.74 L/s as there are seventy two (72) connection points, assuming each resort apartment has its own external connection susceptible to stormwater infiltration affects.

We estimate the additional Proposed Development Flow as

ET = 12

Average Dry Weather Flow	=	0.132 L/s
Peak Dry Weather Flow	=	0.827 L/s
Peak Wet Weather Flow	=	1.523 L/s

We have provided a storm allowance of 0.696 L/s as there are twelve (12) connection points.

We estimate the combined Existing and Proposed Flow as

ET = 68.95

Average Dry Weather Flow	=	0.758 L/s
Peak Dry Weather Flow	=	2.632 L/s
Peak Wet Weather Flow	=	7.504 L/s

We have provided a storm allowance of 4.872L/s as there are eighty four (84) connection points.

11.4 FUTURE SEWER DEMANDS

There are two vacant lots opposite the proposed subdivision in Willow Avenue for future residential sewer demands. The Cabarita Lakeside Resort in Tamarind Avenue has provision for a further sixty (60) apartments and a sporting complex for future sewer demands. The future number of resort dwellings were obtained from their web site.

Sewer load calculations have been undertaken for the future known development demands. We have adopted the demand rate of 1.0ET for all future dwellings and 0.45ET per room for future resort apartments. Table 6.4 summarises the future sewer demands to the existing sewer pump station in Tamarind Avenue.

From Tweed Shire Council Design Guide D12 – Sewerage Systems.
1 EP (Equivalent People) = 240 litres/day (Average Dry Weather Flow)
1 ET (Equivalent Tenament) = 3.2 EP
1ET = 768 L/day

Table 6.4 – Future Additional Sewer Pump Station Demands

Component	Quantity (Unit)	Equivalent Tenement per unit (ET)	ET per component
Future Sewer Demands			
Future Dwellings (2 Lots)	2	1.0	2
Future Resort Apartments	60	0.45	27
Total			**29**

We estimate the Future Flows as

ET = 29

Average Dry Weather Flow	=	0.319 L/s
Peak Dry Weather Flow	=	1.288 L/s
Peak Wet Weather Flow	=	4.884 L/s

We have provided a storm allowance of 3.596 L/s as there are sixty two (62) connection points, assuming each future resort apartment has its own external connection susceptible to stormwater infiltration affects.

11.5 EXISTING, PROPOSED AND FUTURE WASTEWATER DEMANDS

The expected combined wastewater demands are outlined below.

We estimate the Existing, Proposed and Future Flows as

ET (Council) = 97.95
ET (PWD) = 78.36
Average Dry Weather Flow = 1.077 L/s
Peak Dry Weather Flow = 3.523 L/s
Peak Wet Weather Flow = 11.991 L/s

We have provided a storm allowance of 8.468 L/s as there would be one hundred and forty six (146) connection points.

11.6 WASTEWATER IMPACTS AND MITIGATING MEASURES

A telephone conversation with Tweed Shire Councils Water & Sewer Design Engineer Peter Pennycuick on 17 March 2009 has indicated that the existing sewer pump station has sufficient capacity for the proposed twelve (12) lot subdivision. Peter Pennycuick mentioned that the sewer pump station was designed for the future increased loads and each separate proposed development will be individually assessed.

12. WATER RETICULATION

12.1 EXISTING & PROPOSED WATER RETICULATION

On the frontage of the proposed site is an existing 100mm diameter water main. The water main is located within the Willow Avenue road reserve and follows the entire length of road adjacent to the proposed site. There are two fire hydrants located on the frontage of the proposed site. The first hydrant is located opposite lot number 11 of the proposed subdivision and the second opposite lot number 5 of the proposed subdivision. Figure 10.1 shows the existing water reticulation.

Tweed Shire Councils Design Specification D11 contains peak daily and instantaneous demands to be used as a guide for assessing the design demands for development projects. Tweed Shire Council Revenue Policy Fees and Charges 2008/2009 indicate that the peak daily demand for standard residential lots equal or less than 2000m^2 is 1ET, resort apartments 0.3ET and the function centre 0.03 ET per floor area (m^2). The existing and proposed water demand is shown in Table 7.1 below.

Using Tweed Shire Council Design Specification D11
1 EP (Equivalent People) = 850 litres/day Peak Daily Demand
1 ET (Equivalent Tenament) = 0.8 x 3.2 EP
1ET = 2.56 kL/day Peak
= 0.15L/s Instantaneous

Table 7.1 –Existing Water Reticulation Demands

	Daily Rate (kL)	Inst. Rate (L/s)	Peak Daily (kL)	Peak Instantaneous (L/s)
Existing 28 Dwellings	2.56	0.15	71.68	4.20
Existing 200m^2 Function Centre	0.076	0.0045	15.20	0.90
Existing 43 Resort Apartments	0.768	0.15	33.02	6.45
Total			**119.90**	**11.55**
Proposed 12 lot Subdivision		0.15	30.72	1.80
Total			**30.72**	**1.80**
TOTAL Peak flows			**150.62**	**13.35**

We calculate the Peak Daily Water Demand for the proposed twelve (12) lot subdivision is expected to generate a peak daily demand of 30.72 kL/day and instantaneous peak demand of 1.8 L/s. The proposed twelve (12) lot subdivision is expected to have a 20% increase on the existing network. Regional impacts on the proposed water supply will be mitigated by contributions under Section 64 of the Water Supply Authorities Act. The proposed water layout is illustrated on Figure 10.3.

12.2 FUTURE WATER RETICULATION

There are two vacant lots opposite the proposed subdivision in Willow Avenue for future residential water demands. The Cabarita Lakeside Resort in Tamarind Avenue has provision for a further sixty (60) apartments and a sporting complex for future water demands. The future number of resort dwellings were obtained from their web site. The peak demands are calculated using the demands from section of this report.

Table 7.1 –Future Water Reticulation Demands

	Daily Rate (kL)	Inst. Rate (L/s)	Peak Daily (kL)	Peak Instantaneous (L/s)
Future two (2) Residential Lots	2.56	0.15	5.12	0.3
Future 60 Resort Apartments	0.768	0.15	46.08	9
Total			**51.2**	**9.3**

The proposed twelve (12) Lot subdivision and the predicted future demands is expected to have an increase of 40.5% on the existing network.

12.3 WATER IMPACTS AND MITIGATING MEASURES

A telephone conversation with Tweed Shire Councils Water & Sewer Design Engineer Peter Pennycuick on 17 March 2009 has indicated that the existing 100mm diameter water reticulation has sufficient capacity for the proposed twelve (12) lot subdivision.

Water connections to the proposed twelve new allotments will utilise the existing 100mm diameter water main on the frontage of the proposed subdivision. The proposed water layout is shown on Figure 10.3.

13. ELECTRICITY

13.1 EXISTING ELECTRICITY

There are existing overhead power lines located within the Willow Avenue road reserve on the opposite verge. An existing power pole is located on Willow road reserve on the frontage of the proposed Lot 11 and a stay pole on the western side of the proposed Lot 5. Prior to subdivision works any existing electrical services the development site will need to be de-commissioned. The existing electrical lines are shown on Figure 10.1.

13.2 PROPOSED ELECTRICITY

Power supply to the proposed twelve (12) allotments will be from the existing overhead power lines. Prior to issue of a construction certificate the local power authority, Country Energy will provide a Notice of Arrangement letter for electricity supply to a new subdivision. The existing electrical infrastructure is clear of the proposed works and no relocation or augmentation is expected. At the completion of electrical supply to the proposed subdivision a letter is required from Country Energy stating completion of the supply works.

14. TELECOMMUNICATIONS

14.1 EXISTING TELECOMMUNICATIONS

There are existing under ground Telstra lines located within the Willow Avenue road reserve terminating adjacent to lot 2 to service a previous building on site. Prior to subdivision works any existing Telstar within the development site will need to be de-commissioned. The existing Telstra pits are shown on Figure 10.1.

14.2 PROPOSED TELECOMMUNICATIONS

Telecommunication to the proposed twelve (12) allotments service will be extended from the existing pit adjacent to Lot 11 for connection by the new services. Prior to the issue of a construction certificate the local authority, Telstra will be given notice for a Pre-Provisioning Confirmation of the electrical services. At the completion of electrical supply to the proposed subdivision a letter is required from Telstra stating Provisioning Confirmation of the supply works.

15. CONCLUSIONS

The following conclusions are made:

a) As part of the subdivision it is proposed to construct road widening to the Willow Avenue site frontage. Works in the road reserve would include provision for kerb and gutter along the site frontage only and underground drainage and the provision of water, sewer, power and telephone services to each lot. The construction of Willow Avenue will improve on the existing road operating capacity from 1000 vehicles per day to 3000 vehicles per day for an ultimate future width of 9.0 metres to match the existing kerbed section. Road widening to the opposite site frontage would be completed by others.

b) Telephone conversation with Tweed Shire Councils Water & Sewer Design Engineer Peter Pennycuick on 17 March 2009 has indicated that the existing sewer pump station has sufficient capacity for the proposed twelve (12) lot subdivision. To service ten of the twelve lot subdivision a gravity line is proposed along the frontage of the site and will join into the existing sewer gravity main. The remaining Lots 11 and 12 will use the exiting gravity sewer located in Tamarind Avenue.

c) Telephone conversation with Tweed Shire Councils Water & Sewer Design Engineer Peter Pennycuick on 17 March 2009 has indicated that the existing 100mm diameter water reticulation has sufficient capacity for the proposed twelve (12) lot subdivision. Proposed water connections to the twelve lots will utilise the existing 100mm diameter line on the frontage of the proposed subdivision.

d) There are existing overhead power lines located within the Willow Avenue road reserve on the opposite verge. Power supply to the proposed twelve (12) allotments will be from the existing overhead power lines.

e) There are existing under ground Telstra lines located within the Willow Avenue road reserve terminating adjacent to lot 2 to service a previous building on site. Telecommunication to the proposed twelve (12) allotments service will be extended from the existing pit adjacent to Lot 11 for connection by the new services.

f) Flood Modelling of the site has in our opinion shown that the development has no detrimental impact of neighbouring residential properties. Flood levels and flows within adjacent lots are not increased with major modelled flows with outlet lake levels and intensities modelled with increases due to climate change. Flows within the canal are channelized due to the development during the minor event with downstream outlets at a Q100 level. There are no increases to flows within adjacent residential properties or increase in flood level in the minor event. The development has no detrimental impact on adjacent residential properties or the proposed site.

g) Flood modelling has analysed the affects of climate change and impacts are not exacerbated by the development. Rises in sea level and storm intensity increase flows and flood levels within the canal, the proposed site and adjacent residential allotments. The development however does not worsen the affects of sea level rise and storm intensity increase.

h) No treatment measures are proposed to be retrofitted to the existing drainage system as only minor road widening is proposed.

i) Roof water runoff from the new allotments will be diverted into the Canal at the rear of the site reducing the catchment to Willow Avenue by 1800m^2 (12 lots by 150m^2) . The proposed development will increase runoff from the site however the increased stormwater from the development and road reserve will be mitigated by discharging roof water to infiltration pits at the rear of the site with overflows directed to the canal, where the whole of the site runoff previously discharged to the street.

j) The approved design indicates that approximately 0.18 ha of disturbed area would be created by clearing of house pads. The implementation and maintenance of these erosion control measures will result in manageable impacts on the downstream water system.

16. REFERENCES

NEVILLE JONES AND ASSOCIATES PTY LTD AND AUSTRALIAN WATER ENGINEERING	(2007)	Queensland Urban Drainage Manual
DEPARTMENT OF HOUSING MANUAL	(2004)	Managing Urban Stormwater – Soils and Construction.
ROAD AND TRAFFIC AUTHORITY OF NSW	(2002)	Guide to Traffic Generation Developments – Version 2.2
TWEED SHIRE COUNCIL	(2004)	Development Design Specification D1 – Road Design
TWEED SHIRE COUNCIL	(2010)	Tweed Development Control Plan – Development of Flood Liable Land - Section A3 Version 1.3.
TWEED SHIRE COUNCIL	(2004)	Development Design Specification D5 – Stormwater Drainage - Version 1.2.
TWEED SHIRE COUNCIL	(2005)	Development Design Specification D7 – Stormwater Quality – Version 1.3
TWEED SHIRE COUNCIL	(2004)	Development Design Specification D11 – Water Supply – Version 1.2.
TWEED SHIRE COUNCIL	(2007)	Development Design Specification D12 – Sewerage System – Version 1.5.
TWEED SHIRE COUNCIL	(2009)	Section 94 Plan No. 4 - Tweed Road Contribution Plan (Version 5.1).
TWEED SHIRE COUNCIL	(2009)	Revenue Policy – Fees & Charges 2008/2009
TWEED SHIRE COUNCIL	(2004)	Driveway Access to Property Design Specification – Part 1
TWEED SHIRE COUNCIL	(2000)	Tweed Local Environmental Plan 2000.
TWEED SHIRE COUNCIL	(2005)	Tweed Shire Coastline Management Study Stage 2, Managing Objectives.

VEITCH LISTER CONSULTING PTY LTD	(1997)	Tweed Road Development Strategy
WBM OCEANICS AUSTRALIA	(2001)	Tweed Coastline Hazard Definition Study
AUSTRALIAN RAINFALL & RUNOFF	(2007)	A Guide to Flood Estimation – Institution of Engineers, Australia.

APPENDIX A

KENMAR FARMS PTY LTD

SOIL AND WATER MANAGEMENT PLAN

PROPOSED THIRTEEN LOT SUBDIVISION
WILLOW AVENUE
BOGANGAR NSW

THE SOIL AND WATER MANAGEMENT PLAN

This plan is to be read in conjunction with:

i) the engineering plans, and
ii) any other plans or written instructions that may be issued and relating to development at the subject site.

Contractors shall ensure that all soil and water management works are:

i) located as shown in the drawings, specification and Management Plan
ii) constructed in accordance with the:
- Tweed Shire Council – Development Design Specification D7 – Stormwater Quality (Annexure A).
- NSW Department of Housing - Soil and Water Management for Urban Development.

The Contractor shall nominate a competent person to inspect erosion control structures, complete the site diaries and ensure the Soil and Water Management Plan is implemented.

The person nominated to implement the plan shall keep a copy on site.

OBJECTIVES

- To prevent sediment erosion being transported from the site by wind and water.

LAND DISTURBANCE

Other than for essential thinning of plant growth, land disturbance shall be limited to that necessary for implementation of the plans of works. Ideally, lands shall not be disturbed beyond five metres from the edge of any essential construction activity as shown on the engineering plans, other than in access zones. Such zones shall be clearly identified with barrier mesh or "silt" fencing or similar materials. The location of "silt" fences should be determined on site and may vary in position to best conserve the existing vegetation and protect downstream areas. The contractor shall ensure regular watering of exposed surfaces to minimise wind erosion.

Where practical, thinning of plant growth in the development should be by hand or approved small machine. Small branches, leaf litter and other residues shall be retained as mulch.

Generally, works shall be undertaken in the following sequence:

i) where possible, divert clean water likely to run onto lands to be disturbed
ii) install sediment control works
iii) strip and stockpile topsoil
iv) undertake site development works in accordance with the engineering plans
v) rehabilitate the site
vi) remove soil and water management works.

Any temporary culverts or causeways to be installed across drainage reserves should be constructed only in areas of minimal erosion hazard. Such areas should be defined in consultation with the engineer.

EROSION CONTROL

The maximum water velocity in the design storm event in earth based waterways should be in accordance with Table 1.

TABLE 1

MAXIMUM FLOW VELOCITIES (m/sec)

IN EARTH BASED WATERWAYS *

GROUND COVER	VELOCITY (m/sec)
Mat or sward forming grasses with Enkamat ® or other UV stabilised mesh.	2.4
Kikuyu Grass.	1.9
Jute mesh (bitumen sprayed).	1.7
Couch grass, Rhodes grass, other sward forming grasses.	1.4
Other improved perennials.	0.9
Biodegradable blankets.	0.7
Tussock grasses.	0.5
Bare soil.	0.3

- This table assumes slope gradients of less than 10 percent and, other than for base soil, good (ie. >80%) ground cover.

During road works, temporary crossbanks (bunds constructed with earth, straw bales or sandbags) should be constructed to limit slope length, where possible in accordance with Table 2.

TABLE 2

RECOMMENDED MAXIMUM SPACING BETWEEN

CROSS DRAINS ON HAUL ROADS

SLOPE	MAXIMUM SPACING (metres)
0 to 7%	*NN*
7 to 10%	70
10 to 13%	32
13 to 16%	15
>16%	NR

NN – not necessary
NR – construction of haul roads not recommended.

Outlets from erosion or sediment control devices should be to stable disposal areas.

Earth batters should be:

i) constructed with a maximum gradient of 2(H):1(V)
ii) properly topsoiled, seeded and mulched within two weeks from completion of works.

A recommended listing of plant species is:

Spring/Summer sowing:	**Autumn/Winter sowings:**
Couch, hulled	Couch, hulled
Couch, unhulled	Couch, unhulled
Regal Ryegrass	Regal Ryegrass
Japanese Millet	Prairie Grass
Carpet Grass	Ryecorn/Oats
Haifa White Clover	Haifa White Clover
Redquin Red Clover	Crimson Clover

The contractor is to nominate the mixture and application rates to be used to achieve the specified coverage. An approved grass mixture for seeding should contain Broad leaf Paspalm 30%, Carpet Grass 30% and Oats/Rye Grass 30%. The contractor shall provide a list of suitable native bush and tree species where required by the drawings.

The contractor should stage works and implement construction techniques to minimise the length of exposure to disturbed surfaces; topsoil and grass within two weeks of completion. Temporary rehabilitation should be undertaken on disturbed areas where works have stopped and soils are expected to remain exposed for more than two weeks before either works continue or permanent rehabilitation is undertaken. If vegetative means are used, the following species mix is recommended:

Autumn/Winter sowing

Oats/ryecorn @ 20kg/ha

Japanese millet @ 10kg/ha

Spring/Summer sowing

Japanese millet @ 20 kg/ha

Oats/ryecorn @ 10 kg/ha

Alternatively, the contractor shall submit a substitute mix for approval.

On lands where rehabilitation to native plants is not essential, fertilisers/ameliorants should include:

i) dolomite on topsoils at a rate of 2 kilograms per tonne of soil to raise the pH to be more conducive to growth of exotic species, particularly in waterways and other areas of high soil erosion hazard,
ii) Grower 11 (or equivalent) at 250 kilograms per hectare and trace elements according to manufacturers instructions at sowing, and
iii) Nitram (or equivalent) at 100 kilograms per hectare in the following Spring;

SEDIMENT CONTROL

Sediment retarding basins and sediment traps shall be constructed to contain the minimum storage specified on the engineering drawings.

"Silt" fences or straw bale sediment traps should be placed at regular intervals immediately downslope of all unprotected disturbed lands.

- "Silt" fences, straw bale barriers, etc., should rarely be placed along the contour, as water will run to a low point in large storm events and the structure may fail. "Silt" fences should be placed with small returns at about five to thirty metres, creating a series of small sediment traps in line. This system has the added benefit of avoiding concentrated flows.

Sediment barriers (eg. sandbags or straw bales) should be located upstream of stormwater inlet pits prior to the road surface being paved. These barriers should be reinstalled after completion of paving if there are disturbed or bare areas nearby likely to contribute sediment to the road surface.

CONTROL MEASURES

The potential dust problems due to construction activities are to be ameliorated through the implementation of dust control measures. These measures are given in the table below.

FREQUENCY	CONTROL MEASURES
General operational practices	Track-walked slopes • Surface rehabilitation • Limitation of topsoil stripping to current work areas • Stabilisation of stockpiles • Application of woodchip, mulching, organic matting or bitumen emulsions • Speed restriction for site vehicles • Roadways designated and maintained for site vehicles • Watering system utilised during rock face operations
Event based measures (upon identification of dust problem)	Ensure operational practices are being carried out. Watering of disturbed surfaces • Covering of disturbed areas and stockpiles awaiting vegetation growth • Provide screens around earthworks areas

OPERATIONAL TIMES

The operational control measures are to be implemented at all times during site works. These times would depend on the contractor performing the works. Event based measures may be required outside of the operational times of the site upon identification of a dust problem.

WIND CONDITIONS

During dry conditions with high winds a watering truck should be present on site during works.

DUST MONITORING

Monitoring of the dust emissions is to be carried out by visual inspection by the contractor.

WATER SOURCES

Potable water from existing council mains is to be used for dust suppression. Alternatively water from sediment basins may be used when available.

CONSTRUCTION SEQUENCE

Works on the development should be carried out in the following sequence:

i) construction of sediment basin/trap
ii) installation of barrier fencing and "silt" fencing
iii) construct roadworks.

MAINTENANCE

The contractor shall:

i) regularly maintain all soil and water management devices, including removal of accumulated sediment or trash, to ensure that more than 60 percent of the design capacity remains in the settling zone.

ii) dispose of any sediment removed in areas where further pollution to downslope lands and waterways is unlikely.

INSPECTION

Inspections shall be undertaken:

i) during any storm event that threatens to exceed the available capacity in sediment and pollution storage structures
ii) after any storm that has caused runoff
iii) daily, during hot or dry weather when grass cover is less than 100% on vegetated areas
iv) weekly (on Fridays) as a matter of site routine for all site work practices
v) before site closure or any other time when it might be otherwise unattended for more than twelve hours
vi) testing as specified in the water quality monitoring program shall be carried out in accordance with the nominated schedule
vii) signed, completed test results and inspection report shall be kept on site and made available on request to the engineer, Council officers and relevant authorities.

INSTALLATION

The contractor shall ensure a diary or record is kept documenting site work practices such as:

i) dates of installation and removal of site work practices
ii) repair of any damage to site work practices
iii) rainfall depths, durations and times
iv) storage capacity available in pollution control structures
v) condition of site work practice structures and stabilised surfaces
vi) time, date, volume and type of any additions of flocculants
vii) estimates of water volumes discharged
viii) estimates of pollutant volumes removed
ix) water quality test results.

Program

i) Inspect catch drains, earth banks, table drains, and drop-down structures and clean as required.
ii) Remove any stockpiled material or sediment that has encroached within two metres of a surface drain.
iii) Restore any low spots in banks and drains to their original height and compact.
iv) Where necessary, construct extra catch drains that help separate on-site dirty waters from other waters.
v) Install any new erosion and sediment control measures that have become necessary since previous inspections because of severe storms or progress in the site's development.
vi) Check to ensure that banks, channels and waterways are operating within the safe limits for their surface condition by noting any evidence of scour.
vii) Ensure that any construction work at the site since the previous inspection has not diverted sediment and water away from any site work practice.

WATER QUALITY MONITORING PROGRAM

The contractor is to undertake a water quality monitoring and testing program to comply with the Department of Housing Guidelines and Clean Waters Act and Tweed Shire Council Design Specification D7 as tabulated below.

i) Monitoring

Parameter	Frequency	Reporting
Suspended Solids, Non Filterable Residue (NFR)	Fortnightly or during discharge event (defined as >25mm in any 24 hour period).	as per the **Inspection** section, non complying test results are to be notified within 24 hours to Council officers.
pH	• if in acid sulfate soils risk area, daily or during controlled discharge event. • in areas with no identified acid sulfate risk, fortnightly and during controlled discharge event from sedimentation basins.	as per the **Inspection** section, non comply test results are to be notified immediately to Council's Environmental & Health Services Unit.
Total P, Total N	Fortnightly	as per Inspection section

ii) Response to Monitoring, Non Compliance with ESCP, Amelioration Measures

Indicator	Response	Comments

pH too low <6.5	• If possible stop discharge and store runoff on site.
	• Respond in accordance with approved acid sulfate management plan or if no plan then:-
	  • Lime dose as per Acid Sulfate Soil Manual (Assmac), restore to acceptable pH before further discharge.
	  • Notify Council's Environmental & Health Services Unit of non compliant discharge (within 24 hours).
		Reporting as per previous table (i) Monitoring.

pH to high >8.5	• If possible stop discharge and store runoff on site. • Dilute with other water until pH in acceptable range. • Re-test for compliance before further discharge.	
Suspended Solids (NFR) >50mg/litre	Identify if non compliance is due to storm event greater than design storm of control devices. If so accept non compliance. If not then:- • If possible stop discharge and store runoff on site. • Use flocculation agents to lower NFR or • Pump contaminated water over grassed filter strips or buffer areas to lower NFR. • Identify (by inspection and/or analysis) if non compliance is due to damage of ineffectiveness of erosion and sediment control devices. Repair or redesign/replace if necessary (or required by Council) to ensure future compliance.	Non compliance may occur, by design, in >3 month (deemed to be 40% of the ARI one year event).

FIGURES