Tonkin+Taylor

Job No: 1003723
26 July 2017

Hopper Developments Ltd
19 Tamariki Avenue
PO Box 110
Orewa 0931

Attention: Howard Jury

Dear Howard

Whitianga Waterways: Review of flood levels for Stage 10 development

1 Purpose

Hopper Developments Ltd (HDL) are preparing for Stage 10 of the Whitianga Waterways Development (refer Attachment A for the overall development layout and the detail of Stage 10 within the overall project development). HDL commissioned Tonkin +Taylor (T+T) to update the coastal inundation levels included in their 1998 report[1] based on improved local measurements and new projections of sea level rise from the IPCC to support the subdivision consent application for Stage 10 of the Whitianga Waterways development. This assessment does not include an assessment of groundwater or overland flooding and it is assumed that the local SW network and overland flow paths are designed to convey SW away from dwellings and sections.

2 Background

The 1998 report considered the impacts of the proposed development on coastal and harbour dynamics as part of a suite of comprehensive studies to support the original consent application for the development. The report included the establishment of flood levels based on a building block approach adding together storm surge, catchment flooding and sea level rise.

The 1998 report provided elevations in terms of Whitianga Waterways Datum (WWD) and Chart Datum (CD) based on levels on the adjacent harbour and recommended a building floor level of 3.75 m CD (12.43m WWD) based on the following, rounded up to the nearest 5 cm:

- Predicted sea level rise to Year 2100 (0.49 m)
- 2%AEP storm surge (2.18 m CD from Moturiki Island, Tauranga)
- 2%AEP river flood (1.05 m).

It is noted that a bathtub modelling approach was used (i.e. uniform levels) and no attenuation of river flood flows or storm surge was considered within the proposed development.

The proposed Stage 10 canal front sections have building platforms at top of canal-front yard at elevation WWD 13.10m. This is an additional 0.7m above the predicted flood level and lots further

[1] T+T (1998) Whitianga Waterways study on impacts to coast and harbour dynamics. T+T ref. 15470. Report prepared for Hopper Developments Ltd, August 1998.

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'inland' rise to elevations WWD 13.85m and 14.60m. Habitable floors for dwellings will also be subject to further elevations above ground level to comply with New Zealand building code requirements (Building Code Surface Water E1 Acceptable Solution 1 (E1/AS1). This adds a minimum of 0.15 m to the ground levels.

3 Updated storm surge and climate change projections

3.1 Storm surge

Measurements of water level has been carried out at Whitianga Wharf since 31st July 1999 with sampling of levels every 1 to 5 minutes. The wharf is at the entrance to the estuary and some 3 km from the waterways entrance and is set to Moturiki Vertical Datum (MVD-53) i.e. gauge zero = 0m.

NIWA (Stephens et al., 2015[2]) carried out a storm surge analysis on this 15 year data set and the results of this assessment are included in Table 1. This table includes an addition of 0.14 m to the tide gauge data to provide levels relative to MVD-53. Based on the lower bound and upper bound of the 0.5%AEP event a storm surge level ranged from 1.64 to 1.74 m MVD-53 (i.e. around ±0.06 m from the median value shown in Table 1. These levels are less than for Moturiki Island that was used in the 1998 assessment.

Table 1: Extreme storm surge levels at Whitianga Wharf (Source: Stephens et al., 2015)

Probability of occurrence		Level relative to MVD-53 (2008 - 2014), m	Level relative to Whitianga Waterways Datum (1998), m
Annual Exceedence Probability (AEP) %	Average Recurrence Interval (ARI) years)		
39	2	1.3	11.0
18	5	1.3	11.0
10	10	1.4	11.1
5	20	1.5	11.1
2	50	1.5	11.2
1	100	1.6	11.3
0.5	200	1.7	11.4

3.2 River flood levels

To our knowledge there has been no additional catchment modelling on river and estuary flood levels since our 1998 report.

We note that data measured at Whitianga Wharf would take into account the coincidence of storm surge and river flood at that location. This means that it would be the gradient of the water surface that would need to be added to the storm surge levels to represent levels within the estuary.

[2] Stephens, S, B. Robinson, R. Bell (2015). Analysis of Whitianga, Tararu and Kawhia sea-level records to 2014. NIWA report ref HAM-2015.046 for Waikato Regional Council, June 2015

The modelled gradient of the estuary slope from the Wharf to the waterway entrance was around 6 cm/km (T+T, 1988). This suggests that an additional 0.18 m should be added to the storm surge levels at Whitianga Wharf to derive storm surge levels at the entrance to the waterway.

Our modelling in 1998 assumed all flooding extended uniformly into the waterway development area. However, for river flooding this is likely to overestimate flood extents flows are directed along the main channel and only a proportion of the flow is likely to enter the waterways entrance that is oblique to the main channel. Based on cross-sectional area the entrance is 10% of the main channel and it can conservatively be assumed that within the main part of the waterway only 10% of the main channel flood elevation will occur.

3.3 Sea level rise

Historic sea level rise in New Zealand has averaged 1.7 ± 0.1 mm/yr (Bell and Hannah, 2012). Climate change is predicted to accelerate this rate of sea level rise into the future. NZCPS (2010) requires that the identification of coastal hazards includes consideration of sea level rise over at least a 100 year planning period (i.e. 2120). Potential sea level rise over this time frame is likely to significantly alter the coastal erosion hazard.

Modelling presented within the most recent IPCC report (AR5; IPCC, 2015) show predicted global sea level rise values by 2100 to range from 0.27 m, which is slightly above the current rate of rise, to 1 m depending on the emission scenario adopted. The RCP2.6 scenario assumes very low greenhouse gas concentration levels by 2100 after first reaching high levels by mid-century. The RCP4.5 scenario is a 'stabilization' scenario in which emissions are stabilized shortly after 2100 without overshooting. The RCP8.5 scenario assumes a high rate of emissions continue to rise in the 21st century.

The Ministry of Environment (MfE, 2008) guideline recommends a base value sea level rise of 0.5 m by 2090 (relative to the 1980-1999 average), with consideration of the consequences of sea level rise of at least 0.8 m by 2090 with an additional sea level rise of 10 mm/yr beyond 2100.

We have used four sea level rise scenarios that are based around three RCP scenarios derived from IPCC (2015). These are the median projections of the RCP2.6, RCP4.5 and RCP8.5, and (RCP8.5+) the upper end of the 'likely range' (i.e. 83rd percentile) of the RCP8.5 projection. The projections of the potential future scenarios (RCP2.6, RCP4.5, RCP8.5 and RCP8.5+) adjusted to the New Zealand regional scale are shown in Table 2 for 2065 and 2120. The 1.0 m currently used by Environment Waikato represents a level that could be reached just before 2120 with the high rate of emission scenario. We recommend a value of 1.06 m to be consistent with the RCP8.5M value.

Table 2: Sea level rise projections from the 1986-2005 baseline for four IPCC emission scenarios

Year	RCP 2.6 M	RCP 4.5 M	RCP 8.5M	RCP 83rd %
2065	0.30	0.33	0.41	0.55
2120	0.55	0.67	1.06	1.36

4 Tsunami

Substantial work has been recently carried out to understand tsunami risk at Whitianga. Thames-Coromandel District Council, Hauraki District Council and Waikato Regional Council have developed an Eastern Coromandel Tsunami Strategy based on modelling carried out by e-Coast (Borrero, 2017[3]). A range of scenarios were considered including eight M8.8 to M9.0 nearfield earthquakes

[3] Borrero, J.C. (2017) Numerical modelling of tsunami inundation in Whitianga, Mercury Bay, Hahei and Hot Water Beach, New Zealand. https://www.waikatoregion.govt.nz/assets/WRC/Services/regional-services/hazards-and-emergency-

and eight distant source events. Maps have been prepared for the maximum credible event (refer Figure 1). The maximum credible event was defined as source based on the 2011 Tohuku earthquake applied to the Tonga-Kermadec Trench to the north of East Cape.

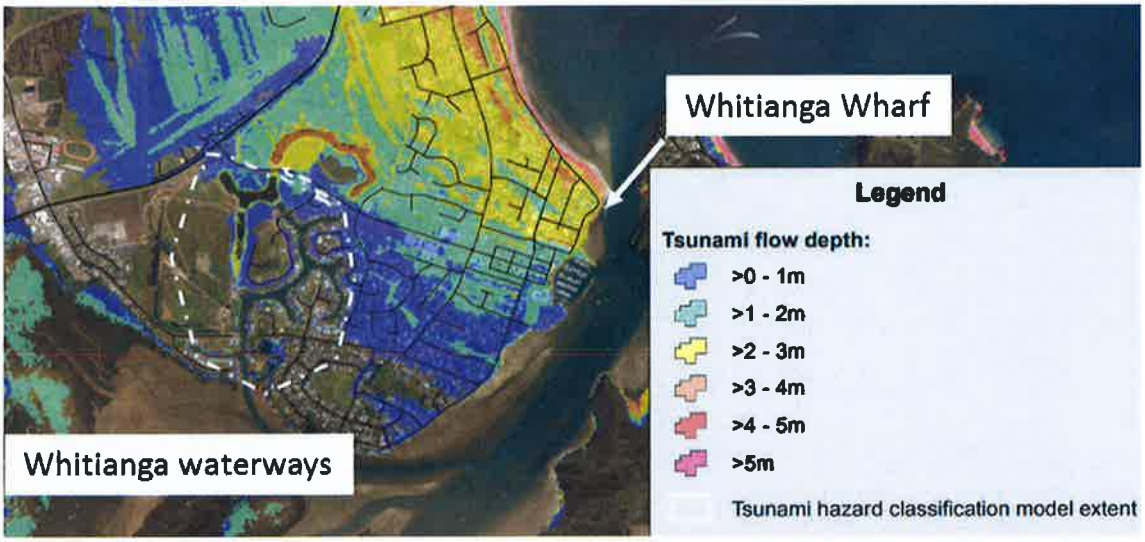

Figure 1 Flow depth of the maximum credible tsunami occurring at high tide (https://www.waikatoregion.govt.nz/assets/WRC/Services/regional-services/hazards-and-emergency-management/coastal/tsunami/eastern-coromandel-strategy/33425-Whitianga-Tsunami-Flow-Depth-v2.pdf)

This figure shows that the ground elevations in the vicinity of the waterway development are typically higher than the maximum credible tsunami levels and the hazard classification is ranges from medium to nil (refer Figure 2).

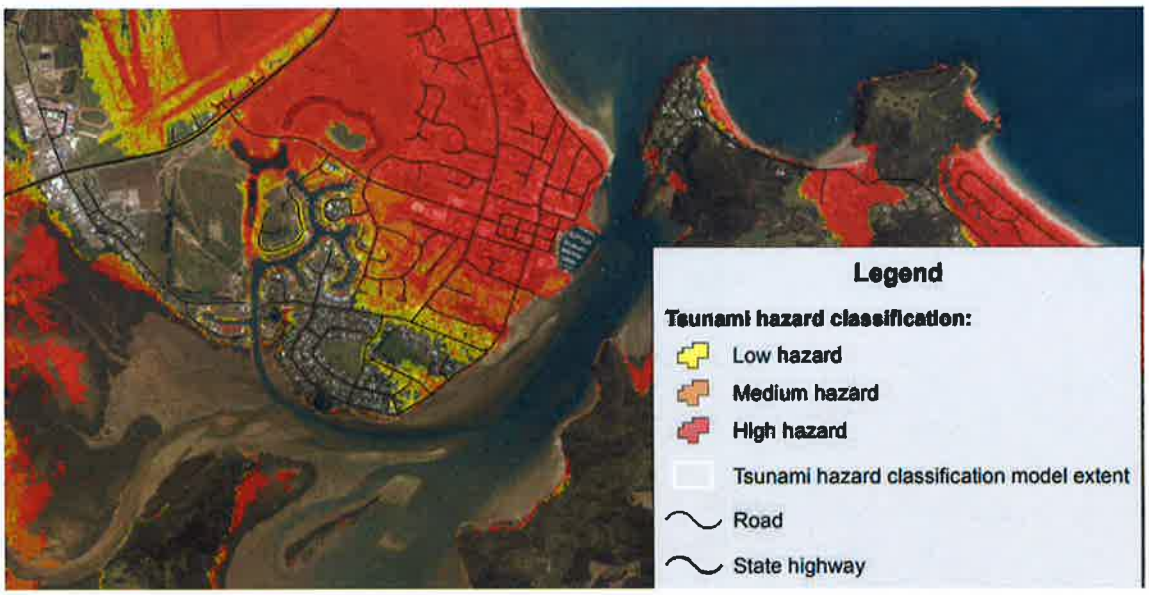

Figure 2 Tsunami hazard classification (https://www.waikatoregion.govt.nz/assets/WRC/Services/regional-services/hazards-and-emergency-management/coastal/tsunami/eastern-coromandel-strategy/33425-Whitianga-Tsunami-Hazard-Classification-v2.pdf)

management/coastal/tsunami/eastern-coromandel-strategy/Numerical-Modelling-Whitianga-Mercury-Bay-Hahei-and-Hot-Water-Beach-2016.pdf

5 Assessment

The local site measurement of water levels at Whitianga Wharf provide a more accurate representation of the local storm surge at the entrance to the waterways, although some allowance of estuary effects need to be considered as the waterway entrance is some 3 km upstream from the wharf.

The revised flood inundation level is based on storm surge at Whitianga Wharf, exclusive of any freeboard requirements, is shown in Table 3. We recommend rounding the storm surge value to 12.65 m.

Table 3: Revised storm surge level

Components	Contribution	
1%AEP storm surge at Whitianga Wharf	11.28	WWD (m)
Gradient from Wharf to waterway entrance	0.18	m
Contribution of river flood (10% of 1%AEP flood level)	0.11	m
Sea level rise	1.06	m
Total	12.63	WWD (m)

This storm surge level is around 2 m higher than present day MHWS but only 0.2 m higher than the proposed level in the 1998 report even with an additional 0.51 m of sea level rise. This is due to lower locally measured storm surge values than those at Moturiki Island and a refinement of the approach for catchment based flood migration into the waterway area.

The proposed Stage 10 canal front sections ground elevation are WWD 13.10m and lots further 'inland' rise to elevations WWD 13.85m and 14.60m. Habitable floors for dwellings will also be subject to further elevations above ground level to comply with building code requirements. These ground elevations are at least 0.45 m higher than the revised flood level. The proposed Stage 10 ground elevations also reduce the likelihood of tsunami inundation.

We note that the proposed minimum levels of WWD 13.10 m are appropriate for use for other areas of the proposed development and provide a reasonable freeboard from the levels determined in Table 4.

6 Applicability

This report has been prepared for the exclusive use of our client Hopper Developments Ltd, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
	p.p. 
.....	.....
Richard Reinen-Hamill	Mark Taylor
Senior Coastal Engineer	Project Director

RRH
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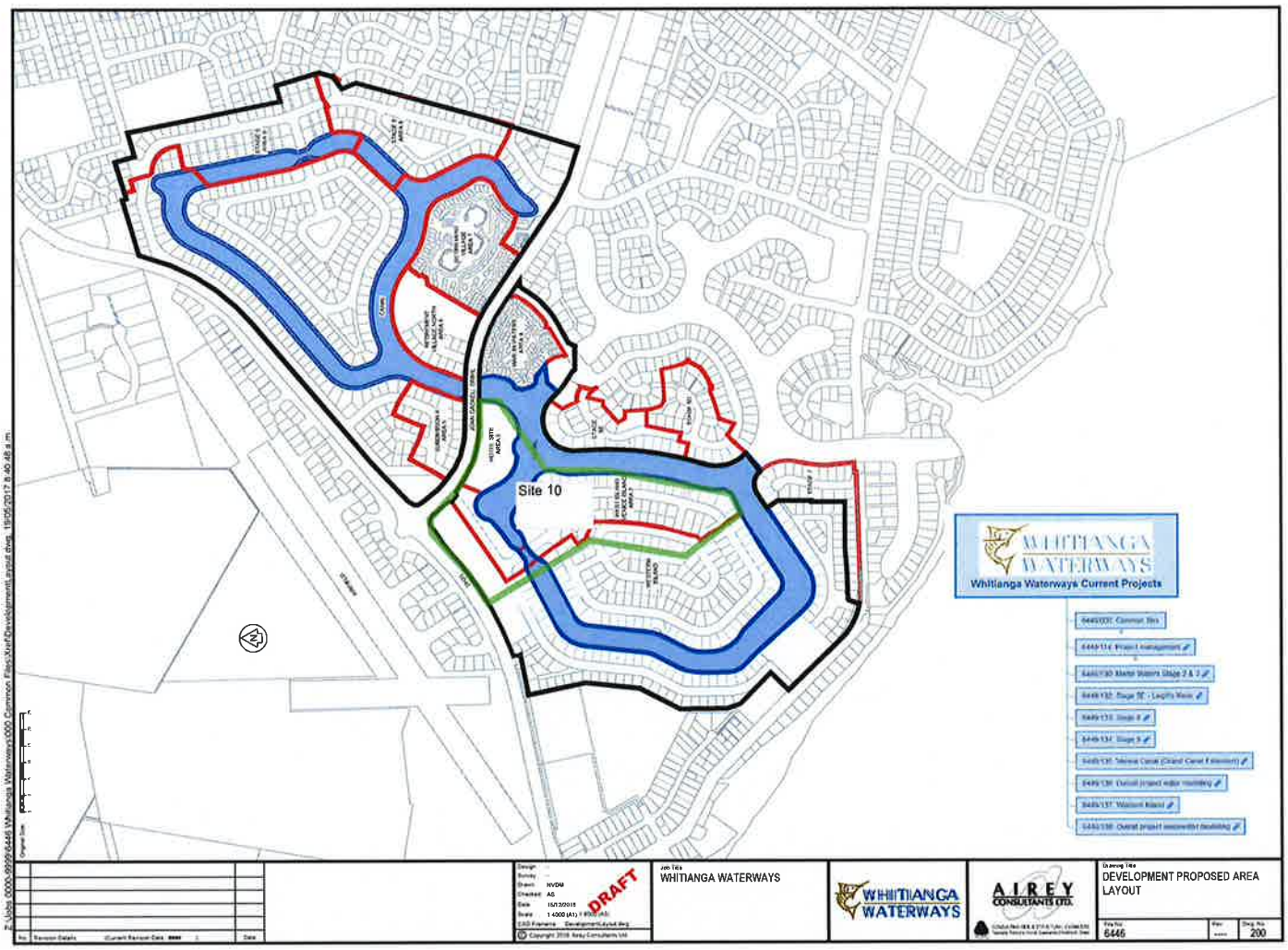
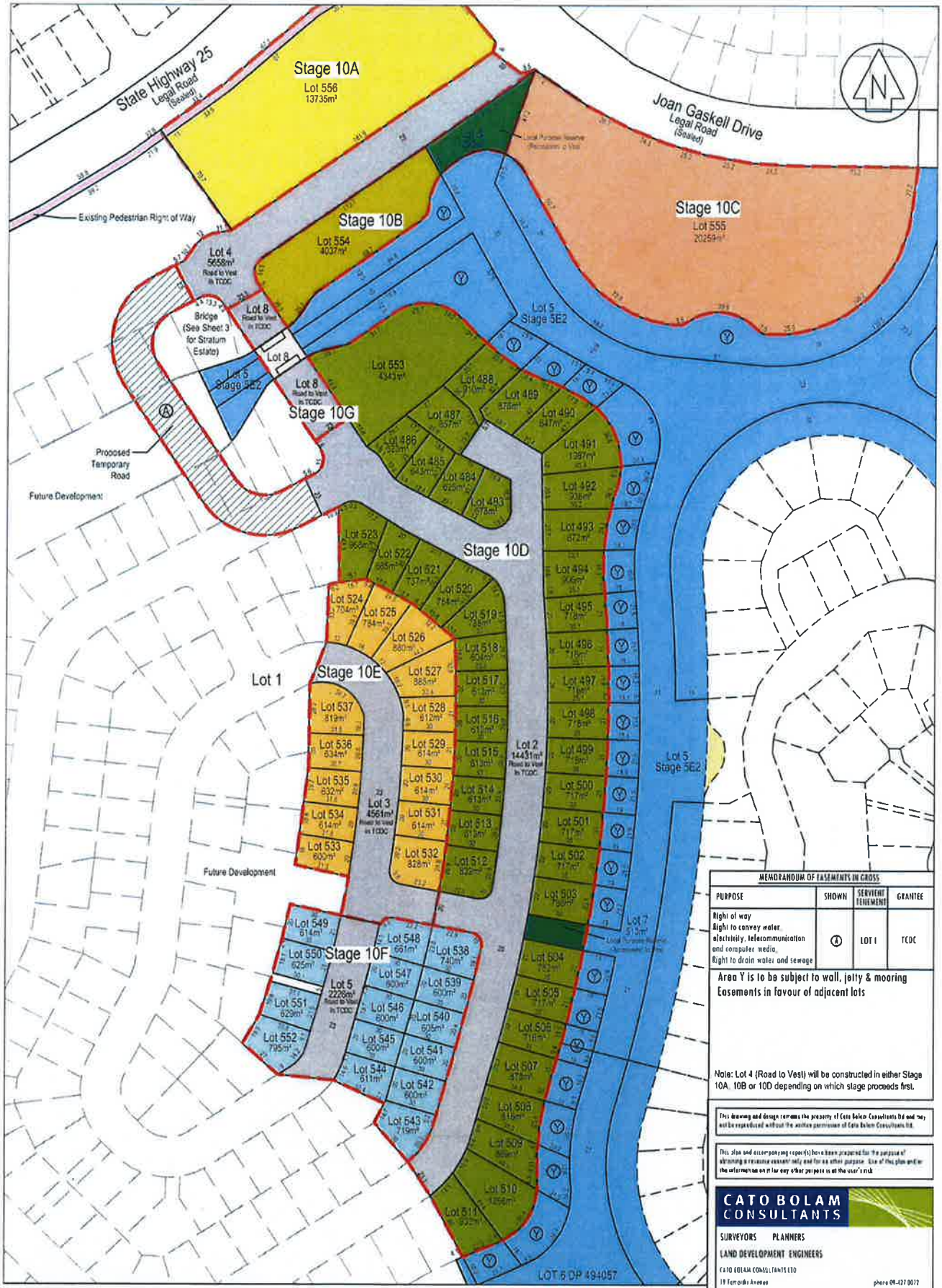
Attachment A: Proposed development area

- Development proposed area layout
- Stage 10 area detail


Site 10
WHITIANGA WATERWAYS
Whitianga Waterways Current Projects
DRAFT
WHITIANGA WATERWAYS
AIREY CONSULTANTS LTD.
DEVELOPMENT PROPOSED AREA LAYOUT
6446
200



MEMORANDUM OF EASEMENTS IN GROSS

PURPOSE	SHOWN	SERVIENT TENEMENT	GRANTEE
Right of way Right to convey water, electricity, telecommunication and computer media. Right to drain water and sewage	A	LOT 1	TCDC

Area Y is to be subject to wall, jetty & mooring Easements in favour of adjacent lots

Note: Lot 4 (Road to Vest) will be constructed in either Stage 10A, 10B or 10D depending on which stage proceeds first.

REVISION (DESCRIPTIONS)	INITIALS	DATE
R7 - Retail South Amended	MB	03/17
R6 - Strata Added Ramp Removed	MB	02/17
R5 - Staging amended	MB	02/17
R4 - Staging	MB	02/17
R3 - Lot 6 (Ramp) Added. Lots 494-497 amended	MB	12/16
R2 - Lots 530-552 added. beach amended	MB	12/16
R1 - Link Rd moved north	MB	11/16
SURVEYED	KK	KK
DESIGNED	MB	08/16
DRAWN	MB	08/16

CLIENT

WHITIANGA WATERWAYS LIMITED

DRAWING TITLE

STAGE 10
LOTS 1 - 8 & 483 - 556

CATO BOLAM CONSULTANTS

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ORIGINAL SCALE	ORIGINAL SIZE	REVISION NO
1:2000	A3	R7
DATE	CAD REFERENCE	SHEET NO
08/16	35327-S1-R1	S2
DIRECTORY		JOB NO
		35327