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5 February 2008

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Mr. Peter A Le Bas
Turnbull Planning International Pty Ltd
30 Bilga Ave
BILGOLA NSW 2107

Dear Peter,

RESPONSE TO PART 3A APPLICATION COMMENTS – DOLPHIN POINT STAGES 2 & 3

1 COMMENTS ON AMENDED LAYOUT

The amended layout incorporates an extended riparian corridor buffer around the two creeks within the site, and rearranged sections of the road and lot layout. As a result of this there would be a greater distance between the 100 year ARI flood extent and the proposed lots. The collector road access over Creek 1 would need a culvert sufficient to convey the 100 year flow. Similarly the link road adjacent to the roundabout at the eastern side of the site would need to be designed to ensure that the Creek 2 flows can be accommodated underneath the roadway.

The developable area has been reduced so it is expected that the pollutant load would also be reduced. Given that the water quality treatment mechanisms (rainwater tanks, GPT's, water quality control pond, and bioretention basins) have been relocated but not reduced, further water quality modelling is not required.

Given that the road and lot layout has changed, the location of the stormwater infrastructure will need to be altered accordingly. Roads will also need to be graded to ensure that flows are able to drain overland from the site. A sketch is provided attached, showing the revised stormwater management plan.

2 CLIMATE CHANGE

2.1 Flooding

The 24ha site is relatively steep (average grade generally around 5%), with external upstream catchments of 58ha drained by Creeks 1 and 2. Given these conditions, the flood risk on the majority of the subject site is low. However, given that some of the lots would be relatively low lying, and that creeks and overland flow paths on the site drain to low lying areas at their outlets, the flood planning level is dictated by tailwater conditions.

Creek 1 drains to the existing dam, to be adapted to a water quality control pond. The downstream tailwater condition for Creek 1(at the western side of the site) in the Water Management Report (dated September 2006) was taken as the permanent water level in the existing dam of RL3.0mAHD.

The downstream tailwater condition for Creek 2 (at the eastern side of the site) in the Water Management Report was taken as the flow's normal depth, with its point of discharge from the development area at approximately RL2.0mAHD. This tailwater condition has been elevated for a sea level rise and flood condition to a water surface level of RL 3.0m AHD in the further analysis described in **Section 2.3**.

As covered in Section 3.1 of the Water Management Report, from the downstream site boundary, runoff flows via a natural creek to Burrill Lake near its outlet to the ocean.

The increased risk of flooding due to climate change would be caused potentially through increased rainfall intensity and sea level rise, and these factors are addressed in Sections 2.2 and 2.3.

2.2 Sea level rise

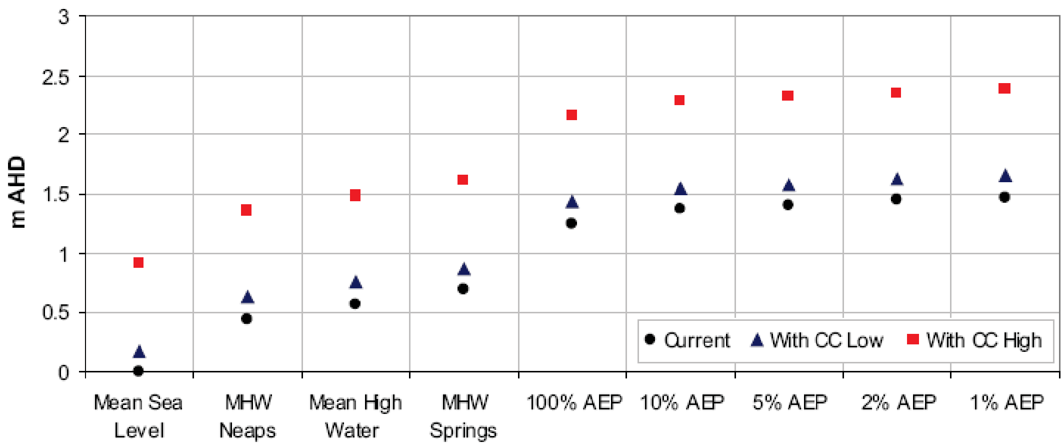
Sea level rise on the NSW coast, as reported in the DECC Floodplain Risk Management Guideline "Practical Consideration of Climate Change" (PCCC), is expected to be in the range of 0.018 to 0.91m by between 2090 and 2100.

When considering the potential impacts of sea level rise on a development, PCCC recommends a sensitivity analysis using the following sea level increases:

- 0.18m (low level ocean impacts)
- 0.55m (mid range ocean impacts)
- 0.91m (high level ocean impacts)

Figure 2.1, taken from PCCC, shows a comparison of sea level for the current, and low and high impact scenarios for different tidal and storm event conditions.

Figure 2-1 Differences in Key Ocean Levels – 2090-2100 (IPCC 2007 + CSIRO McInnes et al



The sea level rise would not affect the tailwater condition of Creek 1, as the permanent water level in the water quality control pond at RL3.0m is above the sea level condition of a 1% AEP event with the high climate change sea level rise scenario. The tailwater condition of Creek 2 has also been elevated to RL 3.0m AHD and likewise, would not be affected by the sea level rise scenarios in the PCCC.

The lowest lots in the proposed subdivision (lots 328 – 332), in the vicinity of the proposed bio retention basin, have their lowest level at approximately RL3mAHD. Therefore, the proposed lots would not be adversely affected by the sea level rise scenarios in the PCCC.

2.3 Rain intensity

The second potential impact of climate change is increased severity of storms and rainfall intensities. PCCC recommends a sensitivity analysis utilising rainfall intensities increased by 10%, 20% and 30%. These intensities are shown in **Table 2.2**.

Table 2-2 Possible Rainfall Intensities due to Climate Change

	20 year ARI				100 year ARI			
	Existing	Possible Climate Change Increase			Existing	Possible Climate Change Increase		
Duration		+10%	+20%	+30%		+10%	+20%	+30%
	mm/hr	mm/hr	mm/hr	mm/hr	mm/hr	mm/hr	mm/hr	mm/hr
30 min	114	125.4	136.8	148.2	153	168.3	183.6	198.9
60 min	82	90.2	98.4	106.6	112	123.2	134.4	145.6
120 min	54	59.4	64.8	70.2	75	82.5	90	97.5
180 min	42.6	46.86	51.12	55.38	59	64.9	70.8	76.7
270 min	33.4	36.74	40.08	43.42	46	50.6	55.2	59.8
360 min	28	30.8	33.6	36.4	38.8	42.68	46.56	50.44
540 min	22	24.2	26.4	28.6	30.5	33.55	36.6	39.65
720 min	18.5	20.35	22.2	24.05	25.7	28.27	30.84	33.41
1080 min	14.4	15.84	17.28	18.72	19.9	21.89	23.88	25.87
1440 min	12	13.2	14.4	15.6	19.6	21.56	23.52	25.48

The increased intensities were input into RAFTS to estimate the flows for Creek 1 and Creek 2, with the results shown in **Table 2.3**.

Table 2-3 Creek 1 and Creek 2 Peak Flows due to Climate Change Rainfall Intensities

	20 year ARI Peak Flows				100 year ARI Peak Flows			
	Existing	Possible Climate Change Increase			Existing	Possible Climate Change Increase		
		+10%	+20%	+30%		+10%	+20%	+30%
	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
Creek 1	7.11	8.053	9.334	10.651	11.11	12.953	14.808	16.729
Creek 2	5.309	6.165	6.962	7.721	7.979	9.323	10.672	12.096

The increased flows for both creeks, and an elevated tailwater condition for Creek 2 (RL 3.0m AHD), have been input into the HEC-RAS hydraulic model to determine the flood levels for each of the creeks. (Refer **Tables 2.4** and **2.5**.)

Table 2-4 Creek 1 Water Surface Levels due to increased rainfall intensities

	20 year Peak Flow				100 Year ARI Peak Flow			
	Original Model	Climate Change Increased rainfall intensity			Original Model	Climate Change Increased rainfall intensity		
River Station	20yr	20yr + 10%	20yr + 20%	20yr + 30%	100yr	100yr + 10%	100yr + 20%	100yr + 30%
	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
240	9.76	9.79	9.81	9.84	9.85	9.89	9.93	9.96
230	9.25	9.27	9.3	9.30	9.34	9.38	9.41	9.44
220	8.82	8.84	8.87	8.90	8.91	8.95	8.99	9.03
210	8.64	8.66	8.69	8.69	8.73	8.77	8.8	8.83
200	8.34	8.36	8.39	8.43	8.43	8.48	8.51	8.55
190	7.96	7.99	8.02	8.02	8.06	8.11	8.15	8.18
180	7.65	7.68	7.72	7.76	7.77	7.82	7.85	7.92
170	7.52	7.56	7.59	7.59	7.63	7.67	7.70	7.73
160	7.32	7.34	7.36	7.38	7.39	7.42	7.45	7.47
150	7.04	7.07	7.09	7.09	7.13	7.16	7.19	7.22
140	6.84	6.86	6.88	6.90	6.91	6.94	6.96	6.98
130	6.73	6.74	6.76	6.76	6.79	6.82	6.85	6.87
120	6.58	6.60	6.62	6.64	6.64	6.67	6.69	6.72
110	5.87	5.90	5.93	5.93	5.96	5.99	6.02	6.05
100	5.59	5.62	5.66	5.69	5.70	5.76	5.81	5.85
90	5.45	5.48	5.52	5.52	5.57	5.62	5.66	5.70
80	5.04	5.07	5.11	5.15	5.15	5.20	5.25	5.29
70	4.91	4.94	4.98	5.01	5.02	5.07	5.11	5.14
60	4.59	4.62	4.66	4.70	4.71	4.76	4.80	4.83
50	4.39	4.42	4.45	4.48	4.49	4.53	4.57	4.6
40	4.11	4.13	4.17	4.20	4.20	4.25	4.29	4.32
30	3.79	3.82	3.84	3.87	3.87	3.91	3.94	3.97
20	3.53	3.55	3.57	3.60	3.61	3.64	3.67	3.70
10	3.33	3.34	3.36	3.38	3.39	3.42	3.46	3.49
0	3.21	3.22	3.24	3.26	3.27	3.30	3.33	3.35

Table 2-5 Creek 2 Water Surface Levels due to increased rainfall intensities

River Station	20 Year ARI Peak Flow					100 year Peak Flow				
	Original Model	Climate Change Analysis – Increased rainfall intensity and elevated tailwater				Original Model	Climate Change Analysis – Increased rainfall intensity and elevated tailwater			
		20yr	20yr + 10%	20yr + 20%	20yr + 30%		100 yr	100yr + 10%	100yr + 20%	100yr + 30%
	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
150	5.81	5.81	5.88	5.93	5.98	5.99	5.99	6.06	6.11	6.14
140	5.59	5.59	5.65	5.71	5.76	5.78	5.78	5.85	5.92	6.03
130	5.31	5.31	5.34	5.37	5.39	5.40	5.40	5.43	5.53	5.6
120	5.18	5.18	5.23	5.27	5.31	5.32	5.32	5.38	5.43	5.48
110	5.14	5.14	5.17	5.19	5.21	5.22	5.22	5.25	5.28	5.31
100	5.04	5.04	5.05	5.07	5.09	5.10	5.10	5.12	5.15	5.18
90	4.54	4.54	4.55	4.57	4.59	4.59	4.59	4.62	4.64	4.66
80	4.21	4.21	4.24	4.26	4.27	4.27	4.27	4.30	4.33	4.35
70	3.97	3.97	3.99	4.01	4.02	4.03	4.03	4.04	4.06	4.09
60	3.76	3.76	3.77	3.79	3.8	3.81	3.81	3.83	3.85	3.87
50	3.60	3.60	3.61	3.63	3.64	3.64	3.64	3.66	3.68	3.70
40	3.36	3.36	3.39	3.40	3.42	3.42	3.42	3.44	3.46	3.49
30	3.13	3.13	3.15	3.17	3.18	3.20	3.20	3.21	3.23	3.25
20	2.91	2.99	2.98	2.97	2.96	2.96	2.97	2.99	3.02	3.03
10	2.67	3.00	3.00	3.00	3.00	2.71	3.00	3.00	3.00	3.00
0	2.56	3.00	3.00	3.00	3.00	2.60	3.00	3.00	3.00	3.00

It is evident that with the greater flows created by the 30% increase in rainfall intensities for the 100 year ARI event, in Creek 1 there is a potential rise in flood level of around 0.1m, and in Creek 2 there is a potential rise in flood level of around 0.2m. These potential increases would be readily accommodated within the 500mm freeboard, and the flood extent would still not encroach on any proposed lot. As such, the potential impact of climate change on sea level and rainfall intensities would not adversely impact on the flood hazard for the proposed lots.

The flood levels shown in Table 2.4 and 2.5 can be compared with the levels of the lots adjacent to Creeks 1 and 2. This is provided in Tables 2.6 and 2.7.

Table 2-6 Lots adjacent to Creek 1

Lot Number	Approximate RL of Lowest Point on Lot	Upstream River Station	Flood Level at Upstream River Station			
			Original 20 yr	20 yr + 30%	Original 100 yr	100 yr + 30%
204	12	XS230	9.25	9.30	9.34	9.44
205	11	XS210	8.64	8.69	8.73	8.83
206	10	XS180	7.65	7.76	7.77	7.92
207	10	XS160	7.32	7.38	7.39	7.47
208	9.5	XS150	7.04	7.09	7.13	7.22
209	8.5	XS130	6.73	6.76	6.79	6.87
210	8.0	XS110	5.87	5.93	5.96	6.05
211	7.5	XS100	5.59	5.69	5.70	5.85
212	7.0	XS80	5.04	5.15	5.15	5.29
213	6.5	XS60	4.59	4.70	4.71	4.83
214	6.0	XS30	3.79	3.87	3.87	3.97
215	6.0	XS20	2.91	2.96	2.96	3.03

Table 2-7 Lots adjacent to Creek 2

Lot Number	Approximate RL of Lowest Point on Lot	Upstream River Station	Flood Level at Upstream River Station			
			Original 20 yr	20 yr + 30%	Original 100 yr	100 yr + 30%
299	6.5	XS140	5.59	5.76	5.78	6.03
300	5.5	XS110	5.14	5.21	5.22	5.31
334	4.5	XS80	4.21	4.27	4.27	4.35
333	4.0	XS70	3.97	4.02	4.03	4.09
332	3.5	XS50	3.60	3.64	3.64	3.70
331	3.5	XS20	2.91	2.96	2.96	3.03
330	3.0	XS10	2.67	3.00	2.71	3.00

Comparing the flood level of the upstream cross section with the lowest point (downstream end) of the lot is conservative. However, a flood planning level for each lot adjacent to creek 2 should be taken as the original 100 yr flood level with an additional 500mm freeboard.

3 FLOOD LEVELS

The catchment that incorporates Dolphin Point Stage 2 & 3 drains by a creek travelling north from the site, through a culvert underneath Dolphin Point Rd into Burrill Lake, near the lake outlet to the ocean. The flood level for the site will be influenced by the flood level in Burrill Lake or by coastal inundation.

The estimated 1% AEP Flood Level for Burrill Lake is 2.7m AHD. It is understood that the flood study carried out by WBM for Shoalhaven Council to determine this flood level utilised “Floodplain Risk Management Guideline No 5 – Ocean Boundary Conditions”, specifying an elevated tailwater condition of RL2.6m AHD. This Guideline does not take climate change sea level rise into account.

Given that the subject subcatchment is at the downstream outlet of Burrill Lake into the ocean, it is likely that the peak flow from the Dolphin Point subcatchment will occur before the peak level at the Burrill lake outlet. Nonetheless the Burrill Lake 1% AEP level has been adopted as the tailwater condition.

The total 100 year ARI peak flow produced from the catchment in the Dolphin Point Stage 2 & 3 area is 30.9m2/s. The minimum width of the floodplain draining this catchment is approximately 50m. With a tailwater level of RL2.7m AHD, the flood level in the vicinity of Dolphin Point Stage 2 & 3 would be approximately RL2.75m AHD. With the allowance of a 500mm freeboard, the flood planning level (habitable floor levels) for the site should be RL3.25m AHD.

The flood planning level for the low lying lots (328 – 332) is governed by downstream flooding due to elevated ocean levels, whilst the flood planning levels of the lots adjacent to Creeks 1 and 2 are governed by local flooding conditions in the creeks.

4 FLOW PATHS

Clarification of the two flow paths has been sought by the Department of Planning. The flow path from the bushland to the west was labelled ‘overland flow path 1’ (OL 1) and the flow path from the bushland to the south was labelled ‘overland flow path 2’ (OL 2).

Rygate and West confirmed with Department of Natural Resources [(*DNR*)-formerly DIPNR] that OL 1 is not required to be maintained as an overland flow path, and as such could be piped. OL 2 conveys a similar amount of flow and would also be piped.

In the case of inlet blockage or an extreme event, overland flows from OL 1 would travel via the roadway at the northern side of Stage 3 to the WQCP and on to Burrill Lake. OL 2 would flow overland to the east along Road no. 8 (regraded to remove a trapped low point) and then down Road no. 3 to Creek 2.

5 WATER QUALITY CONTROL POND

The existing water storage dam is to be upgraded to a water quality control pond (WQCP). Remediation works to the water storage dam would include:

- planting suitable vegetation, including macrophytes;
- providing edge treatment to minimise mosquito habitat; and
- constructing suitable outlet/spillway.

The WQCP design would be finalised in the detailed design stage, however it is expected that it would be designed to ensure that the outlet can safely convey flows from a 100 year ARI event. Detailed structural assessment would also be required to ensure bank stability and to prevent failure of the dam walls.

A site-specific mosquito risk assessment could be carried out to address the related issues, which may include:

- pre-screened inflow (by GPT) to WQCP.
- vertical edges, clear of vegetation at the perimeter of the WQCP edges to minimise the most suitable type of habitat for mosquitoes;
- exposure of WQCP to wind action so as to minimise the growth of algae and floating plants that protect mosquito larvae;
- selection and managing plants to enhance wetland habitat and attract mosquito predators;

We trust this report aids you in your planning process. Should you have any further inquiries, please do not hesitate to contact either Andrew McMillan or myself on (02) 9957 1619.

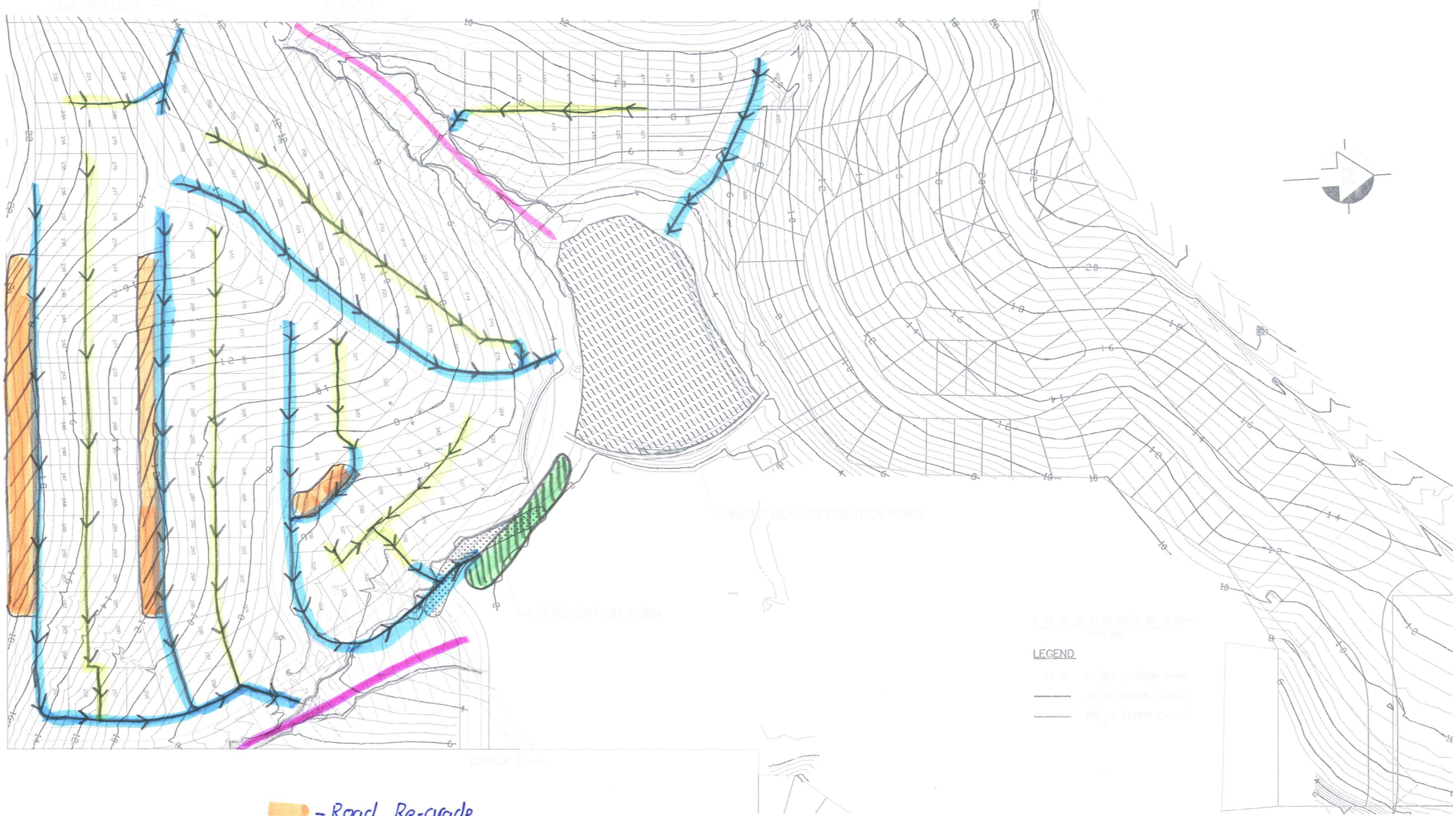
Yours faithfully
WorleyParsons

M Tooker

Mark Tooker
Principal Engineer

Review / Verification by Date

5/2/08



- Road Re-grade
- Bioretention Basin
- Proposed Interallotment drainage line
- Proposed Trunk drainage line
- Creek 1
- Creek 2

& Partners Pty Ltd

consulting engineers

DOLPHIN POINT SUB DIVISION
FLOOD EXTENTS