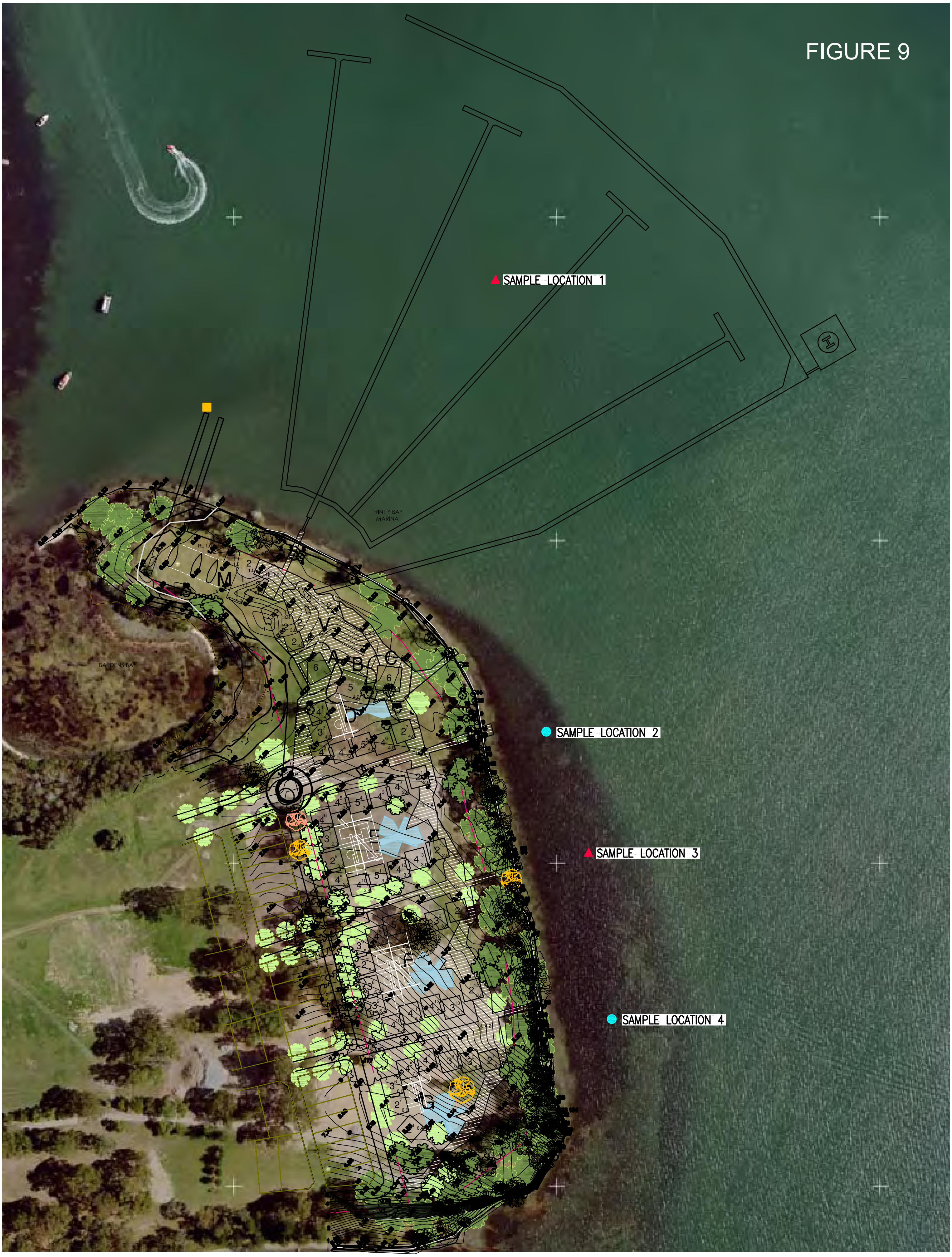

SURFACE SAMPLE (TN, TP, TSS)

SURFACE SAMPLE (TOTAL DISSO0LVED COPPER)

SEDIMENT SAMPLES (HEAVY METALS & TOC)

JOHNSON PROPERTY GROUP
Creating living communities

TRINITY POINT

LAKE MACQUARIE

HBO + EMTB

202669	02.11.2007	1:1000 @ A1 1:2000 @ A3
SITE PLAN		SK000
		OPTION 01 revision J

APPENDIX A - RAINWATER HARVESTING CALCULATIONS

Peak Daily Demand Calculations

Garden Irrigation

Estimated irrigation area	8000	m2
maximum application rate	18	mm/week
Peak daily demand	20.6	KL/day

Toilet Flushing Demand

Proposed Building Schedule

		1B	2B	3B	4B	Penthouse
		number of units				
Building A	Tourism	1	11		5	
Building B	Tourism	1	7		4	
Building C	Tourism	1	9		5	
Group D	Tourism	34	3	6	1	
Group E	Residential			11	18	2
Group F	Residential			12	14	3
Group G	Residential			7	5	3

Note: this table was provided by HBO, refer to draft schedule (25th Oct 2007)

Assumed Occupancy Rate

	1B	**2B**	**3B**	**4B**	**Penthouse**
Tourism	2	4	4	6	3
Residential	2	2.5	2.5	3.5	3.5

Village Center: estimated average peak patronage
1000 persons/day

Daily Demand per person

Residential / Tourism	20	l/person/day
Village centre	10	l/person/day

Average Daily Peak Demand Calculations

	1B	2B	3B	4B	Penthouse	**Total**	
Tourism	61864	100320	20064	75240	0	**257488**	l/day
Residential	60192	39710	35530	81928	5852	**223212**	l/day
Village Center						**10000**	l/day

SIMHYD Rainfall Runoff parameters adopted for garden roof catchment

intCap interception store capacity (mm)	coeff maximum infiltration loss (mm)	sq infiltration loss exponent	smsCap soil moisture store capacity (mm)	sub constant of proportionality in interflow equation (0 to 1)	crak constant of proportionality in groundwater recharge equation (0 to 1)	k baseflow linear recession parameter (0 to 1)	rainMult rainfall multiplier	etMult et multiplier
1.5	200	1	50	0.5	0.6	1	1	1

WATER BALANCE RESULTS

Irrigation and Toilet Flushing

Interation number	Net tank size	Number of Overflows Observed	Average overflow Frequency (days)	Overflow to Total Runoff Ratio	Percentage of Demand from runoff	Percentage of Demand from Source	Average Harvested Stromwater
1	50	1156	31	0.74	18	82	1807
2	100	838	43	0.67	23	77	2302
3	150	674	54	0.62	27	73	2648
4	200	598	61	0.58	30	70	2916
5	250	530	69	0.55	32	68	3137
6	300	475	77	0.52	34	66	3329
7	350	440	83	0.49	35	65	3493
8	400	405	90	0.47	37	63	3640
9	450	388	94	0.45	38	62	3774
10	500	370	98	0.44	39	61	3896
11	550	358	102	0.42	41	59	4010
12	600	345	105	0.40	42	58	4118
13	650	332	109	0.39	43	57	4219
14	700	318	114	0.38	44	56	4314
15	750	304	120	0.36	45	55	4403
16	800	295	123	0.35	45	55	4487
17	850	280	130	0.34	46	54	4566
18	900	270	135	0.33	47	53	4641
19	950	261	139	0.32	48	52	4710
20	1000	247	147	0.31	48	52	4776

Irrigation Only

Interation number	Net tank size	Number of Overflows Observed	Average overflow Frequency (days)	Overflow to Total Runoff Ratio	Percentage of Demand from runoff	Percentage of Demand from Source	Average Harvested Stromwater
1	50	1161	31	0.85	27	73	1051
2	100	957	38	0.79	38	62	1466
3	150	836	43	0.75	45	55	1747
4	200	770	47	0.72	50	50	1953
5	250	728	50	0.69	55	45	2119
6	300	694	52	0.67	58	42	2256
7	350	672	54	0.66	61	39	2375
8	400	649	56	0.64	64	36	2481
9	450	641	57	0.63	66	34	2576
10	500	617	59	0.62	68	32	2658
11	550	606	60	0.60	70	30	2732
12	600	596	61	0.59	72	28	2798
13	650	585	62	0.59	74	26	2860
14	700	578	63	0.58	75	25	2918
15	750	570	64	0.57	76	24	2971
16	800.0	564	64	0.56	78	22	3019
17	850.0	555	65	0.56	79	21	3065
18	900.0	547	66	0.55	80	20	3108
19	950.0	544	67	0.54	81	19	3148
20	1000.0	539	67	0.54	82	18	3186

APPENDIX B - MUSIC RESULTS

Source nodes

Location	Catch A non harvestable	Catch A harvestable	Catch B non harvestable	Catch b harvestable	Catch C non harvestable	Catch C harvestable	Catch D non harvestable	Catch D harvestable
ID	2	3	5	6	9	10	12	13
Node Type	UserDefinedSourceNode	UserDefinedSourceNode	UserDefinedSourceNode	UserDefinedSourceNode	UserDefinedSourceNode	UserDefinedSourceNode	UserDefinedSourceNode	UserDefinedSourceNode
Total Area (ha)	0.5	0.115	0.6	0.237	0.634	0.256	0.6	0.476
Area Impervious (ha)	0.17	0.00	0.20	0.03	0.21	0.05	0.20	0.21
Area Pervious (ha)	0.33	0.12	0.40	0.20	0.42	0.20	0.40	0.26
Field Capacity (mm)	80	80	80	80	80	80	80	80
Pervious Area Infiltration Capacity coefficient - a	220	220	220	220	220	220	220	220
Pervious Area Infiltration Capacity exponent - b	1	1	1	1	1	1	1	1
Impervious Area Rainfall Threshold (mm/day)	1	1	1	1	1	1	1	1
Pervious Area Soil Storage Capacity (mm)	130	130	130	130	130	130	130	130
Pervious Area Soil Initial Storage (% of Capacity)	30	30	30	30	30	30	30	30
Groundwater Initial Depth (mm)	10	10	10	10	10	10	10	10
Groundwater Daily Recharge Rate (%)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Groundwater Daily Baseflow Rate (%)	5	5	5	5	5	5	5	5
Groundwater Daily Deep Seepage Rate (%)	0	0	0	0	0	0	0	0
Stormflow Total Suspended Solids Mean (log mg/L)	2.2	1.55	2.2	1.55	2.2	1.55	2.2	1.55
Stormflow Total Suspended Solids Standard Deviation (log mg/L)	0	0	0	0	0	0	0	0
Stormflow Total Suspended Solids Estimation Method	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Stormflow Total Suspended Solids Serial Correlation	0	0	0	0	0	0	0	0
Stormflow Total Phosphorus Mean (log mg/L)	-0.45	-0.82	-0.45	-0.82	-0.45	-0.82	-0.45	-0.82
Stormflow Total Phosphorus Standard Deviation (log mg/L)	0	0	0	0	0	0	0	0
Stormflow Total Phosphorus Estimation Method	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Stormflow Total Phosphorus Serial Correlation	0	0	0	0	0	0	0	0
Stormflow Total Nitrogen Mean (log mg/L)	0.45	0.32	0.45	0.32	0.45	0.32	0.45	0.32
Stormflow Total Nitrogen Standard Deviation (log mg/L)	0	0	0	0	0	0	0	0
Stormflow Total Nitrogen Estimation Method	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Stormflow Total Nitrogen Serial Correlation	0	0	0	0	0	0	0	0
Baseflow Total Suspended Solids Mean (log mg/L)	2.2	1.55	2.2	1.55	2.2	1.55	2.2	1.55
Baseflow Total Suspended Solids Standard Deviation (log mg/L)	0	0	0	0	0	0	0	0
Baseflow Total Suspended Solids Estimation Method	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Baseflow Total Suspended Solids Serial Correlation	0	0	0	0	0	0	0	0
Baseflow Total Phosphorus Mean (log mg/L)	-0.45	-0.82	-0.45	-0.82	-0.45	-0.82	-0.45	-0.82
Baseflow Total Phosphorus Standard Deviation (log mg/L)	0	0	0	0	0	0	0	0
Baseflow Total Phosphorus Estimation Method	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Baseflow Total Phosphorus Serial Correlation	0	0	0	0	0	0	0	0
Baseflow Total Nitrogen Mean (log mg/L)	0.45	0.32	0.45	0.32	0.45	0.32	0.45	0.32
Baseflow Total Nitrogen Standard Deviation (log mg/L)	0	0	0	0	0	0	0	0
Baseflow Total Nitrogen Estimation Method	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Baseflow Total Nitrogen Serial Correlation	0	0	0	0	0	0	0	0

Treatment Nodes

Location	Catch A Bio-Retention	Catch B - Rainwater Tank	Catch B - Bio-Retention	Catch C - Bio-Retention	Catch D - Bio-Retention	Catch A - Rainwater Tank	Catch D - Rainwater Tank	Catch C - Rainwater Tank
ID	4	7	8	11	14	15	16	17
Node Type	BioRetentionNode	RainWaterTankNode	BioRetentionNode	BioRetentionNode	BioRetentionNode	RainWaterTankNode	RainWaterTankNode	RainWaterTankNode
Lo-flow bypass rate (cum/sec)	0	0	0	0	0	0	0	0
Hi-flow bypass rate (cum/sec)	100	100	100	100	100	100	100	100
Inlet pond volume		0				0	0	0
Area (sqm)	80	25	100	100	120	25	25	25
Extended detention depth (m)	0.4	0.1	0.4	0.4	0.4	0.1	0.1	0.1
Permanent pool volume (cum)		50				50	50	50
Proportion vegetated		0				0	0	0
Equivalent pipe diameter (mm)		50				50	50	50
Overflow weir width (m)	2	10	2	2	2	10	10	10
Notional Detention Time (hrs)		0.377				0.377	0.377	0.377
Orifice discharge coefficient		0.6				0.6	0.6	0.6
Weir coefficient	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Number of CSTR cells	3	2	3	3	3	2	2	2
Total Suspended Solids k (m/yr)	8000	400	8000	8000	8000	400	400	400
Total Suspended Solids C* (mg/L)	20	12	20	20	20	12	12	12
Total Suspended Solids C** (mg/L)		12				12	12	12
Total Phosphorus k (m/yr)	6000	300	6000	6000	6000	300	300	300
Total Phosphorus C* (mg/L)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Total Phosphorus C** (mg/L)		0.13				0.13	0.13	0.13
Total Nitrogen k (m/yr)	500	40	500	500	500	40	40	40
Total Nitrogen C* (mg/L)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Total Nitrogen C** (mg/L)		1.4				1.4	1.4	1.4
Threshold hydraulic loading for C** (m/yr)		3500				3500	3500	3500
Extraction for Re-use	Off	On	Off	Off	Off	On	On	On
Annual Re-use Demand - scaled by daily PET (ML)		0				0	0	0
Constant Daily Re-use Demand (kL)		0				0	0	0
User-defined Annual Re-use Demand (ML)		1.46				1.0	3.5	1.5
Percentage of User-defined Annual Re-use Demand Jan		13				12.6	12.6	12.6
Percentage of User-defined Annual Re-use Demand Feb		13				12.6	12.6	12.6
Percentage of User-defined Annual Re-use Demand Mar		10				9.6	9.6	9.6
Percentage of User-defined Annual Re-use Demand Apr		8				7.8	7.8	7.8
Percentage of User-defined Annual Re-use Demand May		7				6.8	6.8	6.8
Percentage of User-defined Annual Re-use Demand Jun		4				3.8	3.8	3.8
Percentage of User-defined Annual Re-use Demand Jul		4				3.8	3.8	3.8
Percentage of User-defined Annual Re-use Demand Aug		5				5.3	5.3	5.3
Percentage of User-defined Annual Re-use Demand Sep		7				7.3	7.3	7.3
Percentage of User-defined Annual Re-use Demand Oct		7				7.3	7.3	7.3
Percentage of User-defined Annual Re-use Demand Nov		10				10.1	10.1	10.1
Percentage of User-defined Annual Re-use Demand Dec		13				12.9	12.9	12.9
Filter area (sqm)	40		50	50	60			
Filter depth (m)	0.6		0.6	0.6	0.6			
Filter median particle diameter (mm)	2		2	2	2			
Saturated hydraulic conductivity (mm/hr)	100		100	100	100			
Voids ratio	0.3		0.3	0.3	0.3			

APPENDIX C – COPPER SAMPLING RESULTS

		Location								
		A		B		Ci	D		E	
Sample Date	**Test**	**Marina**	**Outside**	**Marina**	**Outside**	**Proposed Site**	**Marina**	**Outside**	**Marina**	**Outside**
20/11/2007	Total Copper (µg/L)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Dissolved Copper (µg/L)	3.2	2.4	N/A	N/A	1.2	2.9	2.5	2.3	3
	Labile Copper	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TSS (mg/L)	12	11	N/A	N/A	24	17	76	10	24
21/01/2008	Total Copper (µg/L)	3.4	2.4	5	2.4	3.9	4.6	3.9	2.4	1.8
	Dissolved Copper (µg/L)	1.9	1.5	3	1.5	3	3.1	2.5	1.7	1.2
	Labile Copper	1.8	1	2.1	1.4	2.3	1.8	0.8	1.4	1.2
	TSS (mg/L)	3	2	7	6	6	13	18	5	6
12/05/2008	Total Copper (µg/L)	2.7	2.2	5.8	3.3	1.8	3.8	1.9	3.9	1.8
	Dissolved Copper (µg/L)	2.3	1.9	4.4	1.5	1.9	2.8	1.4	3.2	1.6
	Labile Copper	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	TSS (mg/L)	2	2	5	1	3	7	8	<1	3
	Max Conc (µg/L)	3.2	2.4	4.4	1.5	3	3.1	2.5	3.2	3
	Min Conc (µg/L)	1.9	1.5	3	1.5	1.2	2.8	1.4	1.7	1.2
	AvgConc (µg/L)	2.5	1.9	3.7	1.5	2.0	2.9	2.1	2.4	1.9

Dissolved Copper - Total Statistics

	Number of Samples	Max Conc (µg/L)	Min Conc (µg/L)	AvgConc (µg/L)
Marina	11	4.4	1.7	2.8
Outside	13	3.0	1.2	2.0

APPENDIX D – INITIAL RESULTS FROM SURFACE AND GROUNDWATER MONITORING

Table D- 1 - Summary of Field Test Results for Lake Surface Water Quality (Douglas Partners - Reference (24))

Sample Location (tested Sept 2007)	**pH**	**ORP (mv)**	**EC (microS/cm)**	**DO (mg/L)**	**Turbidity (NTU)**
SS1	7.94	175	42,570	9.783	6.5
SS2	8.02	164	42,640	8.324	41.9
SS3	8.02	177	42,560	8.349	6
SS4	8.04	191	42,510	9.535	5.6
SS5	8.05	196	42,350	9.940	7.9
SS6	8.04	199	42,820	9.347	5.4
SS7	8.04	199	42,780	9.428	5.7
SS8	8.05	210	42,960	9.572	15.2
SS9	7.94	237	42,200	9.420	15.5
SS10	8.04	205	42,860	9.610	14.1
SS11	8.04	247	42,560	9.470	6.3
SS12	8.05	259	42,410	9.516	3.1
SS13	8.05	237	42,840	9.523	9.7
SS14	8.05	267	42,400	9.487	5.5
SS15	8.06	268	42,371	9.045	87.7
Minimum	7.94	164	42,200	8.324	3.1
Maximum	8.06	268	42,960	9.940	87.7
Average	8.03	215	42,589	9.357	16
ANZECC Guideline Trigger Values for Estuaries and Marine Waters	7.0-8.5	NIG	NIG	80-110% 8.3-9.9 mg/l ^	0.5 -10

Notes to Table D- 1:
ORP . Oxidation reduction potential
EC . Electrical conductivity
DO . Dissolved oxygen
NIG . Not In Guidelines
^ - Converted to DO (mg/L) assuming water temperature at 20 °C

Table D- 2 - Initial Laboratory Results for Lake Surface Water Quality (after Douglas Partners , Ref (24 and Patterson Britton)

Location* and Date Tested	Analyte (µg/L)																			Analyte (mg/L)		
	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Total Copper	Dissolved Copper	Labile Copper	Cobalt	Lead	Manganese	Molybdenum	Nickel	Selenium	Zinc	Tin	Mercury	TSS	Total Phosphorus	Total Nitrogen
SS3 – 25/09/07	1.4	2.8	11	<PQL	5700	0.11	12	-	2.6		2.6	<PQL	<PQL	9.3	5.2	8.5	15	<PQL	<PQL		<PQL	<PQL
SS12 – 25/09/07	2.0	2.7	11	<PQL	5700	<PQL	12	-	2.8		2.6	<PQL	<PQL	9.7	5.1	9.5	15	0.03	<PQL		<PQL	<PQL
Location (1) - 20/11/07								-	1.2	-										24	-	-
Location (1) - 11/12/07									<2	-										6		
Location (1) - 21/01/08								3.9	3.0	2.3										6		
Location (1) - 12/05/08								1.8	1.9	-										3		
Location (2) - 12/05/08																					0.10	0.3
Location (3) - 12/05/08								2	1.8	-											-	-
Location (4) - 12/05/08																				3	0.11	0.3
Laboratory PQL	1	1	1	1	1	0.1	1	0.1	0.1	0.1	1	1	1	1	1	2	1	0.03	5E-04	1	1^^ (0.01)	10^^ (0.1)
95% Trigger values for marine waters	ID	ID	NIG	ID	ID	5.5	4.4*	1.3	1.3	1.3	1	4.4	ID	ID	70	ID	15	0.006^	0.4	NIG	**0.025**@	**0.12**@
90% trigger values for marine waters	ID	ID	NIG	ID	ID	14	20*	3	3	3	14	6.6	ID	ID	200	ID	23	0.02^	0.7	NIG	**0.030**@@	**0.3**@@

Notes on Table D- 2

ID Insufficient Data

NIG Not in Guidelines (ANZECC (2000) Water Quality Guidelines)

Guideline Trigger values for Chromium (CrVI)

^ Guideline Trigger values for Tributyltin (as µg/L of Sn)

^^ Original PQLs from Douglas Partners Reporting, did not take account of dilution required for marine waters, PQLs in parentheses are for lower PQLs adopted by Patterson Britton

@ Default Trigger values for marine waters under Table 3.3.2 of the ANZECC (2000) Water Quality Guidelines

@@ Default Trigger values for estuarine waters under Table 3.3.2 of the ANZECC (2000) Water Quality Guidelines

* For Sample Locations, refer to **Figure 9**

Table D- 3 - Summary of Groundwater Level Sampling Results

Project Component	Bore	Approximate Surface Level (AHD)	Depth to Groundwater Below Ground Surface (m) and date					Range of Groundwater Levels Observed (AHD)
			5/10/07	9&10/10/07	16/10/07	24/10/07	15/5/08	
Marina Village	101	1.27	1.2	1.2	1.2	NM	1.04	0.0 to 0.2
	101A	1.27	NM	NM	1.15	1.22	0.87	0.0 to 0.4
	102	0.89	NM	0.61	0.88	NM	0.57	0.0 to 0.3
	102A	0.89	NM	NM	0.83	0.94	0.64	-0.1 to 0.2
Blocks E to G	103	2.47	1.51	1.57	1.63	NM	1.37	0.8 to 1.1
	104	3.82	2.83	2.85	2.93	NM	2.86	0.9 to 1.0
	105	6.62	Dry	Dry	Dry	Dry	Dry	-

Table D- 4 - Summary of Groundwater Sampling Results – Field Testing of pH and EC

Bore No	Date	Range of pH values	Range of EC values (mS/cm)
101	Oct 2007	7.1 to 7.3	1.7 to 3.8
	15/5/2008	7.0	0.27 – 0.35
101A	Oct 2007	7.2 to 7.7	0.6 to 0.8
	15/5/2008	NM	NM
102	Oct 2007	6.8 to 7.3	8.7 to 21.1
	15/5/2008	6.6 to 7.1	0.9 to 2.6
102A	Oct 2007	7.4 to 7.7	1.2 to 2.1
	15/5/2008	7.2 to 7.6	1.0 to 2.7
103	Oct 2007	5.0	0.6
	15/5/2008	4.7 to 5.0	0.4 to 0.5
104	Oct 2007	4.1 to 4.2	5.6 to 6.8
	15/5/2008	3.5 to 3.7	7.1 to 7.4
105	Oct 2007	dry	Dry
	15/5/2008	dry	Dry

Notes to Table D- 4:
EC – Electrical Conductivity
DO – Dissolved Oxygen
NM – Not measured

Table D- 5 - Summary of Groundwater Sampling Results – Laboratory Testing of Contaminants

Date of Sampling	Project Component	Location	Analyte (µg/L)																Analyte (mg/L)						
			Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Copper	Cobalt	Lead	Manganese	Molybdenum	Nickel	Selenium	Zinc	Tin	Total Iron	Nitrate as N	Chloride, Cl	Sulphate, SO4	Total Phosphorus	Total Nitrogen	Mercury
October 2007	Marina village	101	<PQL	<PQL	33	<PQL	470	<PQL	1.2	<PQL	<PQL	<PQL	260	2.5	<PQL	<PQL	12	<PQL	2.4	<PQL	850	110	0.40	4.6	<PQL
		102	<PQL	6.4	190	<PQL	1500	<PQL	6.3	1.3	22	<PQL	1300	2.6	11	23	120	0.03	250	<1	8400	1300	<0.5	3.3	<PQL
	Blocks E to G	103	<PQL	<PQL	40	<PQL	53	<PQL	<PQL	1.1	2.1	5.4	77	<PQL	3.4	<PQL	33	<PQL	0.25	<PQL	190	44	0.13	<PQL	<PQL
		104	<PQL	<PQL	140	3.6	120	0.64	15	3.9	16	40	300	<PQL	13	<PQL	110	<PQL	15	<0.1	2600	180	<PQL	1.0	<PQL
	QA Sample	D1	<PQL	<PQL	34	<PQL	480	<PQL	<PQL	<PQL	<PQL	<PQL	250	2.5	<PQL	<PQL	14	<PQL	NT	NT	NT	NT	NT	NT	<PQL
15 May 2008	Marina village	101	2.8	8.0	7.1	<PQL	110	<PQL	1.1	1.4	<PQL	1.7	44	4.4	2.1	<PQL	58	<PQL	5.7	0.08	18	4.5	1.7	3.2	<PQL
		102	2.9	1.4	15	<PQL	600	<PQL	1.0	2.0	<PQL	<PQL	57	12	1.3	<PQL	22	<PQL	4.6	0.05	550	72	0.28	0.79	<PQL
	Blocks E to G	103	1.0	<PQL	46	<PQL	59	<PQL	1.1	6.9	<PQL	15	30	1.1	2.4	<PQL	35	<PQL	0.8	0.06	150	52	<PQL	<PQL	<PQL
		104	<PQL	<PQL	78	4.4	120	0.16	4.3	4.8	2.9	29	30	<1.0	8.4	<PQL	210	<PQL	12	0.03	3000	170	0.47	0.8	<PQL
Laboratory PQL			1	1	1	1	1	0.1	1	1	1	1	1	1	1	2	1	0.03(1)/ 0.05 (2)	0.01	0.05(1)/ 0.02(2)	1(1)/ 0.1(2)	1(1)/ 0.4(2)	0.1(1)/ 0.05(2)	1(1)/ 0.2(2)	5E-4(1)/ 1E-4(2)
95% Trigger values for fresh waters			ID	ID	NIG	ID	ID	0.2	1.0*	1.4	1	3.4	ID	ID	11	11	8	0.006^	ID	5-15	NIG	NIG	0.05	0.5	0.6
90% trigger values for fresh waters			ID	ID	NIG	ID	ID	0.4	6.0*	1.8	14	5.6	ID	ID	13	18	15	0.02^	ID	5-15	NIG	NIG	0.005	0.35	1.9

Notes to

Table D- 5:

PQL – Practical quantification limit
1 – PQL for October 2007 Testing
2 – PQL for May 2008 Testing
Sample D1 is a duplicate of Sample 101 during the October 2007 sampling
NT – Not tested

APPENDIX E – CONSIDERATION OF CLIMATECHANGE

E. CONSIDERATION OF CLIMATE CHANGE IMPACT ON FLOODING

The Department of Environment and Climate Change (*DECC*) have prepared a guideline for the consideration of climate change in flood management applications.

The guideline is titled, "Floodplain Risk Management Guideline; Practical Consideration of Climate Change" and was published by DECC in October 2007.

The guideline considers the impact of climate change on <u>sea level</u> and <u>rainfall intensities</u>. The associated recommendations are based on latest research by the Intergovernmental Panel on Climate Change (*IPCC*) and recent modelling undertaken by CSIRO in Australia.

The application of these recommendations to water levels in Lake Macquarie and the proposed marina at Trinity Point is discussed in the following.

E.1 POTENTIAL FOR SEA LEVEL RISE

The IPCC has predicted that average global sea level rise due to climate change will range from 0.18m to 0.79m by between 2090 and 2100 (*DECC, 2007*). The upper limit of sea level rise incorporates an allowance for ice flow melt.

The results of additional modelling by the CSIRO indicate that sea level along the NSW coast is expected to rise by more that the global average (*by up to an additional 0.12m*). Therefore, it is predicted that sea level rise along the NSW coast could be in the range of 0.18m and 0.91m by between 2090 and 2100 (*DECC, 2007*).

Accordingly, for floodplain risk management applications, DECC recommends that sensitivity analyses be undertaken for the following three cases of sea level rise by 2090 to 2100:

- 0.18m increase (*low level impact*)
- 0.55m increase (*mid-range impact*)
- 0.91m increase (*high level impact*)

According to the Lake Macquarie Floodplain Management Study (*LMCC, 2000*), the standing water level in Lake Macquarie is typically at 0.1 mAHD. The ocean tide has a ± 0.5m variation, but this has minimal impact on the water level in the lake (± 0.05m). This suggests that the lake is relatively insensitive to short term fluctuations in ocean level.

However, in the case of long term sea level rise, it is expected that the lake level would increase in parallel to raised ocean levels. In other words, it is suggested that the predictions in sea level rise can be directly applied to the standing water level in the lake (*refer* **Table E.1**).

The predicted sea level rise can, in turn, be directly applied to existing design flood levels in Lake Macquarie.

Table E.1 POTENTIAL IMPACT OF SEA LEVEL RISE ON LAKE MACQUARIE

	LOW LEVEL IMPACT	MID-RANGE IMPACT	HIGH LEVEL IMPACT
Existing Standing Water Level in Lake Macquarie (mAHD)	0.1	0.1	0.1
Sea Level Rise (m)	0.18	0.55	0.91
Standing Water Level by 2090 to 2100 (mAHD)	0.3	0.7	1.0

E.2 POTENTIAL FOR INCREASED RAINFALL INTENSITIES AND STORM VOLUMES

The assessment of increased rainfall as a result of climate change is based on recommendations by DECC and on information extracted from the Lake Macquarie Flood Study (*LMCC, 1998*) and the Lake Macquarie Floodplain Management Study (*LMCC, 2000*).

The DECC guideline recommends that assessment of increased rainfall should consider a sensitivity analysis of three scenarios (*DECC, 2007*):

- 10% increase in peak rainfall and storm volume by 2070.
- 20% increase in peak rainfall and storm volume by 2070.
- 30% increase in peak rainfall and storm volume by 2070.

Investigations for the Lake Macquarie Flood Study (*LMCC, 1998*) indicate that the volume of runoff is considered to be a dominant factor in determination of the peak level of flooding in Lake Macquarie. In other words, an increase in runoff volume is expected to translate directly to an increase in peak flood level. This is typical for large lake systems that are most significantly impacted by storms with longer duration. The critical storm duration for Lake Macquarie was determined to be 144 hours or 6 days (*LMCC, 1998*).

Accordingly, it is assumed that an increase in runoff volume, rather than rainfall intensity, can be used to reliably determine the potential impact of climate change on peak flood levels.

A basic volumetric analysis was undertaken using information contained in the Lake Macquarie Flood Study (*LMCC, 1998*) to determine the total volume of runoff in the lake at the peak of flooding during the 100 year recurrence storm.

Based on a standing water level in the lake of 0.1 mAHD and an ocean level equivalent to the mean neap tide level of 0.6 mAHD, the associated 100 year recurrence flood level in the lake is predicted to be 0.70 mAHD (*LMCC, 1998*). As discussed above, the standing water level in the lake is not affected by raised ocean levels associated with normal tides.

Accordingly, it was determined that catchment runoff during the 100 year recurrence storm is expected to raise the water level in the lake by a maximum of 0.6 metres (*i.e., 0.7 – 0.1 mAHD*).

The surface area of Lake Macquarie is approximately 110 km^2. Therefore, the volume of runoff in the lake at the peak of the 100 year recurrence flood was determined to be about 66,000,000 m^3 or 66,000 megalitres.

This estimate for total runoff volume in the lake was verified through a more detailed assessment of runoff volume from each of the 22 sub-catchments that drain to Lake Macquarie. This involved the application of a basic triangular-shaped hydrograph to peak discharges for each sub-catchment, which were extracted from the Lake Macquarie Flood Study (*LMCC, 1998*). The analysis assumed a storm duration equivalent to the critical storm burst duration of the Dora Creek catchment, which is the largest sub-catchment of Lake Macquarie and therefore contributes the most volume of runoff.

Assuming a storm runoff volume of 66,000 megalitres in the lake, it was determined that a 10% increase in volume would result in an increase in peak 100 year recurrence flood level of **0.06** metres. A 20% increase would translate to a flood level increase of **0.12** metres and a 30% increase in runoff volume would result in a **0.18** metre increase in peak 100 year recurrence flood level.

These estimates were compared to the results of a sensitivity analysis that is documented in the Lake Macquarie Flood Study. The RMA flood model developed for the Flood Study was used to establish that a 20% increase in runoff volume is expected to result in an increase of approximately 0.1 metres to the peak 100 year recurrence flood level (*LMCC, 1998*). This result is similar to the estimate determined through volumetric analysis.

E.3 COMBINED IMPACT OF CLIMATE CHANGE

The overall potential for climate change to impact on flood levels in Lake Macquarie can be determined through a combination of the scenarios for sea level rise and increased rainfall.

Three combinations of potential sea level rise and increased rainfall are presented in **Table E.2** to demonstrate the potential increase in the 100 year recurrence flood level in the lake by 2100. It should be noted that the existing 100 year recurrence flood level is based on an elevated ocean level of 1.8 mAHD, which incorporates an allowance for storm surge and wave setup (*DPWS, 1998*).

The results in **Table E.2** show that the impacts of climate change could increase the 100 year recurrence flood level in Lake Macquarie by as much as 1.1 metres by 2090 to 2100 if a combined high-level impact is assumed. However, it should be recognised that the probability of high-level impacts for both sea level rise and increased rainfall occurring in combination is relatively low.

If a ‘combined’ low-level impact scenario eventuates, the potential increase to the 100 year recurrence flood level could be as small as 0.2 metres (*refer* **Table E.2**).

Table E.2 POTENTIAL IMPACT OF CLIMATE CHANGE ON PEAK FLOOD LEVEL

	LOW LEVEL IMPACT	MID-RANGE IMPACT	HIGH LEVEL IMPACT
Existing 100 Year Recurrence Flood Level (mAHD)	1.38	1.38	1.38
Sea Level Rise (m)	0.18	0.55	0.91
Increase in Flood Level due to Increase in Rainfall Volume (m)	0.06	0.12	0.18
100 Year Recurrence Flood Level by 2090 to 2100 (mAHD)	1.6	2.1	2.5

E.4 POTENTIAL IMPACT OF CLIMATE CHANGE AT TRINITY POINT

The potential impacts of climate change can vary significantly with location (*DECC, 2007*). DECC recommends that a range of factors be considered when managing the impacts of climate change at a particular location. These include any potential changes in flood behaviour, frequency, hazard and damages that may occur due to climate change and whether these impacts can be managed now or in the future as the impacts of climate change manifest.

The development of a marina facility at Trinity Point can be considered to have reduced sensitivity to the impacts of climate change, based on the following local factors:

- Due to its location at the edge of Lake Macquarie, it is not expected that any new floodways will be developed in the vicinity of the marina as a result of increased lake water levels. As a result, it is not likely that increased flood levels would translate to other changes in flood behaviour, such as increased flow velocity.
- The increase in flood hazard associated with increased water levels could be effectively managed by implementing flood evacuation procedures that adapt to any long term changes in water level. Due its lakeside location, the flood evacuation route from the marina is not expected to be cut-off as a result of increased lake water levels (*i.e. a continuously rising evacuation route away from the lakes' edge will be provided*).
- Any increase in flood damages resulting from increased frequency of flooding would be limited to structures and infrastructure that is privately-owned by the marina. Community infrastructure is not likely to become more susceptible to climate change impacts due to the marina development.

Based on these factors, it is recommended that a combined mid-range impact of climate change be considered for design of the Trinity Point Marina. This involves the adoption of a mid-range impact on lake water level due to sea level rise combined with a mid-range impact due to increased rainfall intensity/volume (*refer* **Table E.3**).

Accordingly, the combined effect of potential increases in rainfall and sea level that have been adopted for this study translates to a total increase in lake water level of approximately **0.7** metres (*refer* **Table E.3**).

Table E.3 IMPACT OF CLIMATE CHANGE FOR TRINITY POINT

	STANDING WATER LEVEL	100 YEAR RECURRENCE FLOOD LEVEL
Existing Level (mAHD)	0.1	1.38
Sea Level Rise (m) (i.e., adopt a mid-range impact)	0. 55	0.55
Increase in Flood Level due to Increase in Rainfall Volume (m) (i.e., adopt a mid-range impact)	–	0.12
Level by 2090 to 2100 (mAHD)	0.7	2.1

Adoption of the parameters in **Table E.3** for the design of Trinity Point Marina is considered to provide significant protection against the potential impacts of climate change.

For example, if a minimum habitable floor level of 2.8 mAHD is established for the marina (*i.e., 1.38 mAHD design flood level + 0.5m freeboard + 0.55m sea level rise + 0.12m due to rainfall increase + 0.2m wave set-up = 2.8*), the floor level would be 1.8 metres above the standing water level that might occur in the worst case scenario of sea level rise by 2100 (*refer* **Table E.1**).

REFERENCES

- Department of Environment and Climate Change (*2007*), *'Floodplain Risk Management Guideline; Practical Consideration of Climate Change'*.

- Lake Macquarie City Council (*1998*), *'Lake Macquarie Flood Study'*, prepared by Manly Hydraulics Laboratory (*DPWS*).

- Lake Macquarie City Council (*2000*), *'Lake Macquarie Floodplain Management Study'*, prepared by Webb, McKeown & Associates.