1:50 Yr Post-Development Runoff

SN	Element ID	Description	Area (Ha)	Drainage Node ID	Weighted Curve Number	Conductivity (mm/hr)	Dstore Time (days)	Average Slope (%)	Equivalent Width (m)	Impervious Area (%)	Impervious Area No Depression (%)	Impervious Area Depression Depth (mm)	Impervious Area Manning's Roughness	Pervious Area Depression Depth (mm)	Pervious Area Manning's Roughness	Curb & Gutter Length (m)	Rain Gage ID	Total Precipitation (mm)	Total Runon (mm)	Total Evaporation (mm)	Total Infiltration (mm)	Total Infiltration (ac)	Total Runoff (mm)	Total Runoff (ac)	Peak Runoff (cms)	Time of Concentration (days hh:mm:ss)
1	RF3B		1.89	21	76.40	0.1500	7.00	2.0000	129.15	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	1188.11	283.50		176.28	0.84	0 00:44:57
2	RFP18B-1		1.91	RSTR4B	76.40	0.1500	7.00	5.0000	104.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	1200.68	286.50		176.47	0.94	0 00:39:07
3	RFP18B-2		1.15	61	76.40	0.1500	7.00	5.0000	108.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	722.92	172.50		176.88	0.70	0 00:28:09
4	RFP5		2.47	36	65.00	0.1500	7.00	5.0000	119.76	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	92.2010	2277.36	370.50		147.89	0.91	0 00:41:58
5	RFP9A		0.69	48	76.40	0.1500	7.00	6.1500	86.11	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	433.75	103.50		177.13	0.47	0 00:22:16
6	RMR1		0.26	28	65.00	0.1500	7.00	1.0000	90.58	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	91.5900	238.13		109.20	148.84	0.15	0 00:20:44
7	RMR2		0.28	28	65.00	0.1500	7.00	1.0000	91.79	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	91.6180	256.53		117.60	148.80	0.16	0 00:21:33
8	RMR3		0.69	28	65.00	0.1500	7.00	1.0000	33.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	92.9520	641.37		289.80	146.96	0.19	0 01:08:35
9	RMR4		0.61	28	65.00	0.1500	7.00	1.0000	33.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	92.8130	566.16		256.20	147.12	0.18	0 01:03:44
10	RMR5		2.00	31	65.00	0.1500	7.00	1.0000	38.20	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	94.4530	1889.06		840.00	145.37	0.33	0 01:58:49
11	RMR6		1.15	32	65.00	0.1500	7.00	1.0000	33.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	93.6750	1077.26		483.00	146.17	0.24	0 01:33:08
12	RMR7		1.44	31	65.00	0.1500	7.00	1.0000	62.84	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	93.0910	1340.51		604.80	146.83	0.38	0 01:12:35
13	RPF1		6.30	26	69.40	0.1500	7.00	0.5000	357.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	82.1620	5176.21	945.00		157.74	1.75	0 01:16:17
14	RPF10		0.49	49	76.40	0.1500	7.00	2.9000	72.61	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	308.03	73.50		177.00	0.32	0 00:25:21
15	RPF11		2.77	43	76.40	0.1500	7.00	2.9000	150.06	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	1741.31	415.50		176.24	1.20	0 00:46:12
16	RPF12		1.37	49	65.00	0.1500	7.00	2.9000	108.15	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	92.0620	1261.25	205.50		148.09	0.56	0 00:36:57
17	RPF14		2.61	60	65.00	0.1500	7.00	2.8000	92.83	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	92.7300	2420.25	391.50		147.24	0.79	0 01:00:07
18	RPF15		3.42	44	65.00	0.1500	7.00	2.9000	115.73	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	92.7570	3172.29	513.00		147.20	1.02	0 01:01:22
19	RPF16A		7.45	51	76.40	0.1500	7.00	4.2000	239.57	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	4683.29	1117.50		175.95	2.89	0 00:56:33
20	RPF16B		2.27	63	69.40	0.1500	7.00	5.0000	144.74	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	81.1160	1841.33	340.50		159.08	1.04	0 00:35:37
21	RPF17A		2.32	64	76.40	0.1500	7.00	2.3000	143.73	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	1458.42	348.00		176.26	1.01	0 00:45:43
22	RPF17B		1.58	52	76.40	0.1500	7.00	2.3000	111.66	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	993.24	237.00		176.37	0.73	0 00:42:11
23	RPF18A		1.01	52	76.40	0.1500	7.00	2.5000	64.55	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	634.92	151.50		176.32	0.46	0 00:43:43
24	RPF2A		1.80	21	72.00	0.1500	7.00	0.5000	167.33	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	75.1530	1352.75	270.00		164.86	0.65	0 00:56:35
25	RPF2B		1.38	21	98.00	0.1500	7.00	0.5000	500.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	5.1020	70.41	207.00		231.74	1.12	0 00:25:06
26	RPF3A		3.37	59	76.40	0.1500	7.00	2.0000	296.24	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	2118.48	505.50		176.49	1.67	0 00:38:38
27	RPF4A		18.76	41	76.40	98.0000	7.00	2.5000	339.33	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	11793.10	2814.00		175.04	5.07	0 01:33:22
28	RPF4B		10.13	33	76.40	80.0000	7.00	5.6000	500.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	6368.02	1519.50		176.44	4.89	0 00:40:08
29	RPF6		2.11	62	76.40	0.1500	7.00	5.0000	120.93	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	1326.41	316.50		176.51	1.06	0 00:38:00
30	RPF7		8.87	37	76.40	0.1500	7.00	0.5000	219.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	5575.95	1330.50		174.31	1.80	0 02:05:30
31	RPF8		4.47	29	76.40	0.1500	7.00	5.0000	182.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	2809.98	670.50		176.23	1.92	0 00:46:37
32	RPF9A		2.38	46	76.40	0.1500	7.00	2.0000	150.22	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	1496.14	357.00		176.22	1.01	0 00:47:08
33	RPF9B		0.89	46	76.40	0.1500	7.00	0.5000	500.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	62.8630	559.48	133.50		177.26	0.65	0 00:19:14
34	RSR10B		0.51	54	65.00	0.1500	7.00	6.6000	33.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	91.9230	468.81		214.20	148.27	0.23	0 00:32:36
35	RSR11B		0.55	54	65.00	0.1500	7.00	6.6000	33.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	91.9510	505.73		231.00	148.22	0.24	0 00:33:52
36	RSR5A		0.50	61	65.00	0.1500	7.00	2.0000	18.80	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	92.8410	464.21		210.00	147.10	0.14	0 01:04:16
37	RSR5B		0.33	42	65.00	0.1500	7.00	2.0000	14.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	92.7020	305.92		138.60	147.26	0.10	0 00:59:25
38	RSR6A		0.45	61	65.00	0.1500	7.00	2.0000	14.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	93.0630	418.78		189.00	146.86	0.12	0 01:11:38
39	RSR6B		0.27	42	65.00	0.1500	7.00	2.0000	14.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	92.5070	249.77		113.40	147.48	0.09	0 00:53:05
40	RSR9		0.81	47	65.00	0.1500	7.00	1.2000	41.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	92.7850	751.56		340.20	147.15	0.24	0 01:02:39
41	RSTR10		1.32	27	65.00	0.1500	7.00	6.6000	500.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	91.3120	1205.32		554.40	149.22	0.92	0 00:11:16
42	RSTR10A		0.25	47	65.00	0.1500	7.00	1.0000	33.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	92.0620	230.16		105.00	148.06	0.10	0 00:37:32
43	RSTR11A		0.31	47	65.00	0.1500	7.00	0.5000	33.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	92.4790	286.68		130.20	147.52	0.10	0 00:51:59
44	RSTR4B		8.89	38	80.00	0.1500	7.00	0.5000	214.02	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	37.90	0.0000	51.7240	4598.26		3733.80	221.50	2.30	0 02:07:29
45	RSTR5A		5.98	32	80.00	0.1500	7.00	2.0000	188.93	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	52.9050	3163.72		2511.60	184.72	2.12	0 01:11:25
46	RSTR6		5.28	20	80.00	0.1500	7.00	0.5000	412.11	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	52.9050	2793.38		2217.60	184.91	2.04	0 01:02:57
47	RSTR7		1.27	24	80.00	0.1500	7.00	0.5000	212.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	52.9050	671.89		533.40	185.52	0.66	0 00:39:53
48	RSTR8A		2.50	51	80.00	0.1500	7.00	2.6600	101.32	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	52.9050	1322.63		1050.60	185.07	1.03	0 00:56:30
49	RSTR8B		3.90	63	72.00	0.1500	7.00	0.5000	57.27	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	75.2070	2933.07		1638.00	161.80	0.53	0 02:51:23
50	RSTR9		1.68	21	56.00	0.1500	7.00	0.5000	303.97	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	114.1740	1918.12		705.60	125.87	0.53	0 00:37:58
51	RUND1A		2.44	48	80.00	0.1500	7.00	2.7800	98.98	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	52.9050	1290.88			185.09	1.01	0 00:55:42
52	RUND1B		1.39	47	80.00	0.1500	7.00	2.7800	74.39	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	52.9050	735.38			185.31	0.63	0 00:47:04
53	RUND2		2.51	46	80.00	0.1500	7.00	21.0000	103.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	52.9050	1327.92			185.85	1.55	0 00:30:08
54	SR1		1.39	33	65.00	0.1500	7.00	4.4000	20.24	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	93.5910	1300.91		583.80	146.28	0.30	0 01:29:54
55	SR2		1.42	32	65.00	0.1500	7.00	4.4000	22.34	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	93.4520	1327.02		596.40	146.41	0.32	0 01:25:33
56	SR3		0.85	40	65.00	0.1500	7.00	2.0000	19.94	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	93.4520	794.34		357.00	146.42	0.19	0 01:25:27
57	SR4		1.08	39	65.00	0.1500	7.00	2.0000	19.32	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	93.8970	1014.09		453.60	145.95	0.21	0 01:40:18
58	SR7		0.62	44	65.00	0.1500	7.00	2.0000	19.25	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	93.0630	576.99		260.40	146.84	0.16	0 01:12:13
59	SR8		0.32	49	65.00	0.1500	7.00	2.0000	17.54	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	241.00	0.00	0.0000	92.4790	295.93		134.40	147.53	0.11	0 00:51:47

1:100 Yr Post-Development Runoff

SN	Element ID	Description	Area (ha)	Drainage Route ID	Weighted Curve Number	Conductivity (mm/hr)	Drying Time (days)	Average Slope (%)	Equivalent Width (m)	Impervious Area (%)	Depression Area (%)	Impervious Area No Depression Depth (mm)	Impervious Area Manning's Roughness	Pervious Area Depression Depth (mm)	Pervious Area Manning's Roughness	Curb & Gutter Length (m)	Rain Gage ID	Total Precipitation (mm)	Total Rainfall (mm)	Total Evaporation (mm)	Total Infiltration (mm)	Total Infiltration (m³)		Total Runoff (mm)	Peak Runoff (cms)	Time of Concentration (days)	Time of Concentration (hh:mm:ss)
1	RF3B		1.89	21	76.40	0.1500	7.00	2.0000	129.15	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	1227.69	283.50		220.02	1.11	0	00:41:54
2	RFP18B-1		1.91	RSTR4B	76.40	0.1500	7.00	5.0000	104.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	1240.68	286.50		220.23	1.23	0	00:36:28
3	RFP18B-2		1.15	61	76.40	0.1500	7.00	5.0000	108.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	747.01	172.50		220.68	0.90	0	00:26:15
4	RFP5		2.47	36	65.00	0.1500	7.00	5.0000	119.76	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	97.5740	2410.08	370.50		188.64	1.25	0	00:39:08
5	RFP9A		0.69	48	76.40	0.1500	7.00	6.1500	86.11	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	448.20	103.50		220.94	0.60	0	00:20:46
6	RMR1		0.26	28	65.00	0.1500	7.00	1.0000	90.58	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	96.9690	252.12		109.20	189.68	0.20	0	00:19:20
7	RMR2		0.28	28	65.00	0.1500	7.00	1.0000	91.79	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	96.9950	271.59		117.60	189.64	0.21	0	00:20:05
8	RMR3		0.69	28	65.00	0.1500	7.00	1.0000	33.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	98.3630	678.70		289.80	187.64	0.26	0	01:03:58
9	RMR4		0.61	28	65.00	0.1500	7.00	1.0000	33.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	98.2060	599.06		256.20	187.81	0.24	0	00:59:26
10	RMR5		2.00	31	65.00	0.1500	7.00	1.0000	38.20	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	99.8630	1997.26		840.00	186.01	0.46	0	01:50:48
11	RMR6		1.15	32	65.00	0.1500	7.00	1.0000	33.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	99.0740	1139.35		483.00	186.83	0.34	0	01:26:51
12	RMR7		1.44	31	65.00	0.1500	7.00	1.0000	62.84	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	98.4690	1417.95		604.80	187.50	0.52	0	01:07:41
13	RPF1		6.30	26	69.40	0.1500	7.00	0.5000	357.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	86.2500	5433.75	945.00		199.72	2.37	0	01:11:08
14	RPF10		0.49	49	76.40	0.1500	7.00	2.9000	72.61	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	318.29	73.50		220.80	0.41	0	00:23:38
15	RPF11		2.77	43	76.40	0.1500	7.00	2.9000	150.06	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	1799.31	415.50		219.98	1.59	0	00:43:05
16	RPF12		1.37	49	65.00	0.1500	7.00	2.9000	108.15	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	97.4430	1334.97	205.50		188.86	0.76	0	00:34:28
17	RPF14		2.61	60	65.00	0.1500	7.00	2.8000	92.83	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	98.1000	2560.41	391.50		187.94	1.06	0	00:56:03
18	RPF15		3.42	44	65.00	0.1500	7.00	2.9000	115.73	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	98.1530	3356.83	513.00		187.89	1.37	0	00:57:13
19	RPF16A		7.45	51	76.40	0.1500	7.00	4.2000	239.57	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	4839.30	1117.50		219.66	3.73	0	00:52:44
20	RPF16B		2.27	63	69.40	0.1500	7.00	5.0000	144.74	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	85.2150	1934.38	340.50		201.15	1.40	0	00:33:12
21	RPF17A		2.32	64	76.40	0.1500	7.00	2.3000	143.73	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	1507.00	348.00		219.99	1.34	0	00:42:37
22	RPF17B		1.58	52	76.40	0.1500	7.00	2.3000	111.66	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	1026.32	237.00		220.11	0.97	0	00:39:20
23	RPF18A		1.01	52	76.40	0.1500	7.00	2.5000	64.55	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	656.07	151.50		220.06	0.60	0	00:40:46
24	RPF2A		1.80	21	72.00	0.1500	7.00	0.5000	167.33	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	78.2390	1408.30	270.00		207.55	0.85	0	00:52:46
25	RPF2B		1.38	21	98.00	0.1500	7.00	0.5000	500.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	5.1150	70.59	207.00		277.93	1.37	0	00:23:24
26	RPF3A		3.37	59	76.40	0.1500	7.00	2.0000	296.24	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	2189.05	505.50		220.24	2.20	0	00:36:01
27	RPF4A		18.76	41	76.40	98.0000	7.00	2.5000	339.33	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	12185.93	2814.00		218.72	6.77	0	01:27:04
28	RPF4B		10.13	33	76.40	80.0000	7.00	5.6000	500.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	6580.14	1519.50		220.19	6.45	0	00:37:26
29	RPF6		2.11	62	76.40	0.1500	7.00	5.0000	120.93	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	1370.59	316.50		220.27	1.40	0	00:35:26
30	RPF7		8.87	37	76.40	0.1500	7.00	0.5000	219.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	5761.69	1330.50		217.99	2.45	0	01:57:02
31	RPF8		4.47	29	76.40	0.1500	7.00	5.0000	182.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	2903.58	670.50		219.96	2.55	0	00:43:29
32	RPF9A		2.38	46	76.40	0.1500	7.00	2.0000	150.22	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	1545.98	357.00		219.95	1.35	0	00:43:57
33	RPF9B		0.89	46	76.40	0.1500	7.00	0.5000	500.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	64.9570	578.12	133.50		221.07	0.82	0	00:17:56
34	RSR10B		0.51	54	65.00	0.1500	7.00	6.6000	33.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	97.3110	496.29		214.20	189.06	0.31	0	00:30:24
35	RSR11B		0.55	54	65.00	0.1500	7.00	6.6000	33.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	97.3370	535.35		231.00	189.00	0.32	0	00:31:35
36	RSR5A		0.50	61	65.00	0.1500	7.00	2.0000	18.80	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	98.2320	491.16		210.00	187.79	0.19	0	00:59:55
37	RSR5B		0.33	42	65.00	0.1500	7.00	2.0000	14.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	98.1000	323.73		138.60	187.96	0.13	0	00:55:24
38	RSR6A		0.45	61	65.00	0.1500	7.00	2.0000	14.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	98.4420	442.99		189.00	187.53	0.16	0	01:06:48
39	RSR6B		0.27	42	65.00	0.1500	7.00	2.0000	14.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	97.9160	264.37		113.40	188.19	0.12	0	00:49:30
40	RSR9		0.81	47	65.00	0.1500	7.00	1.2000	41.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	98.1790	795.25		340.20	187.85	0.32	0	00:58:25
41	RSTR10		1.32	27	65.00	0.1500	7.00	6.6000	500.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	96.7060	1276.52		554.40	190.00	1.18	0	00:10:30
42	RSTR10A		0.25	47	65.00	0.1500	7.00	1.0000	33.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	97.4430	243.61		105.00	188.83	0.14	0	00:35:00
43	RSTR11A		0.31	47	65.00	0.1500	7.00	0.5000	33.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	97.8640	303.38		130.20	188.24	0.14	0	00:48:29
44	RSTR4B		8.89	38	80.00	0.1500	7.00	0.5000	214.02	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	47.30	0.0000	53.3640	4744.06		3733.80	275.28	3.07	0	01:58:52
45	RSTR5A		5.98	32	80.00	0.1500	7.00	2.0000	188.93	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	54.3750	3251.63		2511.60	229.11	2.75	0	01:06:36
46	RSTR6		5.28	20	80.00	0.1500	7.00	0.5000	412.11	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	54.3750	2871.00		2217.60	229.31	2.62	0	00:58:42
47	RSTR7		1.27	24	80.00	0.1500	7.00	0.5000	212.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	54.3750	690.56		533.40	229.97	0.85	0	00:37:11
48	RSTR8A		2.50	51	80.00	0.1500	7.00	2.6600	101.32	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	54.3750	1359.38		1050.00	229.47	1.31	0	00:52:42
49	RSTR8B		3.90	63	72.00	0.1500	7.00	0.5000	57.27	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	78.2390	3051.32		1638.00	204.47	0.73	0	02:39:49
50	RSTR9		1.68	21	56.00	0.1500	7.00	0.5000	303.97	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	122.7720	2062.57		705.60	163.41	0.75	0	00:35:25
51	RUND1A		2.44	48	80.00	0.1500	7.00	2.7800	98.98	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	54.3750	1326.75			229.49	1.29	0	00:51:57
52	RUND1B		1.39	47	80.00	0.1500	7.00	2.7800	74.39	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	54.3750	755.81			229.74	0.83	0	00:43:53
53	RUND2		2.51	46	80.00	0.1500	7.00	21.0000	103.00	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	54.3750	1364.81			230.33	2.00	0	00:28:06
54	SR1		1.39	33	65.00	0.1500	7.00	4.4000	20.24	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	98.9950	1376.03		583.80	186.93	0.42	0	01:23:50
55	SR2		1.42	32	65.00	0.1500	7.00	4.4000	22.34	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	98.8630	1403.85		596.40	187.07	0.45	0	01:19:46
56	SR3		0.85	40	65.00	0.1500	7.00	2.0000	19.94	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	98.8630	840.34		357.00	187.07	0.27	0	01:19:41
57	SR4		1.08	39	65.00	0.1500	7.00	2.0000	19.32	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	99.3110	1072.56		453.60	186.60	0.30	0	01:33:32
58	SR7		0.62	44	65.00	0.1500	7.00	2.0000	19.25	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	98.4690	610.51		260.40	187.51	0.22	0	01:07:20
59	SR8		0.32	49	65.00	0.1500	7.00	2.0000	17.54	0.00	0.00	0.0500	0.0100	5.0000	0.1000	0.00	FRASER	287.00	0.00	0.0000	97.8640	313.16		134.40	188.24	0.14	0	00:48:18

ANNEXURE E8

VISUAL SCS – RESULTS

CATCHMENT:	H1
CATCHMENT:	HN1
CATCHMENT:	HS1
CATCHMENT:	WH1
CATCHMENT:	WH2

H1

CATCHMENT NAME : H1- Post-development
PROJECT NO : 243-203
RUN NO : 1
TOTAL CATCHMENT AREA (km^2) : 1.26
STORM INTENSITY DISTRIBUTION TYPE : 2
CATCHMENT LAG TIME (h) : 1.13
COEFFICIENT OF INITIAL ABSTRACTION: 0.10

CURVE NUMBERS:	Initial	Final
Sub-catchment 1	75	75.0
Sub-catchment 2	60	60.0
Sub-catchment 3	54	54.0

RETURN PERIOD (YEARS)	2	5	10	20	50	100	200
DESIGN DAILY RAINFALL DEPTH (mm)	84	122	153	188	241	287	340

DESIGN STORMFLOW DEPTH (mm)

Sub-catchment 1	35.6	65.0	91.1	122.0	170.5	213.6	264.1
Sub-catchment 2	19.0	40.2	60.6	86.0	127.6	166.0	212.0
Sub-catchment 3	14.0	31.8	49.6	72.3	110.4	146.2	189.5
TOTAL RUNOFF DEPTH (mm)	19.2	40.3	60.5	85.7	127.1	165.2	211.0

DESIGN STORMFLOW VOLUME (thousands m^3)

Sub-catchment 1	3.6	6.6	9.2	12.3	17.2	21.5	26.6
Sub-catchment 2	16.5	35.0	52.7	74.7	111.0	144.3	184.3
Sub-catchment 3	4.0	9.2	14.4	21.0	32.0	42.4	54.9
TOTAL STORMFLOW VOLUME (thousands m^3)	24.2	50.7	76.3	108.0	160.1	208.2	265.8
COMPUTED CURVE NUMBER	60.2	60.0	60.0	59.9	59.8	59.8	59.7
PEAK DISCHARGE (m^3/s)	1.9	4.1	6.3	9.0	13.5	17.7	22.7

CATCHMENT NAME : H1-Pre-development
PROJECT NO : 243-203
RUN NO : 1
TOTAL CATCHMENT AREA (km^2) : 1.26
STORM INTENSITY DISTRIBUTION TYPE : 2
CATCHMENT LAG TIME (h) : 1.58
COEFFICIENT OF INITIAL ABSTRACTION: 0.10

CURVE NUMBERS:	Initial	Final
Sub-catchment 1	69	69.0
Sub-catchment 2	45	45.0
Sub-catchment 3	44	44.0

RETURN PERIOD (YEARS)	2	5	10	20	50	100	200
DESIGN DAILY RAINFALL DEPTH (mm)	84	122	153	188	241	287	340

DESIGN STORMFLOW DEPTH (mm)

Sub-catchment 1	28.2	54.4	78.4	107.3	153.4	194.9	243.9
Sub-catchment 2	7.7	20.6	34.4	52.7	84.7	115.7	154.1
Sub-catchment 3	7.1	19.5	32.8	50.6	81.9	112.2	150.0
TOTAL RUNOFF DEPTH (mm)	9.2	23.1	37.6	56.6	89.5	121.2	160.4

DESIGN STORMFLOW VOLUME (thousands m^3)								
Sub-catchment 1	2.8	5.5	7.9	10.8	15.5	19.6	24.6	
Sub-catchment 2	6.7	17.9	29.9	45.8	73.6	100.6	134.0	
Sub-catchment 3	2.1	5.6	9.5	14.7	23.7	32.5	43.5	
TOTAL STORMFLOW VOLUME (thousands m^3)			11.6	29.0	47.3	71.3	112.8	152.7	202.0
COMPUTED CURVE NUMBER			47.4	47.1	46.9	46.8	46.7	46.6	46.5
PEAK DISCHARGE (m^3/s)		0.6	1.7	2.9	4.5	7.3	9.9	13.3	

HN1

CATCHMENT NAME : HN1-Post-development
PROJECT NO : 243-203
RUN NO : 1
TOTAL CATCHMENT AREA (km^2) : 0.88
STORM INTENSITY DISTRIBUTION TYPE : 2
CATCHMENT LAG TIME (h) : 1.01
COEFFICIENT OF INITIAL ABSTRACTION: 0.10

CURVE NUMBERS:	Initial	Final
Sub-catchment 1	69	69.0
Sub-catchment 2	61	61.0
Sub-catchment 3	63	63.0
Sub-catchment 4	57	57.0
Sub-catchment 5	54	54.0
Sub-catchment 6	56	56.0
Sub-catchment 7	59	59.0

RETURN PERIOD (YEARS)	2	5	10	20	50	100	200
DESIGN DAILY RAINFALL DEPTH (mm)	84	122	153	188	241	287	340

DESIGN STORMFLOW DEPTH (mm)

Sub-catchment 1	28.2	54.4	78.4	107.3	153.4	194.9	243.9
Sub-catchment 2	19.9	41.7	62.5	88.3	130.5	169.2	215.6
Sub-catchment 3	21.9	44.7	66.4	93.0	136.2	175.7	222.8
Sub-catchment 4	16.4	35.9	55.0	79.1	119.0	156.1	200.9
Sub-catchment 5	14.0	31.8	49.6	72.3	110.4	146.2	189.5
Sub-catchment 6	15.6	34.5	53.2	76.8	116.2	152.8	197.1
Sub-catchment 7	18.1	38.8	58.7	83.7	124.8	162.7	208.3

TOTAL RUNOFF DEPTH (mm)	19.0	40.0	60.2	85.3	126.7	164.8	210.6

DESIGN STORMFLOW VOLUME
(thousands m^3)

Sub-catchment 1	3.5	6.7	9.7	13.2	18.9	24.0	30.0
Sub-catchment 2	2.6	5.5	8.3	11.7	17.2	22.3	28.5
Sub-catchment 3	1.3	2.8	4.1	5.7	8.4	10.8	13.7
Sub-catchment 4	5.3	11.7	17.9	25.8	38.8	50.8	65.4
Sub-catchment 5	0.5	1.1	1.7	2.5	3.9	5.1	6.7
Sub-catchment 6	1.6	3.6	5.6	8.1	12.3	16.1	20.8
Sub-catchment 7	1.8	3.8	5.7	8.1	12.1	15.8	20.2

TOTAL STORMFLOW VOLUME (thousands m^3)	16.7	35.2	53.0	75.1	111.5	145.0	185.3
COMPUTED CURVE NUMBER	59.9	59.8	59.8	59.7	59.7	59.6	59.6
PEAK DISCHARGE (m^3/s)	1.4	3.1	4.7	6.8	10.2	13.3	17.1

CATCHMENT NAME : HN1-Pre-development
PROJECT NO : 243-203
RUN NO : 1
TOTAL CATCHMENT AREA (km^2) : 0.88
STORM INTENSITY DISTRIBUTION TYPE : 2
CATCHMENT LAG TIME (h) : 1.55
COEFFICIENT OF INITIAL ABSTRACTION: 0.10

CURVE NUMBERS:	Initial	Final
Sub-catchment 1	69	69.0

Sub-catchment 2	45	45.0
Sub-catchment 3	46	46.0
Sub-catchment 4	36	36.0
Sub-catchment 5	28	28.0
Sub-catchment 6	38	38.0
Sub-catchment 7	40	40.0

RETURN PERIOD (YEARS)	2	5	10	20	50	100	200
DESIGN DAILY RAINFALL DEPTH (mm)	84	122	153	188	241	287	340

DESIGN STORMFLOW DEPTH (mm)

Sub-catchment 1	28.2	54.4	78.4	107.3	153.4	194.9	243.9
Sub-catchment 2	7.7	20.6	34.4	52.7	84.7	115.7	154.1
Sub-catchment 3	8.3	21.8	36.0	54.8	87.6	119.1	158.2
Sub-catchment 4	3.1	11.2	20.8	34.3	59.2	84.4	116.5
Sub-catchment 5	0.5	4.5	10.4	19.4	37.2	56.2	81.3
Sub-catchment 6	4.0	13.1	23.7	38.3	64.9	91.4	125.0
Sub-catchment 7	4.9	15.1	26.6	42.3	70.5	98.4	133.5

TOTAL RUNOFF DEPTH (mm)	7.9	19.8	32.5	49.5	79.3	108.2	144.4

DESIGN STORMFLOW VOLUME
(thousands m^3)

Sub-catchment 1	3.5	6.7	9.7	13.2	18.9	24.0	30.0
Sub-catchment 2	1.0	2.7	4.5	7.0	11.2	15.3	20.3
Sub-catchment 3	0.5	1.3	2.2	3.4	5.4	7.3	9.7
Sub-catchment 4	1.0	3.6	6.8	11.2	19.3	27.5	37.9
Sub-catchment 5	0.0	0.2	0.4	0.7	1.3	2.0	2.9
Sub-catchment 6	0.4	1.4	2.5	4.0	6.8	9.6	13.2
Sub-catchment 7	0.5	1.5	2.6	4.1	6.8	9.5	12.9

TOTAL STORMFLOW VOLUME (thousands m^3)	6.9	17.4	28.6	43.6	69.7	95.2	127.0
COMPUTED CURVE NUMBER	45.3	44.3	43.8	43.5	43.1	42.8	42.6
PEAK DISCHARGE (m^3/s)	0.3	1.0	1.7	2.7	4.5	6.2	8.4

HS1

CATCHMENT NAME : HS1-Post-development
PROJECT NO : 243-203
RUN NO : 1
TOTAL CATCHMENT AREA (km^2) : 0.29
STORM INTENSITY DISTRIBUTION TYPE : 2
CATCHMENT LAG TIME (h) : 0.48
COEFFICIENT OF INITIAL ABSTRACTION: 0.10

CURVE NUMBERS:	Initial	Final
Sub-catchment 1	55	55.0
Sub-catchment 2	52	52.0

RETURN PERIOD (YEARS)	2	5	10	20	50	100	200
DESIGN DAILY RAINFALL DEPTH (mm)	84	122	153	188	241	287	340

DESIGN STORMFLOW DEPTH (mm)

Sub-catchment 1	14.7	33.2	51.4	74.6	113.3	149.5	193.3
Sub-catchment 2	12.4	29.2	46.1	67.9	104.7	139.5	181.9

TOTAL RUNOFF DEPTH (mm)	14.0	31.9	49.7	72.4	110.5	146.3	189.7

DESIGN STORMFLOW VOLUME
(thousands m^3)

Sub-catchment 1	2.9	6.5	10.1	14.7	22.3	29.5	38.1
Sub-catchment 2	1.2	2.7	4.3	6.3	9.7	12.9	16.9

TOTAL STORMFLOW VOLUME (thousands m^3)	4.1	9.2	14.4	21.0	32.1	42.4	55.0
COMPUTED CURVE NUMBER	54.1	54.1	54.1	54.0	54.0	54.0	54.0
PEAK DISCHARGE (m^3/s)	0.5	1.3	2.1	3.2	4.9	6.5	8.5

CATCHMENT NAME : HS1-Pre-development
PROJECT NO : 243-203
RUN NO : 1
TOTAL CATCHMENT AREA (km^2) : 0.29
STORM INTENSITY DISTRIBUTION TYPE : 2
CATCHMENT LAG TIME (h) : 0.62
COEFFICIENT OF INITIAL ABSTRACTION: 0.10

CURVE NUMBERS:	Initial	Final
Sub-catchment 1	47	47.0
Sub-catchment 2	38	38.0

RETURN PERIOD (YEARS)	2	5	10	20	50	100	200
DESIGN DAILY RAINFALL DEPTH (mm)	84	122	153	188	241	287	340

DESIGN STORMFLOW DEPTH (mm)

Sub-catchment 1	9.0	22.9	37.6	57.0	90.4	122.5	162.2
Sub-catchment 2	4.0	13.1	23.7	38.3	64.9	91.4	125.0

TOTAL RUNOFF DEPTH (mm)	7.4	19.8	33.2	51.0	82.2	112.6	150.3

DESIGN STORMFLOW VOLUME
(thousands m^3)

Sub-catchment 1	1.8	4.5	7.4	11.2	17.8	24.2	32.0

					HS1				
Sub-catchment 2	0.4	1.2	2.2	3.6	6.0	8.5	11.6		
TOTAL STORMFLOW VOLUME (thousands m^3)			2.1	5.7	9.6	14.8	23.8	32.6	43.6
COMPUTED CURVE NUMBER			44.4	44.3	44.2	44.2	44.1	44.1	44.1
PEAK DISCHARGE (m^3/s)		0.2	0.6	1.1	1.8	3.0	4.1	5.6	

CATCHMENT NAME : WH1-Post-development
PROJECT NO : 243-203
RUN NO : 1
TOTAL CATCHMENT AREA (km^2) : 0.12
STORM INTENSITY DISTRIBUTION TYPE : 2
CATCHMENT LAG TIME (h) : 0.38
COEFFICIENT OF INITIAL ABSTRACTION: 0.10

CURVE NUMBERS:	Initial	Final
Sub-catchment 1	60	60.0
Sub-catchment 2	61	61.0

RETURN PERIOD (YEARS)	2	5	10	20	50	100	200
DESIGN DAILY RAINFALL DEPTH (mm)	84	122	153	188	241	287	340
DESIGN STORMFLOW DEPTH (mm)							
Sub-catchment 1	19.0	40.2	60.6	86.0	127.6	166.0	212.0
Sub-catchment 2	19.9	41.7	62.5	88.3	130.5	169.2	215.6
TOTAL RUNOFF DEPTH (mm)	19.3	40.7	61.2	86.7	128.5	167.0	213.1
DESIGN STORMFLOW VOLUME (thousands m^3)							
Sub-catchment 1	1.6	3.3	5.0	7.1	10.6	13.7	17.6
Sub-catchment 2	0.7	1.6	2.3	3.3	4.9	6.3	8.0
TOTAL STORMFLOW VOLUME (thousands m^3)	2.3	4.9	7.3	10.4	15.4	20.0	25.6
COMPUTED CURVE NUMBER	60.3	60.3	60.3	60.3	60.3	60.3	60.3
PEAK DISCHARGE (m^3/s)	0.4	0.8	1.3	1.8	2.8	3.6	4.6

CATCHMENT NAME : WH1-Pre-development
PROJECT NO : 243-203
RUN NO : 1
TOTAL CATCHMENT AREA (km^2) : 0.12
STORM INTENSITY DISTRIBUTION TYPE : 2
CATCHMENT LAG TIME (h) : 0.59
COEFFICIENT OF INITIAL ABSTRACTION: 0.10

CURVE NUMBERS:	Initial	Final
Sub-catchment 1	42	42.0
Sub-catchment 2	44	44.0

RETURN PERIOD (YEARS)	2	5	10	20	50	100	200
DESIGN DAILY RAINFALL DEPTH (mm)	84	122	153	188	241	287	340
DESIGN STORMFLOW DEPTH (mm)							
Sub-catchment 1	6.0	17.3	29.7	46.4	76.2	105.3	141.8
Sub-catchment 2	7.1	19.5	32.8	50.6	81.9	112.2	150.0
TOTAL RUNOFF DEPTH (mm)	6.3	17.9	30.6	47.7	77.9	107.4	144.4
DESIGN STORMFLOW VOLUME (thousands m^3)							

					WH1				
Sub-catchment 1	0.5	1.4	2.5	3.8	6.3	8.7	11.7		
Sub-catchment 2	0.3	0.7	1.2	1.9	3.0	4.2	5.6		
TOTAL STORMFLOW VOLUME (thousands m^3)			0.8	2.2	3.7	5.7	9.4	12.9	17.3
COMPUTED CURVE NUMBER			42.6	42.6	42.6	42.6	42.6	42.6	42.6
PEAK DISCHARGE (m^3/s)		0.1	0.2	0.4	0.7	1.2	1.7	2.3	

WH2

CATCHMENT NAME : WH2-Post-development
PROJECT NO : 243-203
RUN NO : 1
TOTAL CATCHMENT AREA (km^2) : 0.21
STORM INTENSITY DISTRIBUTION TYPE : 2
CATCHMENT LAG TIME (h) : 0.65
COEFFICIENT OF INITIAL ABSTRACTION: 0.10

CURVE NUMBERS:	Initial	Final
Sub-catchment 1	67	67.0
Sub-catchment 2	40	40.0

RETURN PERIOD (YEARS)	2	5	10	20	50	100	200
DESIGN DAILY RAINFALL DEPTH (mm)	84	122	153	188	241	287	340
DESIGN STORMFLOW DEPTH (mm)							
Sub-catchment 1	26.0	51.1	74.3	102.5	147.6	188.6	237.0
Sub-catchment 2	4.9	15.1	26.6	42.3	70.5	98.4	133.5
TOTAL RUNOFF DEPTH (mm)	10.4	24.5	39.0	58.0	90.6	121.8	160.4
DESIGN STORMFLOW VOLUME (thousands m^3)							
Sub-catchment 1	1.4	2.8	4.1	5.6	8.1	10.3	12.9
Sub-catchment 2	0.8	2.4	4.1	6.6	11.0	15.3	20.7
TOTAL STORMFLOW VOLUME (thousands m^3)	2.2	5.1	8.2	12.2	19.0	25.6	33.7
COMPUTED CURVE NUMBER	49.2	48.3	47.8	47.5	47.1	46.8	46.6
PEAK DISCHARGE (m^3/s)	0.2	0.6	0.9	1.4	2.3	3.1	4.1

CATCHMENT NAME : WH2-Pre-development
PROJECT NO : 243-203
RUN NO : 1
TOTAL CATCHMENT AREA (km^2) : 0.21
STORM INTENSITY DISTRIBUTION TYPE : 2
CATCHMENT LAG TIME (h) : 0.86
COEFFICIENT OF INITIAL ABSTRACTION: 0.10

CURVE NUMBERS:	Initial	Final
Sub-catchment 1	50	50.0
Sub-catchment 2	32	32.0

RETURN PERIOD (YEARS)	2	5	10	20	50	100	200
DESIGN DAILY RAINFALL DEPTH (mm)	84	122	153	188	241	287	340
DESIGN STORMFLOW DEPTH (mm)							
Sub-catchment 1	11.0	26.6	42.7	63.5	99.0	132.7	174.1
Sub-catchment 2	1.6	7.6	15.4	26.7	48.1	70.3	99.1
TOTAL RUNOFF DEPTH (mm)	4.0	12.6	22.5	36.2	61.4	86.5	118.6
DESIGN STORMFLOW VOLUME (thousands m^3)							
Sub-catchment 1	0.6	1.5	2.3	3.5	5.4	7.2	9.5

					WH2				
Sub-catchment 2	0.2	1.2	2.4	4.1	7.5	10.9	15.4		
TOTAL STORMFLOW VOLUME (thousands m^3)			0.8	2.6	4.7	7.6	12.9	18.2	24.9
COMPUTED CURVE NUMBER			38.1	37.4	37.2	37.0	36.8	36.6	36.5
PEAK DISCHARGE (m^3/s)		0.0	0.2	0.4	0.7	1.2	1.8	2.5	

ANNEXURE F:

STORMWATER MAINTENANCE & MONITORING PLAN

CONTRACT NO. 243/203 MARCH 2013

Tongaat Hulett DEVELOPMENTS

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uSHUKELA HIGHWAY

STORMWATER OPERATIONS & MAINTENANCE PLAN

Tongaat Hulett DEVELOPMENTS

dube tradePORT

uSHUKELA HIGHWAY

STORMWATER OPERATION, MAINTENANCE & MONITORING PLAN

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DISCIPLINE: **STORMWATER OPERATION, MAINTENANCE & MONITORING PLAN**	

BOSCH STEMELE

• Consulting Engineers • Project Managers

QUALITY VERIFICATION

This report has been prepared under the control of the Bosch Stemele Quality Management System which meets the requirements of ISO 9001:2008 as independently certified by international auditors (Certificate No. 20705704/1)

ISO 9001:2008 CERTIFIED

Verification	Capacity	Name	Signature	Date
Checked by:	Lead Engineer	**A Knox**		17/4/13
Reviewed by:	Project Manager/Director	**C P Kroeger**		17/4/13
Accepted by:	Client Authorised Representative	**T Wilkinson**		
Accepted by:	Client Authorised Representative			

uSHUKELA HIGHWAY

STORMWATER
OPERATION, MAINTENANCE & MONITORING PLAN

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uSHUKELA HIGHWAY

STORMWATER OPERATION, MAINTENANCE & MONITORING PLAN

1. OVERVIEW

The purpose of this document is to present overall guidelines for the operation, maintenance & monitoring of the stormwater facilities within the proposed uShukela Highway development site. These guidelines were prepared in accordance with accepted Best Management Principles (BMP's) for Stormwater Management and the eThekwini Municipality's Guidelines and Policy for the Design of Stormwater Drainage & Stormwater Management Systems (May 2008).

1.1. Description of the Stormwater System

The development will consist of a number of individual sites for predominantly light industrial, commercial & retail use. The 'on-site' stormwater system consists of "facilities" (i.e. soakaways, permeable paving, kerbing, stormwater conduits) to manage runoff for the up to 1 in 5-year storm event. These facilities are located on the individual sites.

Discharge of excess run-off from these sites will either be directly to the major system as described below (via energy dissipated outlets or stilling ponds) or to the stormwater collection systems situated in the road reserves. These ultimately discharge into the major system at pre-determined points.

The major system consists of the natural streams and attenuation ponds located on the overall development that will limit runoff to outside the development to the pre-development level for storm events exceeding a 1 in 5-year probability. These facilities are located outside the individual sites.

1.2. Management of the Stormwater System

Ethekwini Municipality will be responsible for the management, operation and maintenance of the stormwater system. This will include responsibility for both quality and quantity of stormwater discharge from the sites.

The management association, as constituted by the developers, may in agreement with Ethekwini Municipality, perform operations and management functions including monitoring stormwater management on the individual properties, as well as the operation and management of stormwater facilities falling outside these individual properties.

2. MANAGEMENT OBJECTIVES

The objectives of this OM & M plan are as follows:

- To utilise maintenance, operations and monitoring data to demonstrate to various stakeholders that the proposed minor & major storm event facilities (permeable paving, swales, streams & retention ponds) are achieving their intended design objectives,
- To promote Best Management Principles (BMP's) for the development,
- To minimum the risk of pollution to the natural wetlands and streams during the operational phase of the development, and
- To develop a database for comparison and trend analysis and future re-development considerations.

3. IDENTIFICATION OF RISKS

The following is a broad checklist of concerns applicable to stormwater operation & management:

- Obstructions at the inlet, outlet and overflow of ponds,
- Oil/grease contamination or evidence of hydrocarbon spills in the retention ponds or receiving water course,
- Accumulation of trash/litter in and around the retention ponds/streams,
- Accumulation of algae or other form of choking vegetation (i.e. reeds),
- Sediment build-up in retention ponds or in stream beds,
- Evidence of hydraulic malfunctioning such as frequent high water levels within retention dams,
- Inappropriate or dead vegetation in and around retention ponds / streams / wetlands,
- Evidence of vandalism, encroachment or establishment of informal housing,
- Erosion around inlet and outlet structures, and
- Erosion of stream beds.

4. FACILITY ACCESS AND SAFETY

All stormwater management facilities located outside the individual sites should have a designated access location for inspection, maintenance and monitoring.

5. STORMWATER FACILITY INSPECTION PROCEDURES

5.1. Safety

Safety considerations should be kept at the forefront during inspections. Likely hazards should be anticipated and avoided. Confined spaces (i.e. outlet structures, manholes etc) should never be entered without proper training, number of personnel and correct equipment.

Should potentially dangerous substances be found in stormwater structures, the local authority should be notified immediately.

Steep slopes in and around the retention ponds/wetlands may be encountered, avoid walking on top of embankments where there is a risk of injury or is considered unsafe.

5.2. Field Inspection Equipment

It is imperative that the appropriate equipment is taken to the field with the inspector(s). This is to ensure the safety of the inspector and allow the inspections to be performed as efficiently as possible. Below is a list of the equipment that may be necessary to perform the inspections of all Stormwater facilities:

- Protective clothing and boots,
- Safety equipment (if required),
- Communication equipment,
- IM Plan for the site.
- Clipboard.
- Stormwater Inspection Sheets (See Annexure F1).
- Manhole Lid Remover
- Shovel.

Some of the items identified above need not be carried by the inspector (manhole lid remover, shovel, and confined space entry equipment), but should be available in the vehicle driven to the site. Specialized equipment may require specific training related to that equipment and should only be used by trained individuals.

5.3. Maintaining Stormwater Facilities

Stormwater facilities must be properly maintained to ensure that they operate correctly for which they were designed. Routine maintenance performed on a frequently scheduled basis, can help avoid more costly rehabilitative maintenance that results when facilities are not adequately maintained.

5.4. Maintenance Categories

Stormwater BMP maintenance programs are separated into three broad categories of work. The categories are separated based upon the magnitude and type of the maintenance activities performed. A description of each category follows:

- Routine Work
  The majority of this work consists of scheduled mowings and trash and debris removal around stormwater management facilities. This includes items such as the removal of debris/material that may be clogging the outlet structures. It also includes activities such as weed control and reeds within the retention ponds and wetlands.

- Restoration Work
  This work consists of a variety of isolated or small-scale maintenance and work needed to address operational problems. Most of this work can be completed by a small crew, with minor tools, and small equipment. These items do not require prior correspondence with the local authorities but should be recorded in the maintenance forms.

- Rehabilitation Work
  This work consists of large-scale maintenance and major improvements needed to address failures within the stormwater facilities. This work may require consultation with a professional engineer and the local authorities.

5.5. Maintenance Personnel

Maintenance personnel should be qualified to properly maintain stormwater facilities especially for restoration or rehabilitation work. Inadequately trained personnel can cause additional problems resulting in additional maintenance costs.

6. GENERIC MAINTENANCE REQUIREMENTS

It is good practice to carry out routine inspections of the individual sites and the major stormwater attenuation facilities at least every three months by a competent person. The required qualification for such a person is that they shall be well acquainted with the contents of this document, should be alert and be endowed with sound judgement so that he/she will know when to call for assistance, arrange for maintenance or immediate intervention.

Serious problems should however receive immediate attention. Work which is of a critical nature should be done under the supervision of a professional engineer or according to instructions (see Section 5.4).

During the inspection maintenance requirements are to be noted and arrangements made to complete these works.

Inspections on individual sites would include:

6.1.1. *Kerb Inlets*

Each kerb inlet needs to be inspected and cleared of any build up of silt, litter, vegetation or rubble that may impede the clear flow of water into the inlet. It also needs to be inspected for structural damage and repaired if necessary.

6.1.2. *Piped Systems*

Piped systems need to be checked in a systematic way to ensure they are clear of any obstructions and are able to flow at their full capacity. Any build up of silt or other obstruction is to be removed by hand or by jetting.

6.1.3. *Permeable Surfacing*

To facilitate biodegradation of contaminants such as hydrocarbons, slow release environment friendly fertilisers can be washed in the permeable surfacing. If pollution does occur on the stone layer, the affected stone can be removed and replaced with clean stone or washed and reinstated. It is likely that the bulk of pollutants will be retained in the geotextile layer in which case the affected section of geotextile will have to be removed and replaced.

If permeable paving is used as a surfacing it does tends to lose its infiltration capability due to the closing of voids between pavers. It is good practice to clean these voids with a high pressure cleaner and refill voids with clean gravel.

6.1.4. *Embankments*

Inspect embankment slopes for signs of instability or erosion. Any signs of instability must be reported immediately to a professional engineer for inspection and assessment. Erosion damage must be repaired as soon as possible.

6.1.5. *Pollution Monitoring*

As a good management practice, it is recommended that a monitoring system be put in place to measure possible pollution of subsurface water and the surrounding environment (wetland / riparian zone) at least every six months.
During the inspection maintenance, requirements are to be noted and arrangements made to complete these works.

7. MAINTENANCE FORMS

Maintenance checklists & operation & maintenance plans for the proposed retention ponds are provided in Annexures F1 & F2 respectively. Maintenance checklists must be completed by the developer on a yearly basis and submitted to the local authority if required.

Prepared by L. Streicher
Bosch Stemele (Pty) Ltd

ANNEXURE F1:

INSPECTION CHECKLISTS – RETENTION PONDS/WETLANDS

INSPECTION CHECKLIST AND MAINTENANCE GUIDANCE
STORMWATER POND INSPECTION CHECKLIST

Location: _____

Date:_____ Time:_____ Site Conditions:_____ _____ **Inspection Items**	**Satisfactory (S) or Unsatisfactory (U)**	**Comments/Corrective Action**
Embankment and Emergency Spillway		
Healthy vegetation?		
Erosion on embankment?		
Animal burrows in embankment?		
Cracking, sliding, bulging of dam?		
Blocked or malfunctioning drains?		
Leaks or seeps on embankment?		
Obstructions of spillway(s)?		
Erosion in/around emergency spillway?		
Other (describe)?		
Inlet/Outlet Structures and Channels		
Clear of debris and functional?		
Trash rack clear of debris and functional?		
Sediment accumulation?		
Condition of concrete/masonry?		
Pipes in good condition?		
Slide gate operation?		
Pond drain valve operation?		
Outfall channels function, not eroding?		
Other (describe)?		
Sediment Forebays		
Evidence of sediment accumulation?		
Permanent Pool Areas (if applicable)		
Undesirable vegetation growth?		
Visible pollution?		
Shoreline erosion?		
Erosion at outfalls into pond?		
Headwalls and endwalls in good condition?		
Encroachment by other activities?		
Evidence of sediment accumulation?		
Dry Pond Areas (if applicable)		
Vegetation adequate?		
Undesirable vegetation growth?		
Excessive sedimentation?		
Hazards		
Have there been complaints from tenants?		
Public hazards noted?		

Inspected by _____ on _____

Comments _____

INSPECTION CHECKLIST AND MAINTENANCE GUIDANCE
STORMWATER WETLANDS INSPECTION CHECKLIST

Location: _____

Date:_____ Time:_____ Site Conditions:_____ _____ **Inspection Items**	**Satisfactory (S) or Unsatisfactory (U)**	**Comments/Corrective Action**
Embankment and Emergency Spillway		
Healthy vegetation?		
Erosion on embankment?		
Animal burrows in embankment?		
Cracking, sliding, bulging of dam?		
Blocked or malfunctioning drains?		
Leaks or seeps on embankment?		
Obstructions of spillway(s)?		
Erosion in/around emergency spillway?		
Other (describe)?		
Inlet/Outlet Structures and Channels		
Clear of debris and functional?		
Trash rack clear of debris and functional?		
Sediment accumulation?		
Condition of concrete/masonry?		
Pipes in good condition?		
Slide gate operation?		
Pond drain valve operation?		
Outfall channels function, not eroding?		
Other (describe)?		
Sediment Forebays		
Evidence of sediment accumulation?		
Permanent Pool Areas (if applicable)		
Undesirable vegetation growth?		
Visible pollution?		
Shoreline erosion?		
Erosion at outfalls into pond?		
Headwalls and endwalls in good condition?		
Encroachment by other activities?		
Evidence of sediment accumulation?		
Dry Pond Areas (if applicable)		
Vegetation adequate?		
Undesirable vegetation growth?		
Excessive sedimentation?		
Hazards		
Have there been complaints from residents?		
Public hazards noted?		

Inspected by _____ on _____

Comments _____

_____

ANNEXURE F2:

FACILITY SPECIFIC OPERATION & MAINTENANCE PLAN

WET, EXTENDED WET DETENTION, AND DRY DETENTION PONDS OPERATIONS & MAINTENANCE PLAN

Wet Ponds are constructed ponds with a permanent pool of water. Pollutants are removed from stormwater through gravitational settling and biologic processes.

Extended Wet Ponds are constructed ponds with a permanent pool of water and open storage space above for short-term detention of large storm events. Pollutants are removed from stormwater through gravitational settling and biologic processes.

Dry Detention Ponds are constructed ponds with temporary storage for the detention of large storm events. The stormwater is stored and released slowly over a matter of hours. All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, and twice per year thereafter, and within 48 hours after each major storm event. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

Pond Inlet shall assure unrestricted stormwater flow to the wet pond.

- Inlet pipe shall be cleared when conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.

- Determine if pipe is in good condition:
  - If more than 25mm of settlement, add fill material and compact soils.
  - If alignment is faulty, correct alignment.
  - If cracks or openings exist indicated by evidence of erosion at leaks, repair or replace pipe as needed.

Embankment, Dikes, Berms & Side Slopes retain water in the wet pond.

- Slopes shall be stabilized using appropriate erosion control measures when native soil is exposed or erosion channels are forming.
- Structural deficiencies shall be corrected upon discovery:
  - If cracks exist, repair or replace structure.
  - If erosion channels deeper than 50mm exist, stabilize surface. Sources of erosion damage shall be identified and controlled.

Control Devices (e.g., weirs, baffles, etc.) shall direct and reduce flow velocity. Structural deficiencies shall be corrected upon discovery:

- If cracks exist, repair or replace structure.

Overflow Structure conveys flow exceeding reservoir capacity to an approved stormwater receiving system.

- Overflow structure shall be cleared when 50% of the conveyance capacity is plugged. Sources of sediment and debris shall be identified and corrected.
- Sources of erosion damage shall be identified and controlled when native soil is exposed at the top of overflow structure or erosion channels are forming.
- Rocks or other armouring shall be replaced when only one layer of rock exists above native soil.

Sediment & Debris Management shall prevent loss of wet pond volume caused by sedimentation.

- Wet ponds shall be dredged when 1 foot of sediment accumulates in the pond.
- Gauges located at the opposite ends of the wet pond shall be maintained to monitor sedimentation. Gauges shall be checked 2 times per year.
- Sources of restricted sediment or debris, such as discarded lawn clippings, shall be identified and prevented.
- Debris in quantities sufficient to inhibit operation shall be removed routinely, e.g. no less than quarterly, or upon discovery.

Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion and minimizing solar exposure of open water areas.

- Mulch shall be replenished at least annually.
- Vegetation, large shrubs or trees that limit access or interfere with wet pond operation shall be pruned or removed.
- Grass (where applicable) shall be mowed to 4"-9" high and grass clippings shall be removed.
- Fallen leaves and debris from deciduous plant foliage shall be raked and removed.
- Nuisance or prohibited vegetation shall be removed when discovered. Invasive vegetation of all species shall be removed and replaced.
- Dead vegetation shall be removed to maintain less than 10% of area coverage or when wet pond function is impaired. Vegetation shall be replaced within 3 months, or immediately if required to maintain cover density and control erosion where soils are exposed.
- Vegetation producing foul odours shall be eliminated.

Spill Prevention measures shall be exercised when handling substances that can contaminate stormwater
Releases of pollutants shall be corrected as soon as identified.

Training and/or written guidance information for operating and maintaining ponds shall be provided to all property owners and tenants. A copy of the O&M Plan shall be provided to all property owners and tenants.

Access to the wet pond shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.

- Obstacles preventing maintenance personnel and/or equipment access to the wet pond shall be removed.
- Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.

Insects & Rodents shall not be harboured in the pond. Pest control measures shall be taken when insects/rodents are found to be present.

- If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary and only by a licensed individual or contractor.
- Holes in the ground located in and around the pond shall be filled.

If used at this site, the following will be applicable:

Signage shall clearly convey information.

- Broken or defaced signs shall be replaced or repaired.

Fences shall be maintained to preserve their functionality and appearance.

- Collapsed fences shall be restored to an upright position.
- Jagged edges and damaged fences and shall be repaired or replaced.

Appendix 5: Service confirmation letters

Kindly note the electrical service letter will be included in the Final EIR.

ETHEKWINI MUNICIPALITY

PROCUREMENT & INFRASTRUCTURE
Water & Sanitation Unit

3 Prior Road
Durban, 4001
P O Box 1038, Durban, 4000
Tel: 031 311 1111, Fax: 031 311 8549
www.durban.gov.za

ENQUIRIES : P. Mbhele
TELEPHONE : 311 8579
FAX NUMBER : 311 8549

19 October 2011

Stemele Bosch Africa(Pty) Ltd.
P.O. Box 2009
Durban
4000

ATTENTION: Mr A. Le Roux

Dear Sir,

uSHUKELA HIGHWAY DEVELOPMENT: CONFIRMATION OF CAPACITY ON SEWER INFRASTRUCTURE

This department is in the process of upgrading the Tongaat Wastewater Treatment Works from 10Ml/d to 20Ml/d, to accommodate current and future developments in the area. Completion of this work is anticipated in 2015. With consideration to planning information for this proposed development provided by yourself. We therefore confirm that sewer effluent emanating from the development will be accommodated and treated in the works.

Yours Faithfully

P. MBHELE
ACTING AREA PROJECT ENGINEER

ETHEKWINI MUNICIPALITY

PROCUREMENT & INFRASTRUCTURE
Water & Sanitation Unit

3 Prior Road
Durban, 4001
PO Box 1038, Durban, 4000
Tel: 031 311 1111, Fax: 031 311 8549
www.durban.gov.za

Our ref. :#460474
Enquiries :Nithia Naidoo
Telephone :031-3118169

Date :18/07/2012

Bosch Stemele (Pty) Ltd
1 Holwood Park
5 Canegate Road
La Lucia Ridge Office Estate
4320
P O Box 2009
Durban
4000

Attention: Mr M Vawda

Dear Sir,

uSHUKELA HIGHWAY DEVELOPMENT

Your e-mail dated 03/07/12 for the bulk supply of water for the proposed development for the Tongaat Hulett Development (THD) group and Dube Tradeport has reference.

Bulk water can be made available to the development subject to the upsizing of the existing reservoir and associated pipework and the upsizing of the reticulation network to the site

I trust that the above is in order. Should you have any queries, please feel free to contact me.

Yours faithfully

Nithia Naidoo
WATER & SANITATION:PLANNING

Appendix 6: uShukela Development: Preliminary Services Report – Electrical and the Services Report – Electrical

Ushukela Development

Preliminary Services Report Electrical Revision 1

November 2010

Tongaat Hulett
DEVELOPMENTS

Ushukela Development
Preliminary Services Report - Electrical

November 2010 - Rev 1

Bosch Projects Ref.: 243/181/1040

1 Holwood Park • 5 Canegate Road • La Lucia Ridge Office Estate • Durban
PO Box 2009 • Durban 4000 • KwaZulu-Natal • South Africa
Telephone: +27 (0)31 535 6000 • Facsimile: +27 (0)31 535 6010
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+27 73 655 6633

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1. TERMS OF REFERENCE

Tongaat Hulett Developments (THD) intend developing the area known as Ushukela which is located north of Durban. The locality plan of the site is included in Appendix A. The developments will consist of business park, retail park, mixed use and tradezones.

Bosch Projects (BP) has been appointed to compile a preliminary services report for the electrical infrastructure.

2. ELECTRICAL INFRASTRUCTURE (EXISTING)

The electrical infrastructure is divided into the following categories:

2.1 Sub-Transmission (132/11 kV)

There are currently two 132/11kV 60MVA firm major substations that are located on the south side and north side respectively of the proposed development.

The La Mercy Substation which is located to the south of the proposed development is located quite some distance away and as a result can not be used to service the proposed development. Furthermore, the available capacity at the La Mercy substation has been earmarked for the airport and development around the airport including the Dube Trade Port.

The Tongaat Substation which is located to the north of the proposed development is newly built and is currently in the process of being commissioned. This substation has been built to take over the load of three existing 33/11kV substations namely Truroland, Maidstone and old Tongaat, all of which will be de-commissioned, as well as to cater for future load growth in close proximity to the substation for which eThekwini Electricity have already received applications.

2.2 Sub-Transmission Line Servitudes

No sub-transmission line servitudes exist within the development area.

2.3 Distribution (11kV)

No electrical supply (at 11kV) is available within the boundaries of the project.

2.4 Reticulation

No electrical supply (at 400V) is available within the boundaries of the project.

2.5 Street Lighting

No street lighting currently exists within the boundaries of the project.

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3. PROPOSED DEVELOPMENT REQUIRMENTS

The preliminary planning criteria are based on information as provided by THD. In formulating the preliminary planning criteria BP have used good engineering practice and load factors as Per Annex B of NRS 069: 2004 (Appendix B) which are approved by eThekwini Electricity. The system will be designed to cater for the failure of any single MV cable, i.e. electrical load can be transferred via switching in the event of a fault occurring.

The estimated electrical loads for the developments are as follows:

Sub-Precinct	Land Use	Area (Ha)	% Site Area	FAR	Bulk (Ha)	Load (kVA)
1	Business Park - Offices and Showrooms	7.9	5.85	0.6	4.74	3792
2	Retail Park - Offices, showrooms, retail warehousing	16.83	12.47	0.6	10.12	8096
3	Mixed use - Offices, showrooms, service retail, hotels	16.68	12.36	0.6	10.01	8008
4	Business Park - Offices and Showrooms	5.06	3.75	0.6	3.04	2432
5	Business Park - Offices and Showrooms	6.12	4.53	0.6	3.67	2936
6	Tradezone - Offices, light/clean industry, warehousing, distribution, manufacturing	31.46	23.31	0.6	18.88	15104
7	Tradezone - Offices, light/clean industry, warehousing, distribution, manufacturing	10.02	7.42	0.6	6.01	4808
8	Conference, management and offices	4.33	3.21	0.6	2.6	2080
	TOTAL LOAD REQUIREMENT					**47256**

Table 1

4. FUTURE ELECTRICAL INFRASTRUCTURE REQUIRMENTS

The proposed electrical infrastructure is covered under the headings below:

4.1 Sub-Transmission (132/11 kV)

It is envisaged that this project will span eight years with the load requirements being phased in over the years as follows:

Year	2013	2014	2015	2016	2017	2018	2019	2020
Load per Year (MVA)	6	6	6	6	6	6	6	5
Total Load (MVA)	6	12	18	24	30	36	42	47

Table 2

The existing 132/11kV 60MVA Tongaat substation will be used to supply the initial phases of the development. It will in time however, be essential to construct a new 132/11kV 60MVA firm substation in close proximity to the

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proposed development. There are 2 options available whereby the proposed new substation can be supplied:

- The Tongaat substation will have to be extended to include two new line bays which will be used to service the proposed new substation.
- A T-off from the existing 132kV line between the La Mercy substation and Tongaat substation can be created.

Please refer to the attached drawing (Appendix C) for clarity on the two available options.

4.2 Sub-Transmission Line Servitudes

Sub-Transmission line servitudes may be required in close proximity or within the development area. Overhead line servitudes are normally quite large and hence the developer runs the risk of losing valuable developable area. Underground cable may be used to save on the land requirement for servitudes, but will cost twice as much as the overhead line. The difference in cost between the overhead line and underground cable will have to be borne by the developer. However, this cost can be off-set by the availability of more developable land as compared to overhead line servitudes.

4.3 Distribution (11kV)

11kV supplies will be taken from the 132/11kV major substation and be fed into a series of Distribution Substations. Distribution substations are planned and positioned in key locations throughout the development. 11kV cable routes will be planned to run adjacent or be in close proximity to each proposed site allowing sales and transfers of sites to take place.

4.4 Reticulation

In most instances the internal electrical reticulation will be undertaken by each individual site owner to meet his specific requirements. THD will be responsible for the costs of the 11kV bulk supply to the boundary of these developments.

4.5 Street Lighting

Provision is made for both street lighting as well as public open space lighting. It is recommended that lighting form part of a separate report due to the aesthetic requirements of the urban architecture.

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5. FINAL COMMENTS

As detailed information becomes available, co-ordination meetings with the Supply Authority shall take place to ensure that the development milestones are achieved.

6. ACTION ITEMS

The following actions are required going forward.

- On receipt of Tongaat Hulett Developments appointment letter, Bosch Projects will undertake the preliminary design.
- Subject to Tongaat Hulett Developments' approval, continue and finalise the electrical design, including street and public lighting.
- On completion of the design, co-ordinate with Tongaat Hulett Developments as to the phased implementation of this project to meet sales objectives.

APPENDICES

- **Appendix A – Locality Plan and Draft Land Use Concept**
- **Appendix B – Annex B of NRS 069: 2004**
- **Appendix C – 132kV Sub-Transmission Line Options**

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APPENDIX A
LOCALITY PLAN

USHUKELA HIGHWAY DRAFT LAND USE CONCEPT

N

1:5,987

USHUKELA DRIVE

N2

KING SHAKA INTERNATIONAL AIRPORT
AND DUBE TRADEPORT

0 120 240 480 Meters

Legend

- Conference, Management, Recreational, Leisure, Hotel - 4 ha
- Business Park, Offices, Showrooms, Retail Warehouse - 45 ha
- Business Park, Offices - 12 ha
- Light, Service Industry, Business Park - 50 ha
- Open Space - 12 ha

APPENDIX B
Annex B of NRS 069: 2004

Annex B
(informative)

Network standards

B.1 Throughout this code of practice reference is made to standards. To set such standards can be an extensive job as many aspects have to be addressed and different utilities are applying very different standards. Standards are proposed in this code of practice that can be used by utilities who have not yet set such standards for themselves.

B.2 Each utility will, however, set its own standards according to utility circumstances but deviations from the standards proposed should be motivated to customers/developers and the NER. The standards set a base from which to start. The standards should be set to reflect the economically wise approach. The network standard has to be set according to the kilovolt-ampere capacity of the network:

Kilovolt-ampere zoning ADMD standard for urban areas at the transformer LV bus.

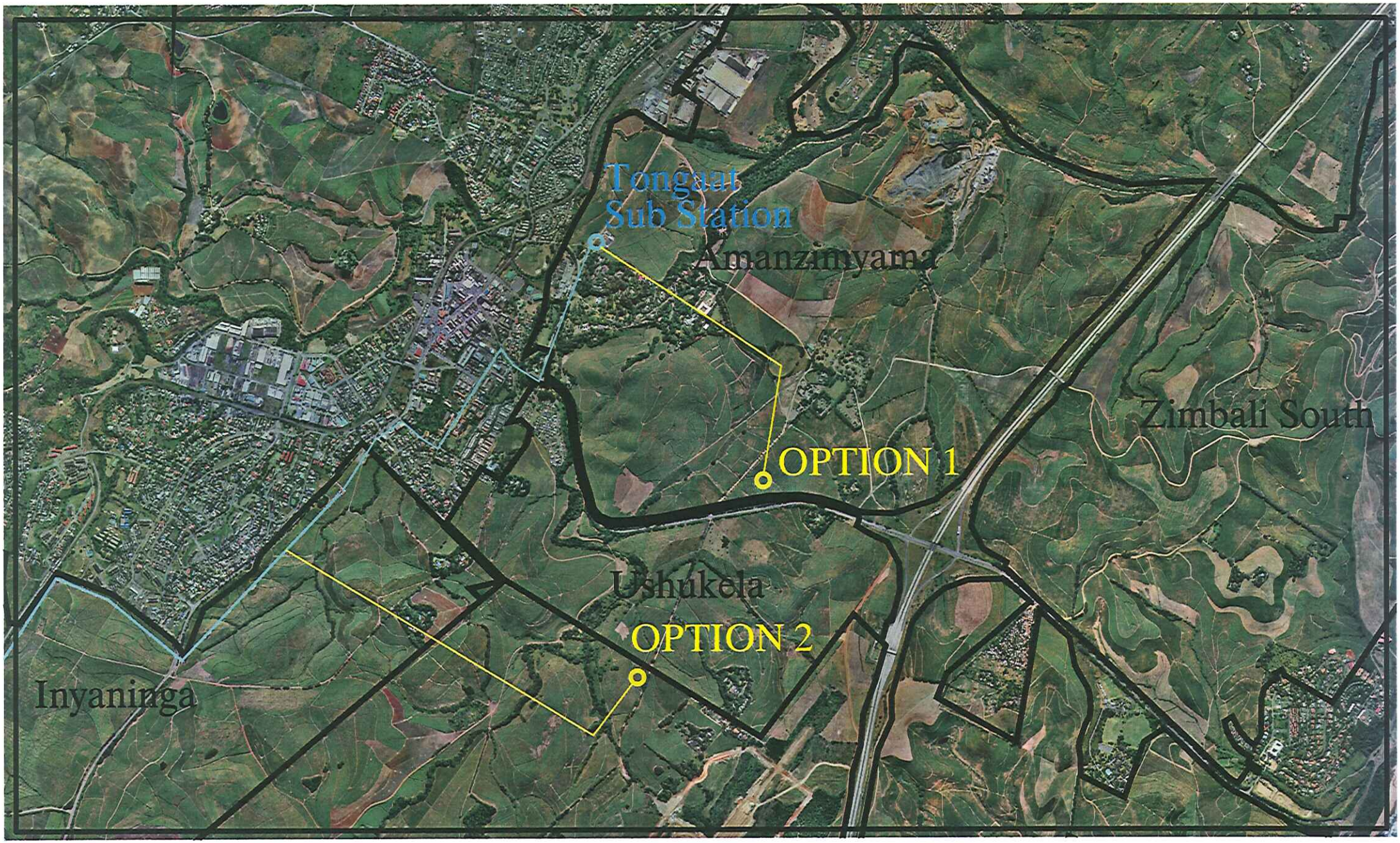
a)	Domestic electrification	Individual + 0,2 to 1 kVA/stand
b)	Domestic low income	Individual >1 to 3 kVA/stand
c)	Domestic normal	Individual >3 to 6 kVA/stand
d)	Domestic upmarket	Individual >6 to 8 kVA/stand
e)	Domestic luxury one phase	Individual >8 to 12 kVA/stand
f)	Domestic luxury three phase	Individual >12 kVA/stand
g)	For business or office or equivalent	80 VA/m^2 = 0,08 kVA/m^2
h)	Light industrial or equivalent	40 VA/m^2 = 0,04 kVA/m^2
i)	Industrial	100 VA/m^2 = 0,1 kVA/m^2
j)	Heavy industrial	Individually by development

B.3 The standards proposed in B.2 are different from those stipulated in NRS 034-1. Table B.1 as derived from table 3a in NRS 034-1:2001 below has been included for information purposes only.

Table B.1 — Typical design load parameters for domestic consumers

1	2
Load category	**Assumed load (ADMD)** kVA/unit
Informal settlement	1,0 – 1,3
Township area	2,4
Urban residential	3,6 – 4,7
Urban upmarket	5,3
NOTE Assumed loads in the KwaZulu-Natal area should be reduced by 12 % and those in the Western Cape escalated by 12 %.	

APPENDIX C
132kV Sub-Transmission Line Options


Tongaat
Sub Station
Amanzimyama
Zimbali South
OPTION 1
Ushukela
OPTION 2
Inyaninga

BOSCH PROJECTS

Ushukela Developments

Services Report - Electrical Revision 06

February 2013

Tongaat Hulett DEVELOPMENTS

A BOSCH HOLDINGS company

Ushukela Development Services Report - Electrical

February 2013 – Rev 06

Bosch Projects Ref.: 243/208/1040

1 Holwood Park • 5 Canegate Road • La Lucia Ridge Office Estate • Durban
PO Box 2009 • Durban 4000 • KwaZulu-Natal • South Africa
Telephone: +27 (0)31 535 6000 • Facsimile: +27 (0)31 535 6011
Internet: http://www.boschprojects.co.za
E-mail: sunderlalls@boschprojects.co.za

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Sudesh Sunderlall	+27 83 283 1397
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5.2 Sub-Transmission Major Substations (275/132 kV) 4

5.3 132kV Sub-Transmission Lines & Servitudes 4

5.4 Sub-Transmission (132/11 kV) 4

5.5 Distribution (11kV) 4

5.6 Reticulation 4

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1. EXECUTIVE SUMMARY

This report provides an indication of the electrical load requirements for the Ushukela Development. It covers the existing electrical infrastructure as well as comments on the projected electrical loads in the short and long term. The report identifies the electrical infrastructure that will be required major substations from which the development will obtain its anticipated ultimate load requirements.

2. TERMS OF REFERENCE

Tongaat Hulett Developments (THD) and Dube Trade Port (DTP) intend developing the area known as Ushukela which is located north of Durban. These developments will be a tradezone.

Bosch Projects (BP) have been appointed to compile a services report for the electrical infrastructure.

3. ELECTRICAL INFRASTRUCTURE (EXISTING)

The electrical infrastructure is divided into the following categories:

3.1 275kV Sub-Transmission Lines & Servitudes

No 275kV sub-transmission line servitude exists within the development area.

3.2 Sub-Transmission Major Substations (275/132 kV)

There are currently no 275/132kV substations that are located in the vicinity of the proposed development.

3.3 132kV Sub-Transmission Lines & Servitudes

An existing 132kV overhead line linking the new Tongaat substation to the La Mercy substation traverses through the proposed area of Ushukela development. There is a registered servitude for this overhead line.

3.4 Sub-Transmission Major Substations (132/11 kV)

The Tongaat 132/11kV Substation is newly built and commissioned. It is rated at 60MVA firm. This substation has been built to take over the load of three existing 33/11kV substations namely Truroland, Maidstone and old Tongaat as well as to cater for future load growth in close proximity to the substation for which eE have already received applications. The current available spare is 18 MVA, which can be used to supply the initial phases of the Ushukela development. This spare capacity will be used on a first come first served basis for developments in close proximity to the substation.

3.5 Distribution (11kV)

There is electrical supply at 11kV available within the proposed Development however it cannot support the demand of the development.

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3.6 Reticulation

There is electrical supply at 400V available within the proposed Development however it cannot support the demand of the development.

3.7 Street Lighting

No street lighting currently exists within the boundaries of the developments.

4. PROPOSED DEVELOPMENT REQUIRMENTS

The preliminary planning criteria are based on information as provided by THD. In formulating the preliminary planning criteria BP have used good engineering practice and load factors as Per Annex B of NRS 069: 2004 which are approved by eThekwini Electricity. The system will be designed to cater for the failure of any single MV cable, i.e. electrical load can be transferred via switching in the event of a fault occurring.

The estimated electrical loads for the developments are as follows:

4.1 Ushukela Development

Project	Type	No. of Units / m²		Demand		LOAD (kVA)
Ushukela	Tradezone	431,843	m²	68	VA/m²	29,365

4.1.1 Diversity Factors

The following diversity factors are used:

- Distributor Substations - 87%
- Major Substations - 92%

Table 1

The results of this calculation based on the above are as follows: -

DEVELOPMENT	FUTURE CONNECTED LOAD	DIVERSIFIED LOAD @ DISTRIBUTOR SUBSTATION	DIVERSIFIED LOAD @ MAJOR SUBSTATION
Ushukela	29,37 MVA	25.55 MVA	23.50 MVA

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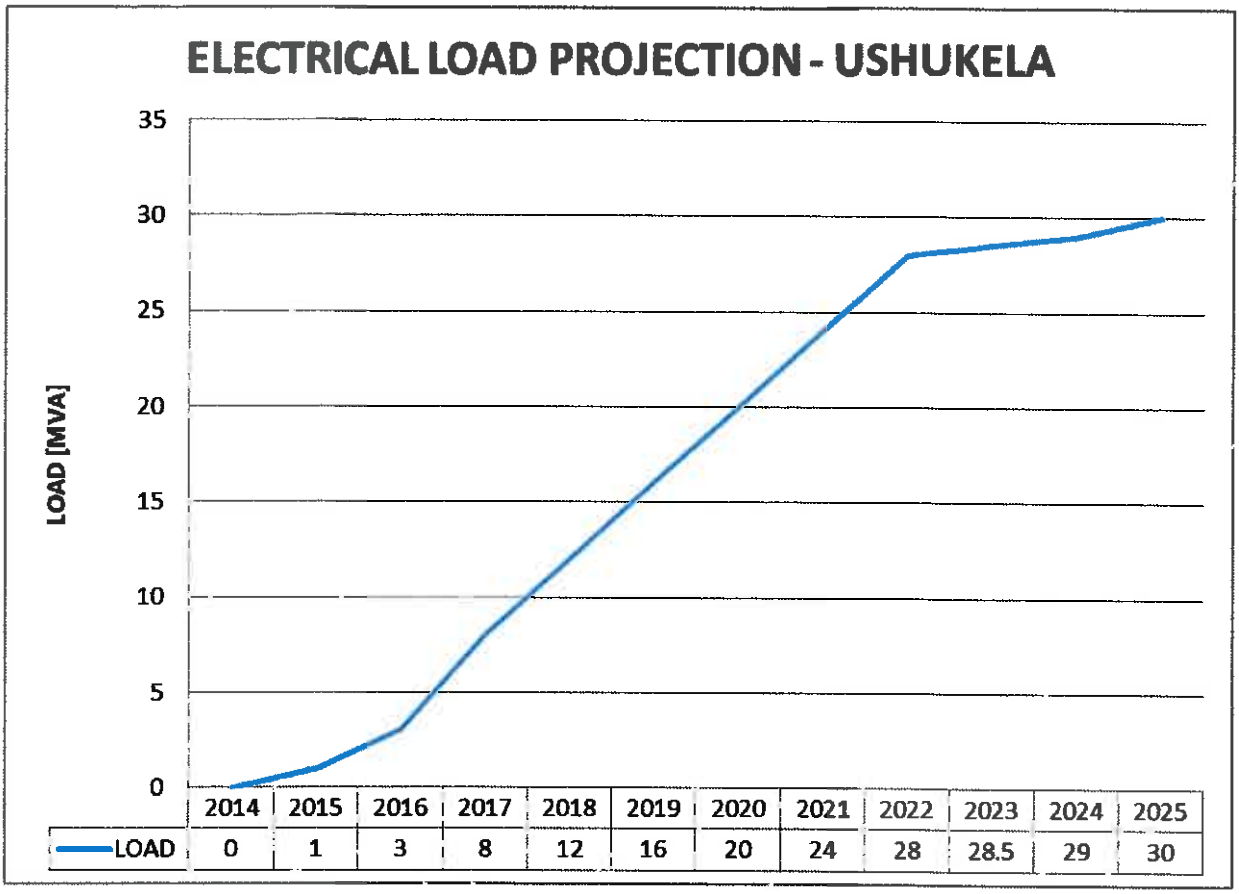

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
LOAD	0	1	3	8	12	16	20	24	28	28.5	29	30

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5. FUTURE ELECTRICAL INFRASTRUCTURE REQUIRMENTS

The proposed electrical infrastructure is covered under the headings below:

5.1 275kV Sub-Transmission Lines & Servitudes

No 275kV sub-transmission line servitudes will be required in the developmental area.

5.2 Sub-Transmission Major Substations (275/132 kV)

A new 3150MVA 275/132kV substation will be required and will be located in the vicinity of the adjacent Inyaninga development. An Environmental Impact Assessment will be required to confirm the position of the proposed substation which will be used to feed the new 132/11kV substations that will be required to be built for the development. One of the substations will be used to feed the Ushukela Development in the future.

5.3 132kV Sub-Transmission Lines & Servitudes

No 132kV sub-transmission lines and servitudes are required within the development boundary.

5.4 Sub-Transmission (132/11 kV)

The existing 132/11kV 60MVA Tongaat substation will be used to supply the initial phases of the Ushukela development. It will in time however, be essential to construct two new 132/11kV 60MVA firm substations within the adjacent Inyaninga Development. The sites will have to be selected in conjunction with eThekwini Electricity.

5.5 Distribution (11kV)

11kV supplies will be taken from the 132/11kV major substation and be fed into a series of Distribution Substations. Distribution substations are planned and positioned in key locations throughout the development. 11kV cable routes will be planned to run adjacent or be in close proximity to each proposed site allowing sales and transfers of sites to take place.

5.6 Reticulation

In most instances the internal electrical reticulation will be undertaken by each individual site owner to meet his specific requirements. THD will be responsible for the costs of the 11kV bulk supply to the boundary of these developments.

5.7 Street Lighting

Provision is made for both street lighting as well as public open space lighting. It is recommended that lighting form part of a separate report due to the aesthetic requirements of the urban architecture.

6. FINAL COMMENTS

As detailed information becomes available, co-ordination meetings with the Supply Authority shall take place to ensure that the development milestones are achieved.

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7. ACTION ITEMS

The following actions are required going forward.

- On receipt of Tongaat Hulett Developments appointment letter, Bosch Projects will undertake the preliminary design.
- On completion of the design, co-ordinate with Tongaat Hulett Developments as to the phased implementation of this project to meet sales objectives.

APPENDICES

- **Appendix A – Proposed Major Substations and Servitudes**
- **Appendix B – Load Factors**

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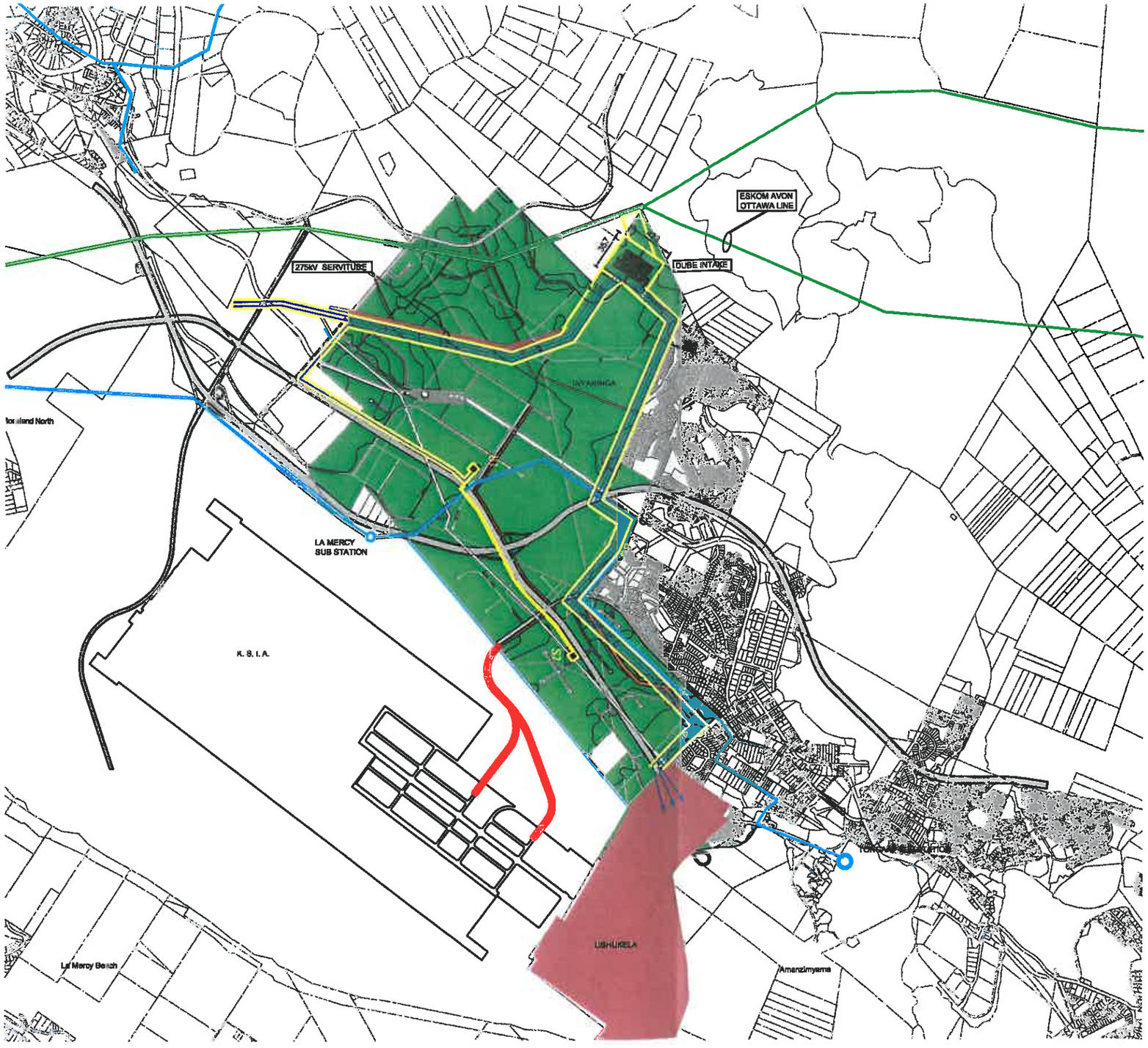
APPENDIX A
PROPOSED MAJOR SUBSTATIONS AND SERVITUDES



LEGEND

- PROPOSED NEW 132/11kV SUB-TRANSMISSION SUBSTATIONS
- EXISTING 132/11kV SUB-TRANSMISSION SUBSTATIONS
- EXISTING 132kV LINES
- ESKOM AVON OTTAWA LINE
- NEW SERVITUDE AQUISITION
- NEW 132kV OVERHEAD LINE

01	ISSUED FOR INFORMATION	20/11/12
1	FOR INTERNAL REVIEW	16/11/12

BOSCH STEMELE

Consulting Engineers • Project Managers

ISO 9001:2008 CERTIFIED

XX	S.L.
S.S.	N/A
N/A	N/A
S.S.	N/A
C.P.K.	C.P.K.

1:20000 | 13/11/12

APPENDIX B

LOAD FACTORS

Type	Income	Load Factor	Unit
Single Residential	High	8000	VA
Residential	High	7000	VA
Residential	Middle – High	6000	VA
Apartments	Middle-Middle-High	5500	VA
Residential	Middle-Middle-High	5500	VA
Residential	Middle	4000	VA
Residential	Low-Middle	3000	VA
Low Income - Med density	Low	2400	VA
Hotel Room		3000	VA

Commercial		72	VA/m²
Offices		72	VA/m²
Retail		72	VA/m²
Hotel		85	VA/m²
Commercial/Business Park		72	VA/m²
Industrial		68	VA/m²
Mixed Use		72	VA/m²
Industrial/Business Park		85	VA/m²
Business Park		68	VA/m²
Light Industrial		40	VA/m²

Trade Zone		68	VA/m²

Appendix 7: Specialist Planning Report

uShukela Highway Environmental Impact Assessment

Specialist Planning Report

The Planning Initiative

February 2013

dube tradePORT

SOUTHERN AFRICA'S PREMIER AIR LOGISTICS PLATFORM

Tongaat Hulett DEVELOPMENTS

The Planning Initiative

DOCUMENT CONTROL

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1 INTRODUCTION

1.1 PURPOSE OF THE REPORT

This report, prepared by The Planning Initiative, outlines the spatial planning assessment of the potential impact of the proposed uShukela Highway development, north of the Dube TradePort - King Shaka International Airport complex. The development proposed is a joint initiative between Tongaat Hulett Developments and the Dube TradePort who own portions of the land in question. The spatial planning assessment forms one component of the Environmental Impact Assessment which has been co-ordinated by Kerry Seppings Environmental Management Services (KSEMS). Other specialist studies include:

- Engineering services
- Traffic Impact Assessment
- Geotechnical Investigation
- Agricultural Impact Assessment
- Heritage Impact Assessment
- Socio Economic Impact Report
- Wetland Assessment
- Major Hazardous Installation
- Ecological Assessment

1.2 SCOPE OF THE ASSESSMENT

It was noted in the Environmental Scoping report prepared by KSEMS that a number of specialist reports are required to complete the EIR, one of which is a planning assessment:

> "7.2.10 Planning Assessment: The Planning Initiative has been commissioned to conduct a planning assessment of the development and determine if the proposal compliments existing and future plans for the area." KSEMS Draft Scoping Report, uShukela Highway Development, November 2010, EIA Number: 12/12/20/2013

Specific issues raised in Environmental Scoping report that would need to be addressed in the specialist planning report are:

- Synergy between the overall spatial development plans of the area and proposed development.
- Need and desirability of the development in relation to the overall demand for such land use, within the broader region.

1.3 OUTLINE OF THE REPORT

The spatial planning assessment report provides

- A summary of the methodology used in undertaking this assessment, together with the assumptions made during the assessment and the limitations of the process.
- A brief description of the proposed uShukela development. A full description of the project can found in the Environmental Impact Assessment Scoping report.
- A description of the spatial planning environment likely to be impacted on by the proposed development.
- A summary of relevant policies and legislation that should be taken into account in reaching a decision on this development.
- A summary of the plans that have been prepared for the area which provide the spatial planning framework for making an informed decision on the proposed development.

- An assessment of the issues raised in the scoping process.
- The report concludes with a summary of the assessment findings.

1.4 Methodology, Assumptions and Limitations of the Assessment Process

The spatial planning assessment has been based on a review of the relevant National and Provincial policy documents, legislation and local government spatial plans. These include:

- National Development Plan of the National Planning Commission (2011)
- The New Growth Path Framework for South Africa launched on 23 November 2010
- The Provincial Growth and Development Strategy (2011)
- eThekwini Integrated Development Plan and Spatial Development Framework (2011)
- eThekwini Northern Spatial Development Plan (2011)
- Northern Urban Development Corridor (2011)

The relevant descriptions and analyses as well as the recommendations within these framework plans are detailed in the Spatial Planning Frameworks (Section 4) and Spatial Planning Impact Assessment (Section 5) sections of this report.

With respect to the analysis of the need for the development no primary research has been undertaken on need and the assessment has been based on the teams understanding of the development of land around an aerotropolis. Whilst the lack of primary research may be viewed as a limitation in our view the nature of the Dube TradePort development is such that the facilitation of the release of land in proximity to the TradePort is imperative to maximise the potential opportunities for economic development and use of infrastructure investment and thus primary research is not required.

2 Project Description

2.1 The Application Site

The application site is 135 ha in extent. It is bounded by the Dube TradePort to the South, uShukela Highway to the North and sugar cane to the East and West. Currently the site is largely being used for the cultivation of sugar cane. Existing development on site includes a large upmarket house owned by Tongaat Hulett Developments. Between the site and the Dube TradePort are a row of five houses which are privately owned known as the Herwood development.

The site has a rolling topography, with the Hlawe River bounding its Western edge. There are minor wetlands on the site. The site is accessed off of the uShukela Highway, and will also have access via the Dube TradePort site in the future.

Figure 1: Locality Plan

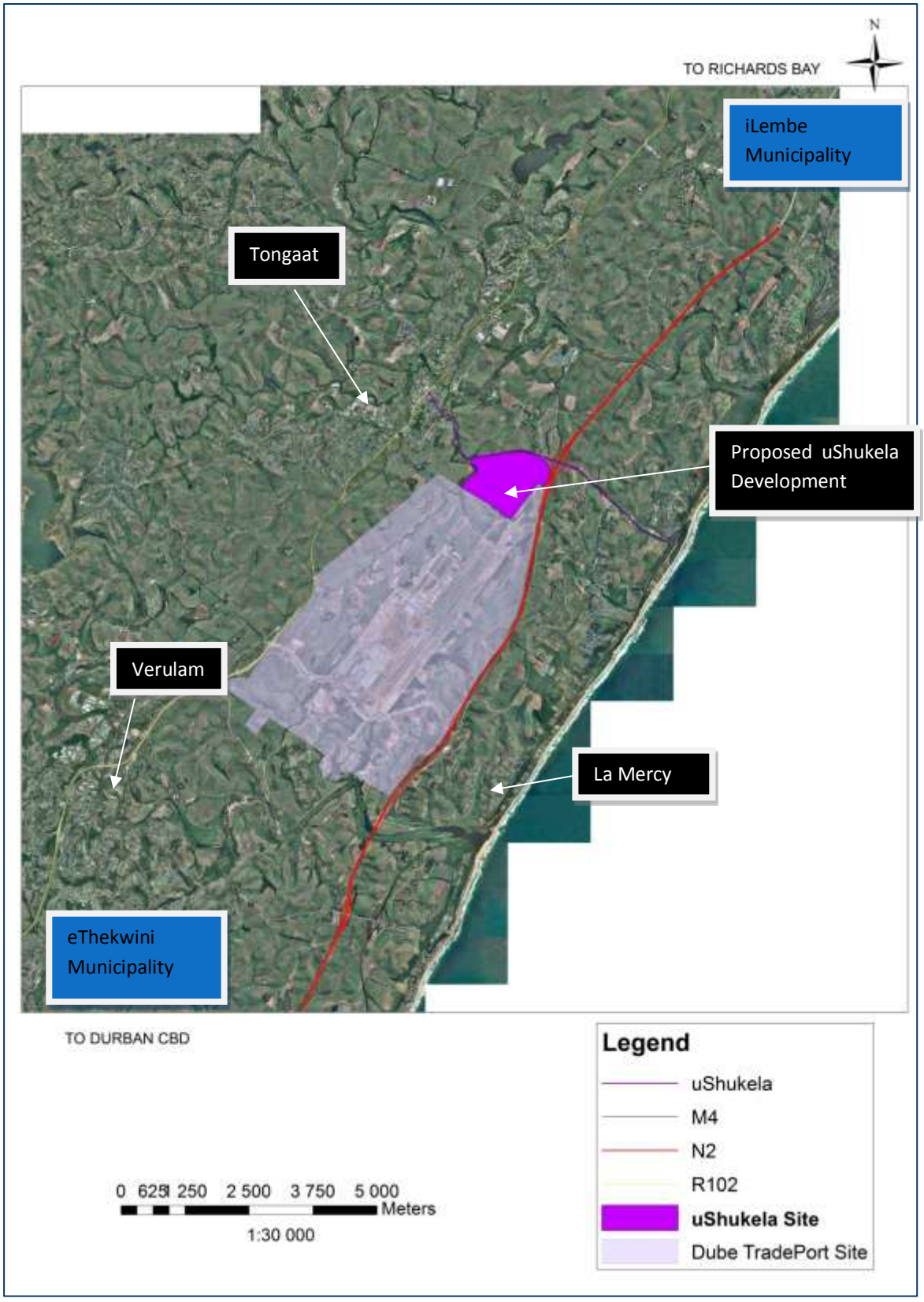


Figure 2: Zoom In On existing Development on Site

2.2 HISTORY OF THE SITE

The site is located directly adjacent to the northern boundary of King Shaka International Airport and the Dube TradePort (40 km north of the Durban CBD). The site was originally entirely owned by Tongaat Hulett (TH), however, in 2009, Dube TradePort (DTP) entered into negotiations with Tongaat Hulett to purchase a portion of the site (Figure 3). The sale of this portion was effected early in 2010. The proposal covers both the land owned by Tongaat Hulett and Dube TradePort (Figure 4).

It is noted that the site has been used for the cultivation of sugar cane and an application for the sub-divisions and change of use of agricultural land in terms of the Subdivision of Agricultural Land Act, Act No. 70 of 1970 was submitted by Tongaat Hulett for this portion of land. The application was granted on 03 March 2011 per Consent No. 45766 issued in terms of Section 4 of the Subdivision of Agricultural Land Act, Act No. 70 of 1970.

Figure 3: Portion of Site purchased by Dube TradePort from Tongaat Hulett Developments

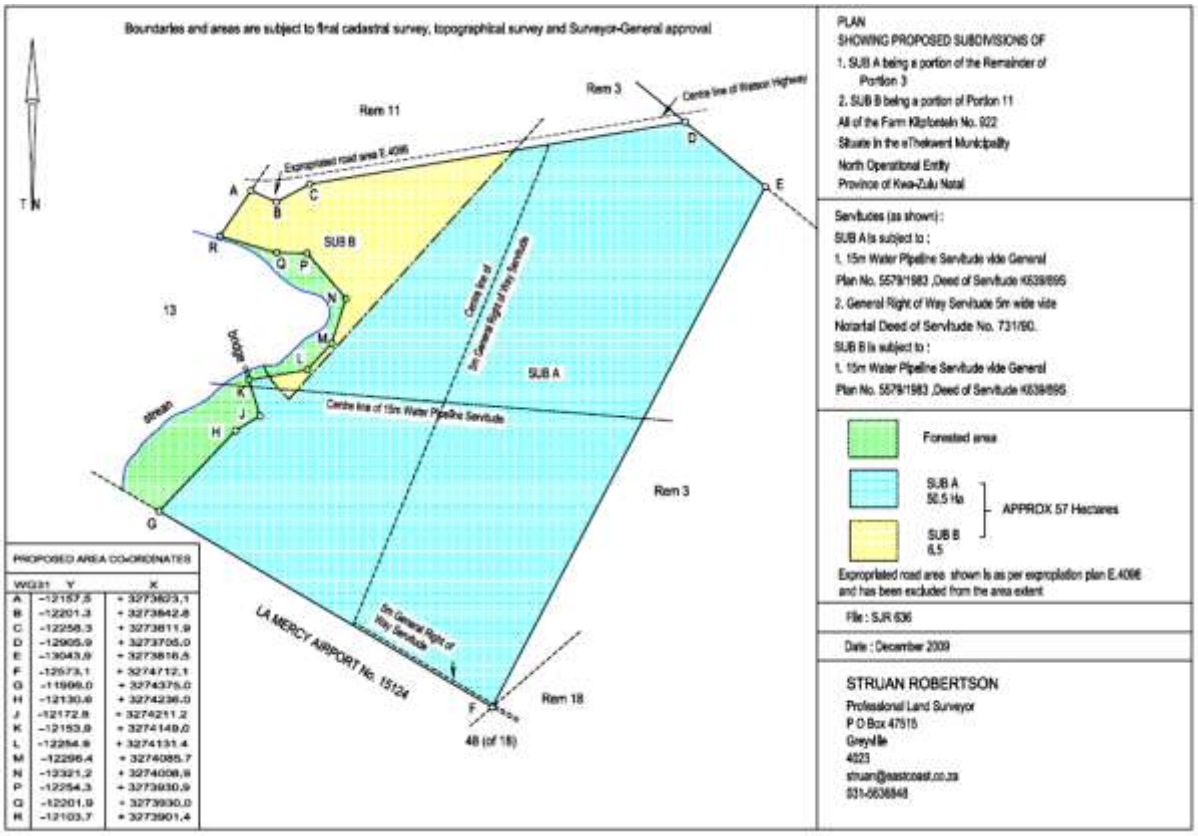
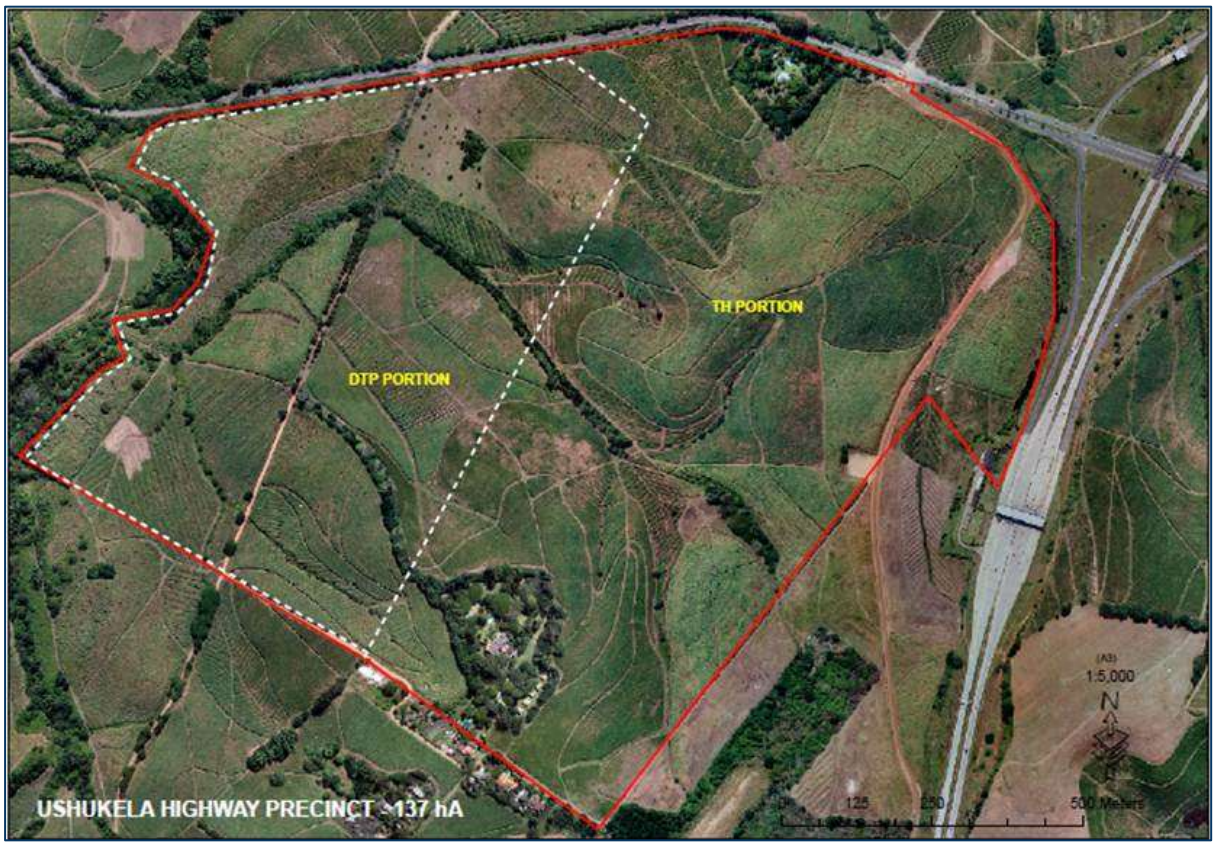


Figure 4: uShukela Ownership



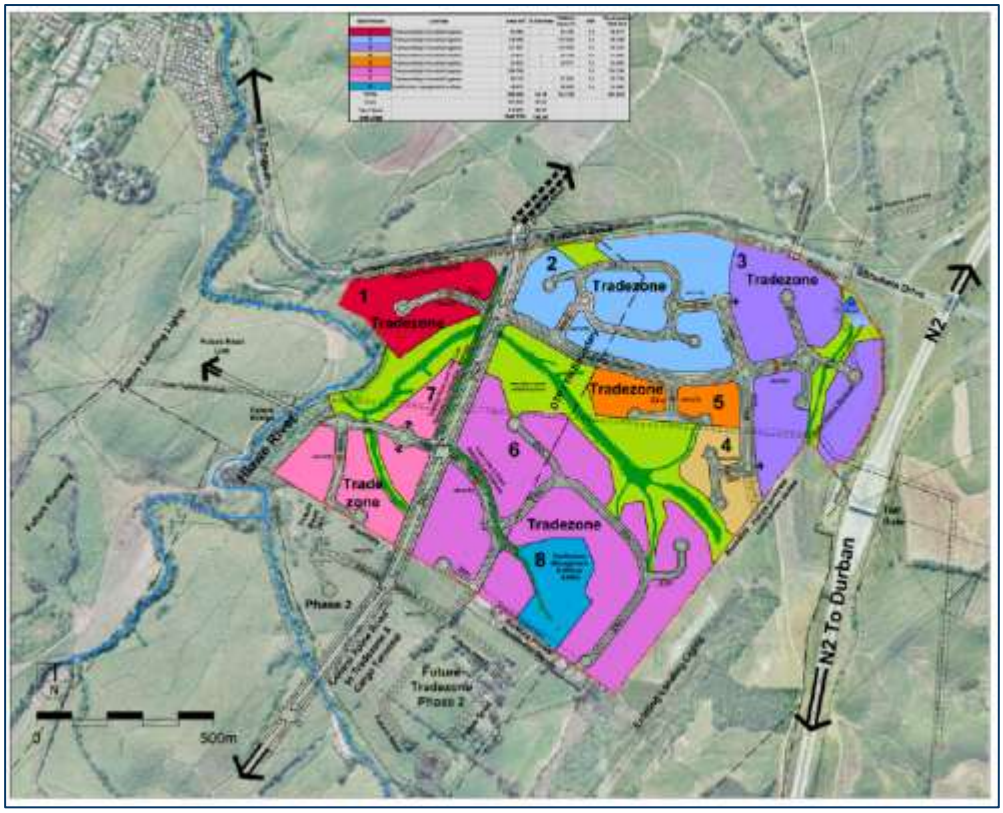
2.3 PLANNING SCHEME

This site falls outside the Municipal Scheme area. Schemes in the vicinity of the site were: Tongaat, Umhlanga Scheme No. 1 and Verulam. The Municipality has recently advertised and approved a consolidated Scheme to replace these Schemes, known as the North Scheme of the eThekwini Municipality.

2.4 PROJECT PROPOSAL

The proposal (Figure 5) is to develop a high-end, mixed-use development on the application site. This will effectively be a natural extension of the TradeZone on the Dube TradePort site which forms the hub of the proposed Aerotropolis region (Figure 6).

Figure 5: Project Proposal



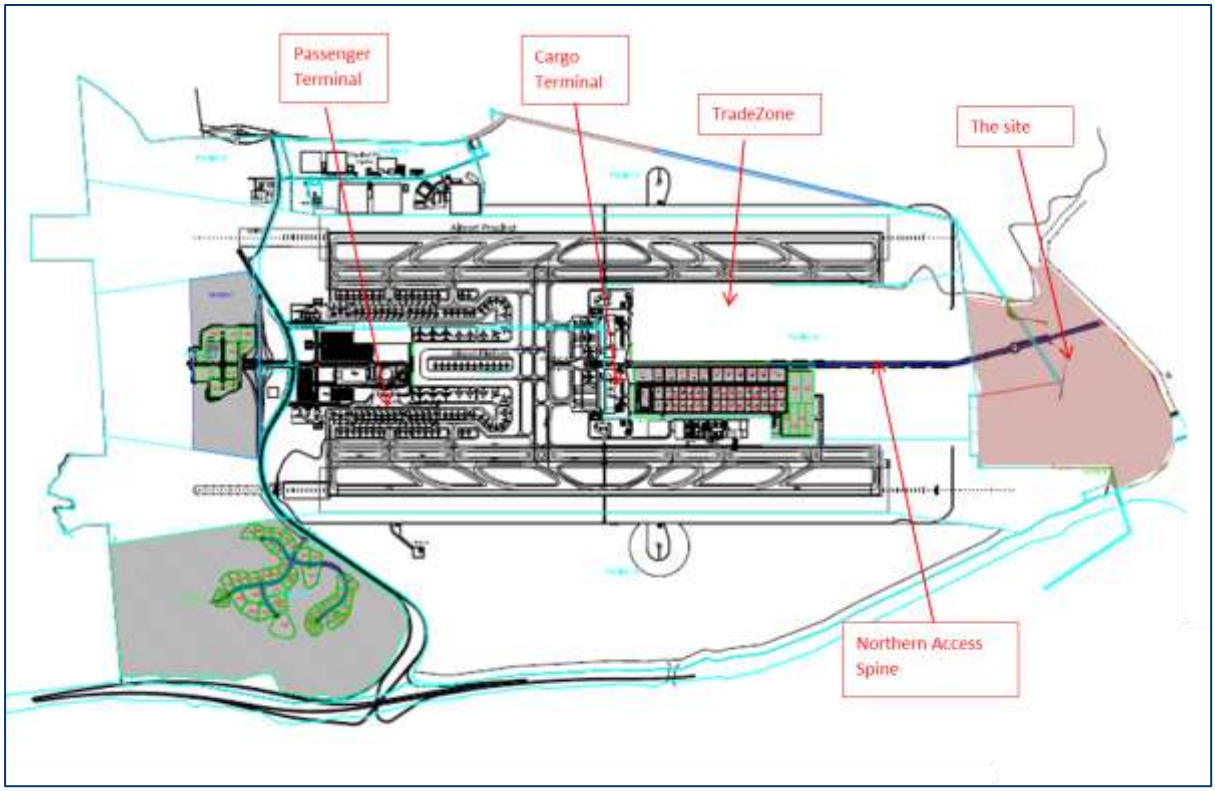
The proposed land uses are as follows:

Table 1: Proposed Land Uses

Sub Precinct	Proposed Land Use
1	Tradezone/ Light Industrial/ Logistics
2	Tradezone/ Light Industrial/ Logistics
3	Tradezone/ Light Industrial/ Logistics
4	Tradezone/ Light Industrial/ Logistics
5	Tradezone/ Light Industrial/ Logistics
6	Tradezone/ Light Industrial/ Logistics
7	Tradezone/ Light Industrial/ Logistics
8	Conference, management and offices
Roads	**26.38 ha**
Open Space	**21.95 ha**
Approximate Total Area (ha)	**134.78 ha**
Approximate Total Bulk (ha)	**43.84 ha**

All bulk services to the site are in place, or will be put in place by the developer. This includes roads, water, waste water and electricity infrastructure. (Refer to specialist infrastructure report for further details).

Figure 6: Proposed Development as a Natural Extension of the TradePort as the Hub of the Aerotropolis Development



2.5 Description of Affected Environment

For the purposes of assessing the planning impact of the application, the affected environment has been split into four spatial areas:

- The eThekwini Metropolitan area and wider region
- The Ilembe District north of the site
- The site itself and its immediate surrounds.

Table 2 summarises comparative statistics of the size and population for these areas.

Table 2: Summary of Relative Population and Size of Planning Areas

Spatial Area	Size	Approximate Population
Metropolitan Area	231,127 ha 100%	3,000,000 people 100%
Northern Spatial Area	60,093 ha 26% of Metro	890,380 people 30% of Metro
Dube TradePort Site	2,040 ha 0,9% of Metro and 3% of Northern area	0
Ilembe District	326,900 ha	560,000 people
Development Site	135 ha 0.06% of metro 0.22% of northern area	0

2.5.1 The eThekwini Metropolitan Area and Wider Sub-region

The site is located within the northern portion of eThekwini Municipality, approximately 40 kilometres to the north of the CBD. As shown in Figure 1 previously, the site is in close proximity to Verulam and Tongaat, and is within a short driving distance to Umhlanga.

eThekwini is the major metropolitan area in the Province of KwaZulu-Natal and the third largest City in South Africa. Schematically, the City of Durban has historically developed outwards from the port and the CBD along the three main axes i.e. westwards, northwards and southwards. This growth initially occurred in a westerly direction along the Old Main Roads and railway, followed by growth along the N3 and N2 moving towards the north and south. Industrial development has previously been associated with the Port and the Southern Industrial Basin. Middle and upper income housing developed along the axes whilst lower income residential development filled in the sectors both north and south of the city. An imbalance developed where a large number of people lived to the north of the city and had to commute to the Southern Industrial Basin for employment, increasing daily travel times and costs.

More recently high income residential development has moved both westwards and northwards and various reports have highlighted that the north coast area has the fastest growing real-estate industry in South Africa with the KwaDukuza Municipality being one of the fastest growing, in terms of development applications, in the country. The Umhlanga New Town Centre, Gateway, La Lucia Ridge area has also seen significant growth since the late 1990's thus the City has experienced a shift in growth from the western axis to the northern axis. Development has largely followed the Coastline with the focus of commercial development being around Umhlanga and then leapfrogging to Ballito. This growth trend will be reinforced by the development of the Dube TradePort.

Regionally the site is located on the N2, the major north-south axis in the Province and within the corridor between the two largest Ports in South Africa being Durban and Richards Bay. It is located directly adjacent to King Shaka International Airport and Dube TradePort, which will entrench this corridor as a major development corridor within the Province and the country.

The development of the King Shaka International Airport and the Dube TradePort will attract industrial, commercial, office and residential development. It will thus have a significant impact on the future spatial structure of the City, entrenching the development thrust to the north.

2.5.2 iLembe District

The site is located south of, but in close proximity to, the Ilembe District Municipality, with the major towns of Ballito and Stanger having easy access to the site. It offers some opportunity for the iLembe District from an employment point of view.

The Ilembe District is the smallest of the ten District Councils of KwaZulu-Natal with a population estimated at 560 000 people (2001 census), and an area of 3,269 km^2. The Municipal area encompasses four local municipal council areas, namely Mandeni, Ndwedwe, Maphumulo and KwaDukuza. The urban development in the area has tended to focus on the coastline, with a significant hinterland under sugar cane production, as well as a large rural hinterland characterised by dispersed traditional settlement. The potential to capitalise on targeted spill over from the major initiatives planned for Durban viz. the Dube TradePort has been identified as one of the more significant competitive advantages of the District in the latest review of the IDP for the Municipality, and is further highlighted as a key Local Economic Development driver (Ilembe IDP Review, 2011). Opportunities for agricultural, agri-processing, industrial, tourism and residential developments have been recognised.

The Municipality of Ndwedwe with a population of some 152 000 (2001 census quoted in Ilembe IDP Review 2011) lies to the west of the application site. This Municipality comprises extensive areas of rural settlement and has been identified as one of the poorest, un-serviced and most under-capacitated Municipalities in the country, with an extremely high unemployment rate (Ilembe IDP Review, 2011). With appropriate linkages along the P25, P100 and identification of land for housing, industrial and agricultural opportunities the development application as an extension of the TradePort has the potential to have a significant positive impact on the economy of the Municipality and overall levels of poverty.

2.5.3 The site Itself and its Immediate Surrounds

The site itself is located directly adjacent to the northern boundary of King Shaka International Airport and Dube Tradeport. It is currently accessed from uShukela Highway, which joins the M4, N2 and R102. Being in close proximity to major roads, the site is thus well linked by road to the Durban Port, as well as the Richards Bay Port. In future a link road will be constructed between the site and the TradeZone on the Dube TradePort site giving the area direct access to the Passenger and Cargo terminals of the King Shaka International Airport.

Tongaat is located to the west of the site, along uShukela Highway. Verulam and La Mercy are also in close proximity to the site.

3 SPATIAL PLANNING LEGISLATION

3.1 INTRODUCTION

This section summarises the various pieces of spatial planning legislation that will have to be complied with or taken into account in approving this application.

3.2 LEGISLATION DIRECTLY RELATED TO THE PROPOSAL

3.2.1 KWAZULU-NATAL PLANNING AND DEVELOPMENT ACT, ACT NO. 6 OF 2008

The primary piece of legislation from a spatial planning perspective is the KwaZulu-Natal Planning and Development Act, Act No. 6 of 2008 (PDA). This Act encompasses all spatial planning related processes and procedures and replaces all previous spatial planning related legislation (i.e. Natal Town Planning Ordinance, Ordinance No. 27 of 1949 as amended).

The PDA spells out the application procedure requirements and timelines for all aspects of planning applications. These timelines and requirements have to be stringently followed by both the applicant and local government.

The application site currently falls outside of any Scheme area and a Scheme will need to be extended over the area in terms of Chapter 2 of the PDA which deals with the processes involved with the preparation of Schemes.

The land will also require sub-division in terms of Chapter 3 of the PDA which provides for the subdivision and consolidation of land.

3.2.2 DEVELOPMENT AND FACILITATION ACT, ACT NO. 67 OF 2005

In terms of Section 12 (l), the Planning and Development Act, Act No 6 of 2008 requires that the general principles of land development as stated in Section 3 of the Development Facilitation Act, Act No. 67 of 1995 (DFA) be considered in an application. Section 3 of the DFA requires that the following principles be applied to all land development:

a) Policy, administrative practice and laws should provide for urban and rural land development and should facilitate the development of formal and informal, existing and new settlements.
b) Section 3 (c) then highlights the following:
   Policy, administrative practice and laws should promote efficient and integrated land development in that they-
   (i) promote the integration of the social, economic, institutional and physical aspects of land development;
   (ii) promote integrated land development in rural and urban areas in support of each other;
   (iii) promote the availability of residential and employment opportunities in close proximity to or integrated with each other;
   (iv) optimise the use of existing resources including such resources relating to agriculture, land, minerals, bulk infrastructure, roads, transportation and social facilities;
   (v) promote a diverse combination of land uses, also at the level of individual erven or subdivisions of land;

> (vi) discourage the phenomenon of "urban sprawl" in urban areas and contribute to the development of more compact towns and cities;
> (vii) contribute to the correction of the historically distorted spatial patterns of settlement in the Republic and to the optimum use of existing infrastructure in excess of current needs; and
> (viii) encourage environmentally sustainable land development practices and processes."

Furthermore, section 3 j states:

> "Each proposed land development area should be judged on its own merits and no particular use of land, such as residential, commercial, conservational, industrial, community facility, mining, agricultural or public use, should in advance or in general be regarded as being less important or desirable than any other use of land."

3.2.3 Local Government Municipal Systems Act, Act No. 32 of 2000 and Municipal System Act Regulations 2001 (Department of Provincial and Local Government)

The Act and Regulations have the following requirements that form the overarching decision making guide for the development application within the Province:

- Chapter 5 sets out the requirements for the Integrated Development Planning including the preparation of a Municipal Integrated Development Plan.
- Section 23 of Chapter 5 requires that Integrated Development Planning be developmentally orientated.
- Section 24 of Chapter 5 stipulates that the IDP must be aligned with and complement the plans of adjoining municipalities and other organs of state so as to give effect to the principles of co-operative governance.
- Section 26 (e) of the Municipal Systems Act (MSA) and the Regulations attached to the Act stipulate that the IDP must contain a Spatial Development Framework (SDF) that includes the basic guidelines for a Land Use Management System (LUMS) for the municipality.

In terms of this legislation the eThekwini Municipality has prepared an Integrated Development Plan (2011-2016) and a Spatial Development Framework. The application must comply with the policies set out in these documents.

3.3 Other legislation that is applicable to the development application

3.3.1 National Land Transport Transition Act, Act No. 22 of 2000:

Department of Transport National Land Transport Principles and Policy: Sect. 18 (f) requires the Integration of Transport and Land Use Planning in terms of Development Facilitation Act, Act No. 67 of 1995 or similar Provincial law and Sect. 29 (2) states that all persons are bound by the plans required in terms of the Act and no change in land use will be allowed without the written consent of the Transport Planning Authority. In this case the relevant Transport Authority is the eThekwini Transport Authority (ETA). The development of the site will therefore require approval from the ETA.

3.3.2 KwaZulu-Natal Provincial Roads Act, Act No. 4 of 2001 (Provincial Road Transportation Act 1994 as amended 1997):

The KwaZulu-Natal Department of Transport Approval is required for any change of Land Use adjacent to a Provincial Road or within 500m of the intersection of a Provincial Road. The R102 to the west of the application site is a provincial road thus DOT approval for the development of the site will be required.

3.3.3 Restitution of Land Rights Act, Act No. 22 of 1994:

No Land Claims have been registered on the site.

3.3.4 Subdivision of Agricultural Land Act, 1970 (Act No. 70 of 1970)

An application for the sub-divisions and change of use of agricultural land in terms of the Subdivision of Agricultural Land Act, No. 70 of 1970 was submitted by Tongaat Hulett for this portion of land. This was granted on 3 March 2011 (consent number 45766 issued in terms of Section 4 of the Act).

3.3.5 Regulations linked to the National Environmental Management Act, 1998 (Act No. 107 of 1998)

These are covered in detail in the scoping report.

4 Spatial Planning Frameworks

Development is required to align with the various spatial planning frameworks prepared for National, Provincial and Local Government. This section summarises the relevant frameworks that will need to be taken into account in assessing this application.

4.1 National Framework

4.1.1 National Development Plan: Vision 2030 (2011)

The National Development Plan, launched in November 2011 provides an overarching framework for the development of South Africa over the next 20 years. It highlights the issues facing the country (unemployment, education, crime, spatial inequalities etc.). These are all dealt with through various plans as put forth in the document.

The National Development Plan notes that over the next two decades, the world will completely change. Economies will become more diverse, and will also become more interconnected. It also notes that "air transport, container traffic and logistical chains have diminished distance" (National Development Plan 2011: 50).

The following key elements of the National Development Plan relate to this proposal:

- The transport sector is key to driving the change of the country. An improved sector will lead to access to economic opportunities, social spaces and services. The logistics sector is seen as an important part of this (National Development Plan 2011: 161).
- The economy needs to grow as fast as is possible. Reference to the strategies in the New Growth Path Framework (2011) is made (see below). Furthermore, the importance of reducing costs in transportation, manufacturing etc. will assist in the growing of the economy. Sustainable employment, labour absorbing industries and strengthening the exporting and competitiveness of the country are some of the key elements noted under this theme (National Development Plan 2011: 93).

- The theme on "Positioning South Africa in the global economy" (National Development Plan 2011: 215) emphasises the importance of globalisation, an integrated economy, the interrelationships of the economy and trade with other countries and ensuring that infrastructure facilitates this.
- The theme on "Transforming Human Settlements" notes the importance of co-operation and integration between municipalities in terms of their spatial planning. Transportation systems and an understanding of economic principles are seen as some of the key issues facing urban settlements (National Development Plan 2011: 245). This section stresses the importance of the following spatial principles which should guide the spatial planning of the country:
    - Spatial Justice
    - Spatial Sustainability
    - Spatial Resilience
    - Spatial Quality
    - Spatial Efficiency

As an extension of the Dube TradePort which seeks to promote growth of business and job creation though proximity to the new international airport with state of the art Cargo facilities for import and export, the development proposal being assessed is fully in line with the National Development Plan.

4.1.2 The New Growth Path Framework for South Africa launched on 23 November 2010

The New Growth Path Framework for South Africa places an emphasis on economic growth and development, through job creation. One of the key aspects of this is through "Systemic changes to mobilise domestic investment around activities that can create sustainable employment" (The New Growth Path Framework for South Africa: 1).

South Africa has for the majority of the last decade experienced "relatively strong economic growth" (The New Growth Path Framework for South Africa: 2). However, this growth has not always trickled down to the poorer communities, as job creation has not been of a standard to break the inequalities of the past. Thus, the New Growth Path Framework has taken the position that in order to resolve this issue, South Africa needs to promote job creation both in the short, as well as medium and long term. Various options ranging from employment schemes (short term), promoting light manufacturing and servicing (medium term) to supporting knowledge and capital intensive sectors (long term).

The proposed development which is the subject of this assessment promotes job creation (i.e. light industry, businesses, service type development in the form of hotels etc.) and is thus in line with the New Growth Path Framework for South Africa.

4.2 Provincial Framework

4.2.1 The Provincial Growth and Development Strategy (2011)

The Kwazulu-Natal Provincial Growth and Development Strategy (2011) has recently been released.

According to the document, the vision for the KwaZulu Natal (pg. 69) is as follows:

"By 2030, the Province Of Kwazulu-Natal should have maximized its position as a gateway to South and Southern Africa, as well as its human and natural resources so creating a safe, healthy and sustainable living environment. Abject poverty, inequality, unemployment and current disease burden should be history, basic services must have reached all its people, domestic and foreign investors are attracted by world class infrastructure and a skilled labour force. The people shall have options on where and how they opt to live, work

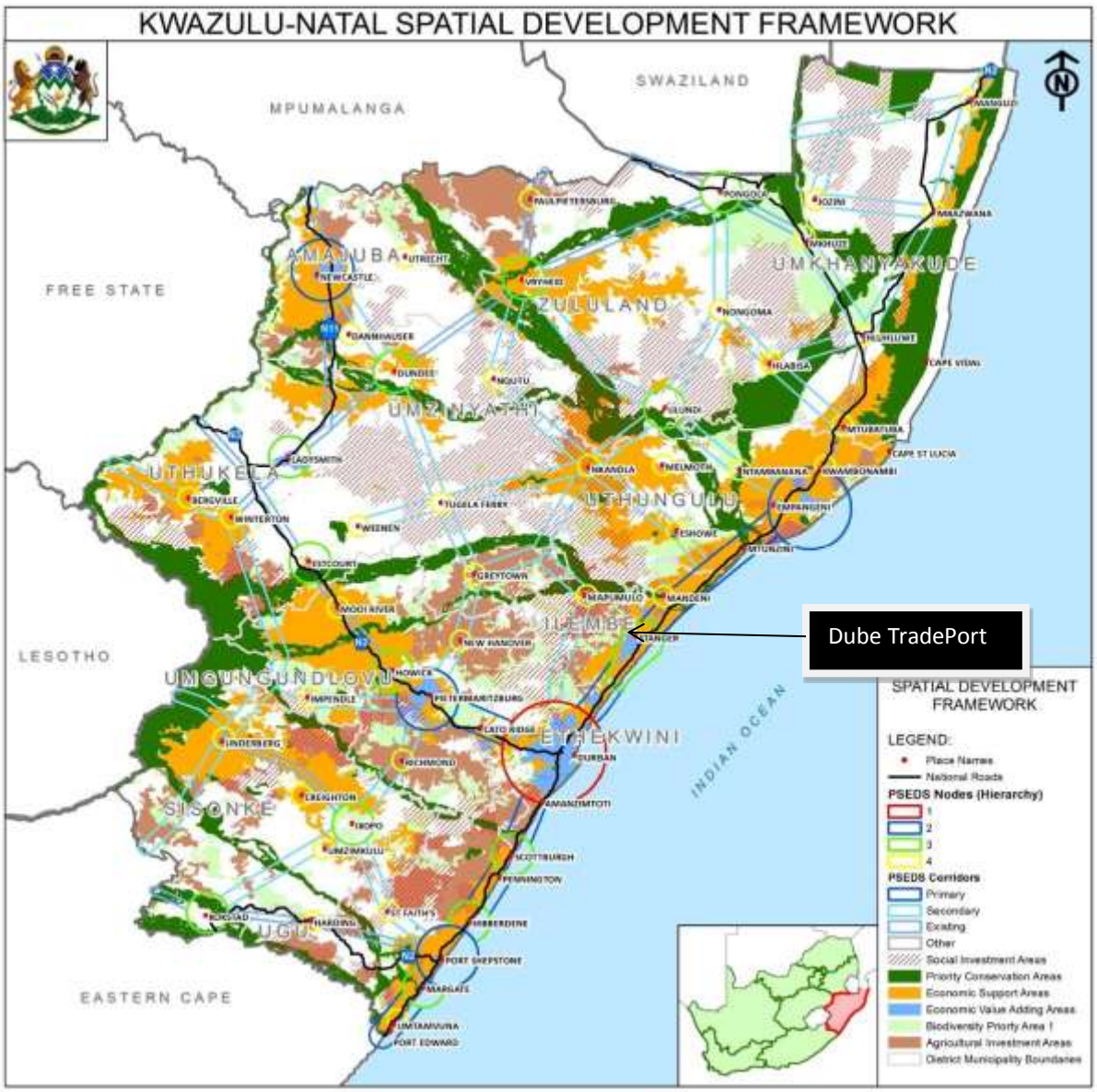
and play, where the principle of putting people first and where leadership, partnership and prosperity in action has become a normal way of life."

Dube TradePort is consistently referenced in the document as being a key driver in the economic growth of the province. Strategic Objective 1.2 focuses on enhancing industrial development through trade, investment and exports. This proposed development is directly in line and helps fulfil with this strategy. The importance of Dube TradePort is further noted in Strategic Objective 3.7.1 which specifically highlights the importance of logistics and transportation in stimulating growth. Under this section, the importance of Dube TradePort as an intervention (economic driver) which needs to be optimised, is stressed. Essentially this proposal is an extension of the TradeZone component of Dube TradePort and thus assists in fulfilling the role of logistics and related land uses as highlighted in the PGDS. The resultant land uses as envisaged in this proposal will further lead towards job creation and have the potential to attract investors, both local and foreign, to the region. Strategic Objective 4.2 in the PGDS prioritises sustainable development as key to the growth of the Province. Development, as noted in the Strategic Objective, needs to be not only environmentally sustainable, but provide economic benefits, and follow the principle of spatial concentration (in other words, promoting densification along corridors and around nodes). As a consolidation of the DTP development this proposal is thus also in line with Strategic Objective 4.2

The Provincial Growth and Development Strategy, also contains the Provincial Spatial Development Framework (PGDS 2011: 134). This framework provides an overarching spatial plan for the Province. The vision for this plan is: *"Optimal and responsible utilisation of human and environmental resources, building on addressing need and maximising opportunities toward greater spatial equity and sustainability in development"* (PGDS 2011: 135).

Within the Spatial Development Framework, Dube TradePort and its surrounds are described as an Economic Value Adding Area (see Figure 7). These are defined as: "The key economic centres and areas where all of the varieties of economic sectors (Agriculture, Tourism, Manufacturing, and Services) are prevalent and perceived to have good potential to be further expanded on. These areas are visibly linked to high accessibility areas with existing bulk infrastructure and relatively high population densities which would both contribute to the economic expansion and benefit from interventions in these areas. Due to these factors, further economic processing and value adding at a provincial level, are mainly proposed within these identified areas" (PGDS 2011: 149).

Figure 7: Kwazulu-Natal Spatial Development Framework 2011



Source: KwaZulu Natal Provincial Growth and Development Strategy Presentation 2011

4.3 Local Government Framework

4.3.1 eThekwini Integrated Development Plan and Spatial Development Framework (2011)

The long term vision of eThekwini Municipality is "By 2020, eThekwini Municipality will enjoy the reputation of being Africa's most caring and liveable City, where all citizens live in harmony" (eThekwini IDP, 2011:37). In order to achieve this vision, the following basic elements are required:

1. Ease of movement in the Municipality;
2. A safe environment in all parts of the municipal area;
3. Access to economic opportunities;
4. Resources to afford what the Municipality offers;
5. A clean and green Municipality, capable of delivering a range of ecosystem goods and services;

6. Homely neighbourhoods;
7. Access to services, in particular municipal, health and education services.

In order to deliver on the vision for the Municipality, eThekwini has developed an 8 point plan, which consists of the following: (eThekwini IDP, 2011:46)

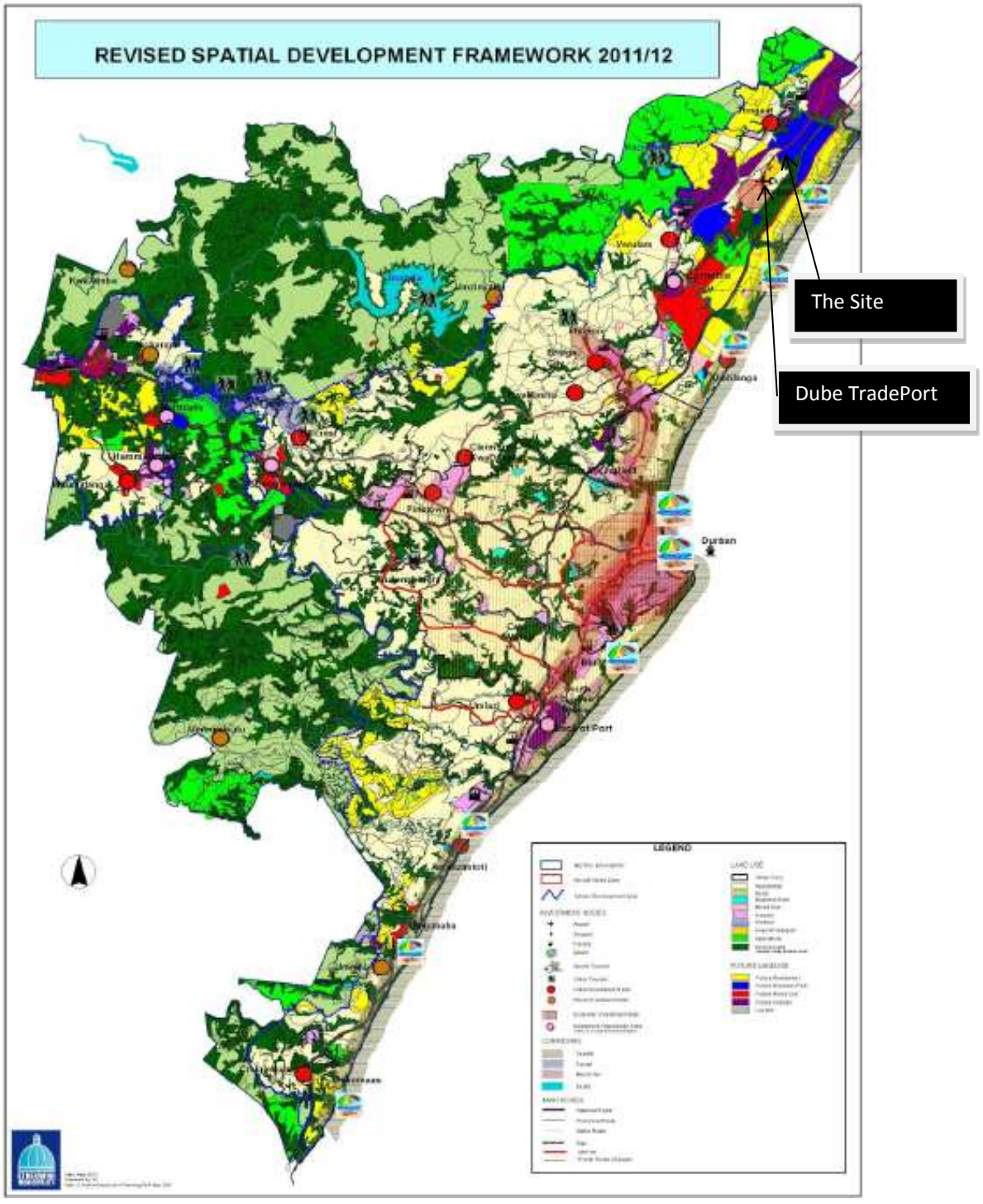
1. Develop and Sustain our Spatial, Natural and Built Environment.
2. Developing a Prosperous, Diverse Economy and Employment Creation.
3. Creating a Quality Living Environment.
4. Fostering a Socially Equitable Environment.
5. Creating a Platform for Growth, Empowerment and Skills Development
6. Embracing our cultural diversity, arts and heritage.
7. Good Governance and Responsive Local Government.
8. Financially Accountable and Sustainable City.'

Dube TradePort features strongly in the Spatial Development Framework for eThekwini and is identified as one of the key spatial drivers that will determine the direction and response in economic investment in the City (eThekwini IDP, 2011:53).

The eThekwini Spatial Development Framework includes the following elements:

- Densification and supporting thresholds for a range of services, industry and public transport around the Urban Core.
- The Urban Development Line (UDL) concept used not only to demarcate the extent to which urban development will be permitted to establish within the metropolitan area in the long term, but more specifically to promote a more convenient, compact, efficient, equitable and sustainable settlement form.
- Some of the relevant features of the SDF are:
    - Identification of future land uses including areas for industrial expansion, mixed use development and residential infill. Future residential development outside the UDL supports different lifestyles, densities and has different servicing needs and constraints as opposed to those within the UDL which are higher density and urban in nature
    - The Port of Durban, **Dube Trade Port** and Cato Ridge as **economic investment** areas which require major investment.
    - The provision of investment opportunity areas within Hammarsdale, Bartletts, Shongweni and Cornubia as a way of encouraging private investment and partnerships within the city subject to servicing and phasing limitations.
- Smaller urban investment nodes which provide convenient and efficient access to a hierarchy of commercial, community and social facilities. These nodes have number of characteristics and may include higher residential densities, mixed use, public transport and pedestrianisation, public amenities and good infrastructure.
- Support for a high priority public transport network by improving their viability with densification along routes either within the urban core or distinct investment corridors.
- Emphasis on accessibility and convenience in more densely populated urban areas including the provision of priority route and rail linkages.
- The promotion and preservation of upper catchment open space areas that provide free services and supports the health of the entire metropolitan area.
- The promotion of Coastal, Mixed Use and Tourism corridors that provide diverse opportunities for development and lifestyle whilst protecting against the risks of sea level rise (eThekwini IDP, 2011:38-39).

Figure 8: eThekwini Revised Spatial Development Framework 2011



Source: eThekwini IDP (2011)

To summarise, some of the spatial framework's defining features include:

- A compact city model
- Emphasis on accessibility and convenience in more densely populated urban areas.

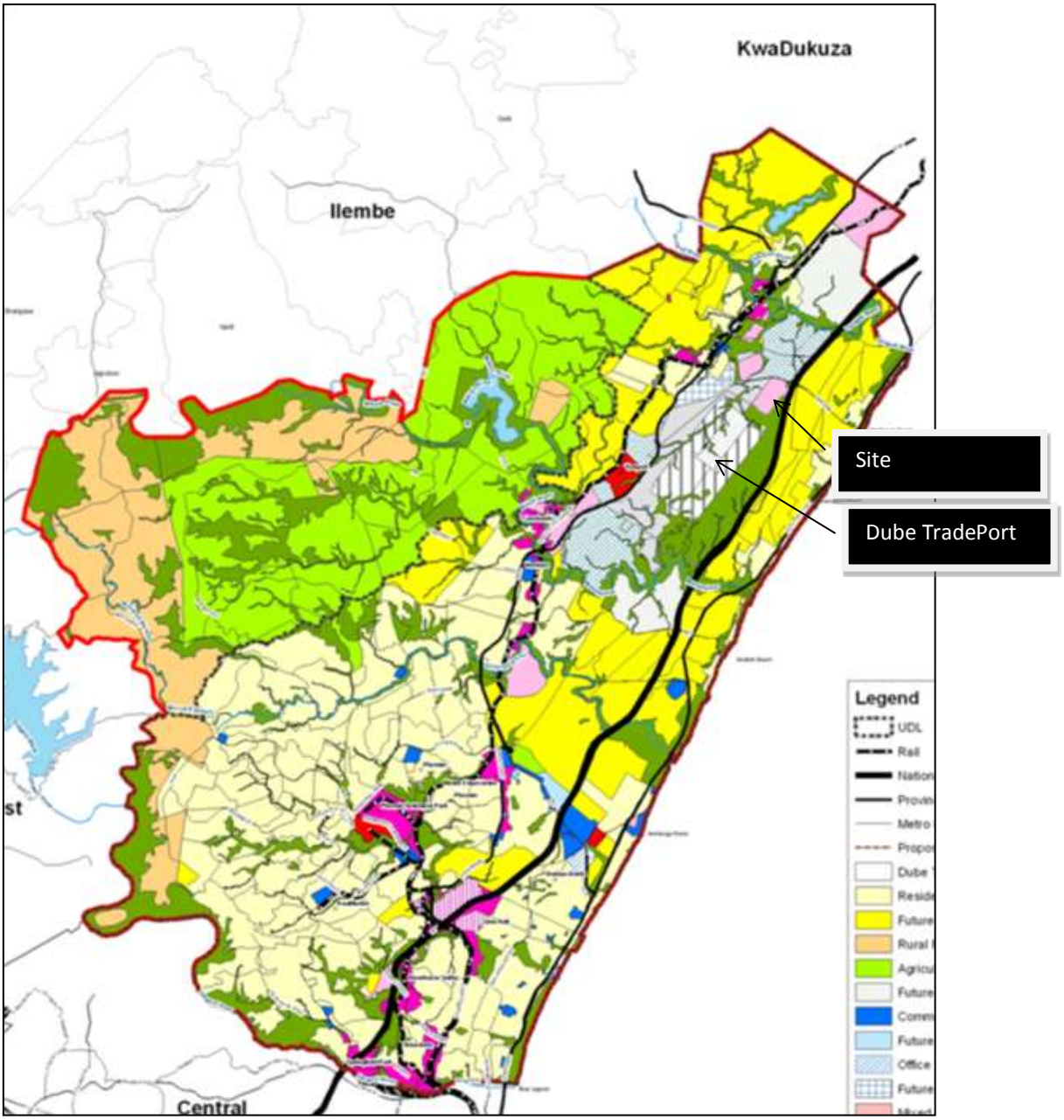
- Durban Central Business District (CBD) and South Durban Basin (SDB) play dominant roles in terms of jobs and rates
- Dube TradePort and the northern area plays a significant role as economic investment areas which require major investment.
- Small satellite centres play support roles
- Support for a high priority public transport network
- Infrastructure excess capacities utilised
- Upper catchment open space area continues to provide free services in support of the health of core urban area

The eThekwini IDP, as well as the SDF have identified the Dube TradePort area as a key driver of investment in the city. As such, as this proposal is a natural extension of the TradePort, it falls in line with the IDP.

4.3.2 eThekwini Northern Spatial Development Plan (2009)

Forming part of the eThekwini hierarchy of plans is the Northern Spatial Development Plan (NSDP). Within the NSDP, Dube TradePort and the Airport are highlighted as in the IDP as a driver of economic growth. Within the NSDP the proposed uShukela Highway development site is shown as Mixed Use (pink), thus the proposal is perfectly in line with the NSDP. The Development Corridor Map of the NSDP further strengthens this site's importance as indicating the site as a Future Industrial Opportunity Area.

Figure 9: Northern Spatial Development Plan (2009)



Source: eThekwini IDP (2011)

4.3.3 Northern Urban Development Corridor (2011)

The Northern Urban Development Corridor Report (NUDC) was prepared in response to the Northern Spatial Development Plan as a more detailed set of plans for much of the area. The emphasis of the plan is on strengthening the Development Corridor that is already emerging.

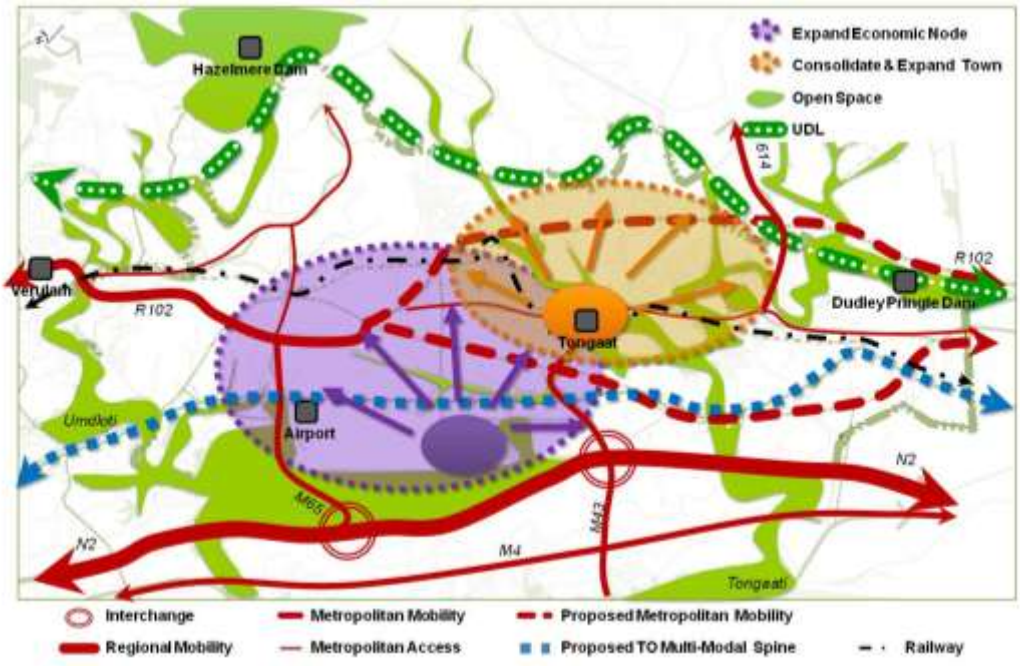
The NUDC has the following core principles (taken from: Draft Tongaat-DTP Local Area Plan v3.1(2011): 6):

- Any planning must align with the principles contained within the National SDP
- The northern expansion of Durban is supported

- Development of NUDC has national, provincial and local policy support
- Promotion of high density living environments
- Promotion of high quality and sustainable living environments
- Clustering of economic, social and transport facilities is required to maximize thresholds and to ensure the maximum and efficient use of resources
- Fully integrated multi-modal transport systems must be promoted through the integration of land use and transportation (e.g. densification)
- Increase in mixed use/multi-use spaces
- Basic needs of citizens in NUDC must be met
- The development of the corridor requires more than just physical investment and intervention and must focus on the development of people
- Development must not compromise environmental assets
- Integrated catchment management should govern development and infrastructure services planning
- Development of the corridor must not compromise high value/potential agricultural land Development in corridor is not to be "business as usual"
- Focused investment to ensure sustainable and maximum impact

With regards to the overall spatial concept of the NUDC, the Dube TradePort area is shown as an economic node requiring expansion. This then also ties back to the core principle that facilities should be clustered to promote efficient use of resources). This proposal shows an expansion of the Tradezone with suitable land uses for economic development and as such links into the overall spatial concept for the area.

Figure 10: Draft NUDC Spatial Concept (2011)



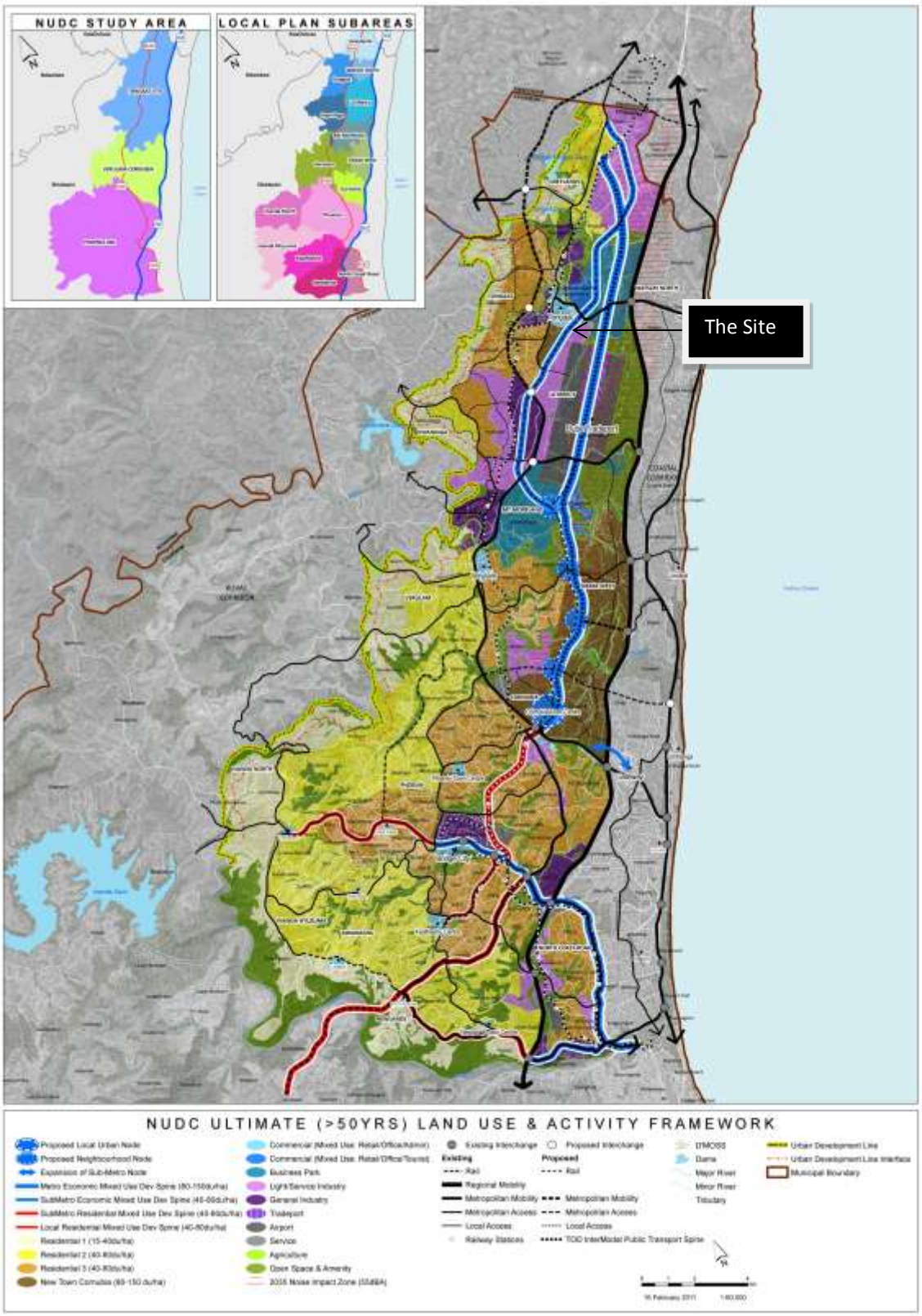
Source: NUDC (2011)

The NUDC has also broken down the plan into various Local Areas, with their associated plans (Local Area Plans or LAP's) which further detail out the various proposals. These LAP's cover the areas of Phoenix- INK, Verulam-Cornubia and Tongaat- DTP.

According to the Tongaat-DTP LAP which has recently been prepared and approved by the Council, the area is a key component of the NUDC, and will "be developed as a mixed use development corridor which will consolidate existing and anticipated future population and economic growth in the northern metropolitan area into a spatial pattern that reinforces the new airport node as an internationally competitive "Aerotropolis" (Draft Tongaat-DTP Local Area Plan v3.1 (2011): 31).

In terms of the long term or ultimate vision and development principles for the area, the expansion of the Tradezone as depicted in the uShukela Highway proposal, falls in line as it promotes the corridor and node concept of the NUDC by clustering economic activities to maximise the use of resources (Tongaat-DTP Local Area Plan v3.1 (2011): 6).

Figure 11: Excerpt from Northern Urban Development Corridor Spatial Concept (2011)



Source: NUDC (2011)

4.3.4 DRAFT TONGAAT-DTP LOCAL AREA PLAN V3.1 (2011)

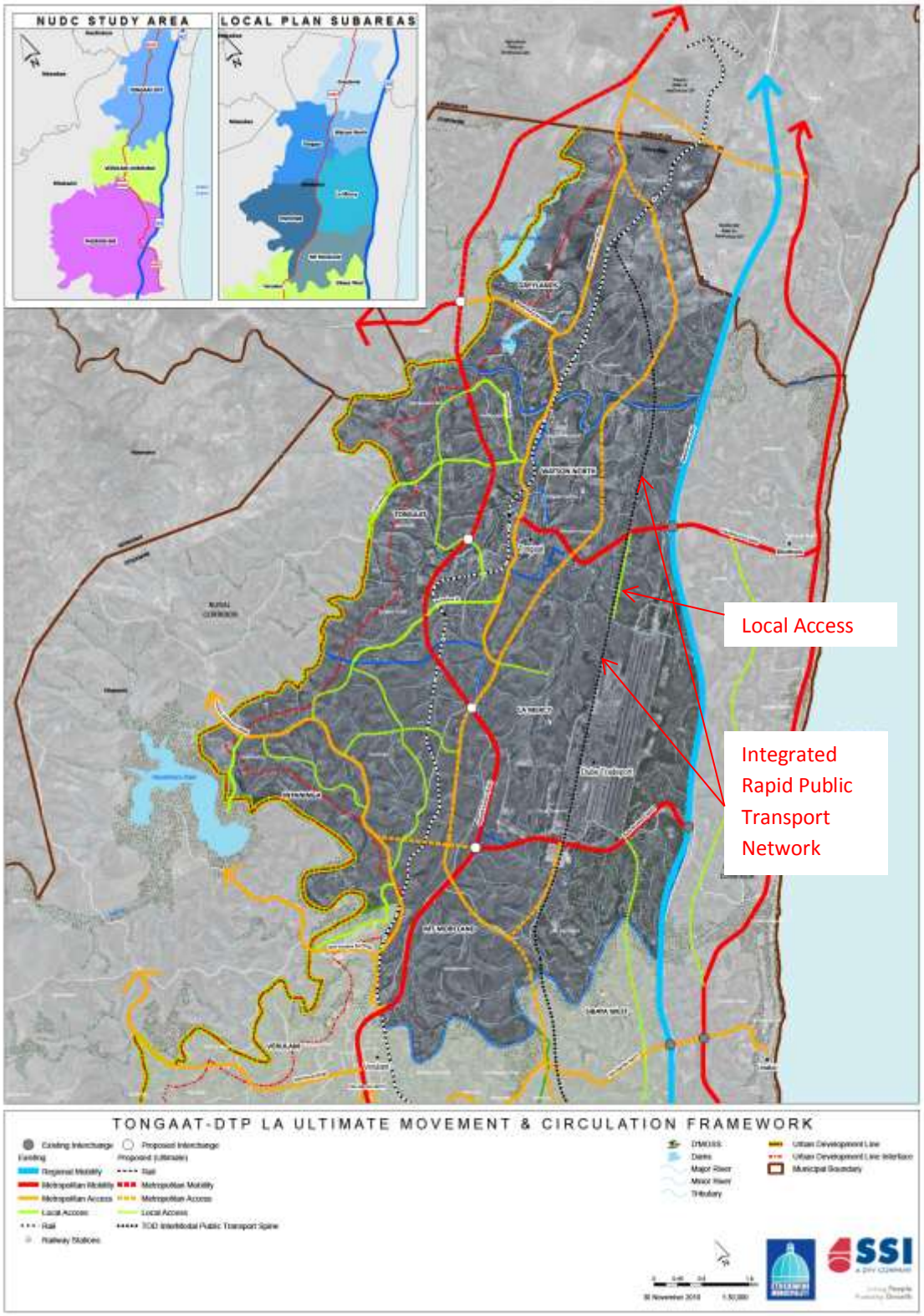
The Tongaat DTP Local Area Plan (2011) was prepared as a component of the Northern Urban Development Corridor Plan and focused specifically on the area surrounding Tongaat and the DTP site. The site falls within the La Mercy Sub-area and the plan identifies the economic role of this area to be :

- International airport and metropolitan logistics platform.
- Metropolitan office, industrial, business and tourism support zone to King Shaka Airport and Dube Trade Port.
- Metropolitan freight multi-modal terminus.

The development proposal clearly falls within this vision for the area.

The following plan also indicates that the main access to the proposed development area via a link road from uShukela Highway to the TradePort is a key linkage in the eThekwini Integrated rapid Public Transport Network the Local Area Plan supports the building of the link road from the TradePort to the uShukela Highway to improve local access in the area. This access is critical to linking freight movement from the proposed industrial areas to the north and west of the TradePort to the Cargo terminal. Without this all access is focused on the M65 of Dube Boulevard which is the primary access for passenger traffic which should not be mixed with freight traffic where ever possible.

Figure 12: Tongaat – DTP Local Area Plan Movement and Circulation Framework 2011



Source: Tongaat – Dube LAP (2011, page 51)

5 Spatial Planning Impact Assessment

5.1 Introduction

The assessment focuses on the issues that were raised by the Interested and Affected Parties in the scoping stage of the environmental impact assessment. The issues raised during the scoping process were:

1. The synergy between the overall spatial development plans of the area and the proposed development
2. Need and desirability of the development in relation to the overall demand for such land use, within the broader region

The impact is assessed on the basis of a standard set of criteria used in the specialist study impact assessments. These are listed below and further explained in the Appendix:

- Extent or spatial influence of impact:
  - International, National, Regional, Local, Site specific
- Magnitude of impact (at the indicated spatial scale):
  - High, Medium, Low, Very low, Zero
- Duration of impact:
  - Construction, Short term, Medium term, Long term
- Significance:
  - High, Medium, Low, Very low, Neutral
- Probability:
  - Definite (95%), Probable (5-95%), Unlikely (< 5%)
- Confidence:
  - Certain, Sure, Unsure (amount of information and assumptions)
- Irreversibility:
  - Irreversible, Reversible in long term, Reversible in short term
- Mitigation

5.2 Summary of Findings

5.2.1 The synergy between the overall spatial development plans of the area and the proposed development

The concern raised is that the proposed development may not be aligned with the overall spatial plans of the area.

Spatial planning frameworks for the area were summarised in Section 4 of this report. The proposed development was outlined in Section 2.4 of the report and includes Tradezone/ Light Industrial/ Logistics type land uses all of which are uses that align with and will contribute to the development of an aerotropolis in the area. Thus in all instances it was concluded that the development proposal aligns with the relevant spatial planning proposals.

- The proposed development has the potential to strengthen the economic hub of the Dube TradePort and therefore aligns with the National Development Plan and New Growth Path, as well as the

Provincial Growth and Development Strategy, all of which highlight the role of the TradePort in improving international connectivity and contributing to National economic growth.

- The eThekwini IDP (2011) identifies the Dube TradePort area as a priority area in terms of infrastructure investment and economic growth. This proposal falls in line with this priority in that it will strengthen the core created by the airport and TradePort. This then further strengthens the Municipal IDP's requirement for a compact city approach.
- The NSDP (2010) shows this development as a natural extension of the airport TradeZone (i.e. it is termed future industry in the NSDP). The development is a direct extension of the Tradezone, and its land use is the same as depicted in the Municipal plans.
- Northern Urban Development Corridor and Tongaat-Dube LAP (2011) shows the development as light industry, and although it is not stated, it is shown on all the plans as a natural extension of the Tradezone, which also contains similar land uses.

The proposal will be fully serviced by the developer which means that from a municipal perspective, funding of services will not be an issue.

In terms of fitting in with the overall picture for the area, this site clearly aligns with the regional plans, which are designed to promote appropriate land uses in the areas. Furthermore, the expansion of the Tradezone, as shown in the regional plans will have a positive impact on the local economy, and conceivably the broader economy, as it will enhance the value offered by King Shaka International Airport and Dube TradePort.

Table 3: Criteria to assess the synergy between the overall spatial development plans of the area and the proposed development

Criteria to assess the synergy between the overall spatial development plans of the area and the proposed development	Impact	Reason
Extent (Regional; Local; Site Specific)	Regional	The development aligns with all regional plans for the eThekwini Municipality, the KwaZulu-Natal Province as well as with National policies.
Magnitude (High, Medium, Low, Very Low, Zero)	High	The development links in directly with plans for the area.
Duration (Construction – 2010, Medium – 2015; Long Term – 2035)	Long Term	The development of the site will have a long term impact on job creation and economic development in the area.
Significance (High, Medium, Low, Very Low, Neutral)	Medium to high	In terms of the overall picture for the area, the development has a medium significance. It serves to provide an opportunity to expand the Dube TradePort development and would therefore play an important role in job creation and economic development.
Probability (Definite, Highly Probable, Probable, Possible, Unlikely)	Definite	The development is definitely aligned with the plans for the area.
Confidence (Certain, Sure, Unsure)	Certain	From looking at the NSDP, IDP and other provincial documents, it is clear that this development is in line with regional plans
Irreversibility	Impact will be irreversible.	
Mitigation	No mitigation required as the development proposal aligns with National, Provincial and Local Government Frameworks.	

5.2.2 NEED AND DESIRABILITY OF THE DEVELOPMENT IN RELATION TO THE OVERALL DEMAND FOR SUCH LAND USE, WITHIN THE BROADER REGION

The development proposed is both needed and desirable as it contributes to achieving the vision of developing an Aerotropolis or Airport City with the International Airport and TradePort as the Hub of development. Increasingly it is recognised that airports are generators of economic growth. This is based on new business realities (speed and agility; e-commerce; networks and supply chains; sell to anyone anywhere in the world; flexibility and customization; corporations increasingly operate internationally; higher value to weight ratios; Just-in-time; global sourcing and sales; built to order; customers won't wait; time is money). Within this context quick international access is critical. These drivers of international business have resulted in the role of airports changing dramatically from points of arrival and departure to leading urban growth generators often referred to as an Airport City or Aerotropolis. The purpose of an aerotropolis/airport region development is to use public sector investment to leverage private investment into a configuration that yields enhanced business efficiency and competitiveness in the global arena, and in so doing yield maximum returns in terms of sustainable jobs, taxes and other public benefits. Spatially the aerotropolis development is characterised by distinct clusters and spines of aviation-linked business radiating outward from airport for up to 20 to 30 km's. These clusters include both passenger and freight related activities such as logistics and business parks, time sensitive and high value, light weight product, manufacturing and repair, information and communications technology complexes, air-intensive and air-related office, research, education and health related activities, convention and exhibition facilities, hotels and residential, wholesale and retail, leisure and entertainment developments where people can live, work and recreate. The proposed development considered in this report forms one such cluster along the northern access spine from the Cargo and Passenger terminal (See Figure 6).

Moreover, The Municipal IDP has determined that there is a need to increase employment within the Municipality. In terms of the goals of the IDP, the following is noted regarding the issues facing the Municipality:

- Relatively high levels of poverty
- Low economic growth and high rate of unemployment

By the nature of the land uses proposed for this development i.e. Tradezone/ Light Industrial/ Logistics, the uShukela Highway development will result in job creation both in the short and long term. Furthermore, the uses planned for the site are desirable as per the land uses to be promoted according to the New Growth Path and The Provincial Spatial Economic Development Framework i.e. positioning South Africa within the global economy through increased international air connectivity, and promoting logistics and transport related industry (linked to the airport).

eThekwini also has a shortage of suitable land available for industry and business parks, as noted in the report prepared by Ken Davies entitled The eThekwini Industrial/ Business Park Land Market and its Implications For The Planned Developments Of Moreland (Davies 2008) and the eThekwini Industrial Spatial Strategy (2009). Davies' report (2008) further notes that Durban's demand for industrial land has consistently been high, with supply being low. He also notes that whilst in a contracting economy (as is currently being experienced), demand will decrease, major transportation routes and ports will still create a demand for land (including land around the airport). As the economy starts coming out of the recession, this demand should increase. As such, this proposal also caters for the demand for land for industrial/business park uses.

Within the eThekwini Industrial Spatial Strategy (2009) a scenario is painted whereby eThekwini would become a modern and efficient international gateway city with world class intermodal transport/logistics capability including substantial freight handling capacity. Air freight is critical to the development of this vision. The local industrial market would more than double the present level, expanding strongly along the western

and northern corridors beyond the municipal limits. DTP and Back of Airport would become an essential contributor to this level of growth and would underpin the City's status as a modern international trade gateway. Durban would become firmly entrenched as both a trade hub and a travel hub. This proposal forms part of such a vision and is therefore desirable in contributing to the process of achieving it.

The site is well located with regards to the existing road network (as per previous sections), and all bulk services will be in place. As such, the 135 hectare development will be able to come on stream very quickly. This also means that there will be no significant impact on servicing requirements by the Municipality. (For further information, refer to specialist servicing report).

The proposed development area falls within the 55 LRDn noise contour, and as such is a suitable land use for the site. There is also no significant development (other than the airport) in close proximity to the site, and this combined with the fact that the land use proposed will be clean industry/logistics and business park uses, means that there will be minimal impact on the surrounding land by way of noise and pollution. (For further information, refer to the environmental report).

The development will have no negative socio-economic impacts, but rather positive socio-economic impacts as it will be creating jobs and contributing to the growth of the economy. There are also no significant issues on site that relate to heritage or issues relating to the historical effects of past racially discriminatory legislation and policies. (For further details, refer to the Socio-economic Impact Assessment and Heritage Impact Assessment).

The site will result in some loss of agricultural production. However, the value added by the proposed land uses and employment opportunities outweigh the loss in the small amount of agricultural land. (For further details, refer to the Agricultural Impact Assessment).

A Traffic Impact Assessment report has been undertaken as part of the EIA process and the reader is referred to this report for information on traffic issues. Primary access to the proposed development area will be via a road linking uShukela Highway to the TradePort access road. This road is shown as a key linkage in the Integrated High Priority Public Transport Network (C8) as well as a key local access road within the local area plan that is critical to the movement of freight to the Cargo terminal from surrounding industrial areas.

An important point to consider is the importance of the compact city and nodal approach. This approach promotes the densification around nodes, from both a servicing cost perspective, and from an environmental protection perspective. This proposal falls in line with the desired compact city approach by densifiying development on land where it is appropriate i.e. in close proximity to a massive government investment in infrastructure in the form of the new airport and the TradePort, thus actually assisting in environmental protection and keeping servicing costs down.

As the site is serviced, and has a high level of accessibility, combined with the proximity to the airport, the site is well suited to the land uses proposed. These land uses will also assist in the creation of employment, thus fulfilling a key challenge facing the country and region. The municipality will also benefit from improved rates collection from the development.

Table 4: Criteria to assess the need and desirability of the development in relation to the overall demand for such land use, within the broader region

Criteria to assess the need and desirability of the development in relation to the overall demand for such land use, within the broader region	Impact	Reason
Extent (Regional; Local; Site Specific)	Regional	The demand for land comes from the greater eThekwini region.
Magnitude (High, Medium, Low, Very Low, Zero)	Medium to high	At present, despite an economic downturn there is demand for industrial/business land, especially well located land near trade ports.
Duration (Construction – 2010, Medium – 2015; Long Term - 2035	Long Term	Once developed, the site will link into long term plans for the area. Once developed, the sites impact will continue for the foreseeable future.
Significance (High, Medium, Low, Very Low, Neutral)	Medium	In terms of the overall picture for the area, the development has a medium significance in terms of demand for land use.
Probability (Definite, Highly Probable, Probable, Possible, Unlikely)	Definite	The positive impact on job creation and economic growth will occur should the development proceed.
Confidence (Certain, Sure, Unsure)	Certain	Certain.
Irreversibility	Positive Impact will be irreversible.	
Mitigation	No mitigation required as there is a need for the development and it is desirable.	

6 CONCLUSION

The intention of this report was to provide specialist planning input to the environmental Impact assessment of the uShukela Highway area by DTP and TH for mixed use/ industrial development.

Two areas of concern were raised in the scoping phase relating to planning:

1. The synergy between the overall spatial development plans of the area and the proposed development
2. Need and desirability of the development in relation to the overall demand for such land use, within the broader region

This assessment has concluded that the proposed development is aligned with spatial plans for the area as well as National and Provincial Policy.

It has also concluded that the proposed development is needed and desirable given the demand for industrial/business park land and its proximity to the TradePort effectively extending the opportunities offered by the development whilst promoting compact city development and efficient use of existing services, and contributing to the vision of developing an aerotropolis in the northern region of the City as set out in the Northern Urban Development Corridor Proposals (2011, eThekwini Municipality).

7 APPENDIX: ASSESSMENT CRITERIA

Table 5: Assessment criteria for the evaluation of impacts

CRITERIA	CATEGORY	DESCRIPTION
Extent or spatial influence of impact	**International**	Over boundary of RSA
	National	Within RSA but wider than KwaZulu-Natal
	Regional	KwaZulu-Natal, Greater eThekwini area, Ilembe and ….
	Local	The area from the Umhlanga River up the north coast to Sheffield beach and inland to Tongaat and south to Verulam and Phoenix.
	Site specific	On site or within 50m of the site boundary
Magnitude of impact (at the indicated spatial scale)	**High**	Natural and/or social functions and/or processes are *severely* altered.
	Medium	Natural and/or social functions and/or processes are *notably* altered.
	Low	Natural and/or social functions and/or processes are *slightly* altered.
	Very low	Natural and/or social functions and/or processes are *negligibly* altered.
	Zero	Natural and/or social functions and/or processes remain *unaltered*.
Duration of impact	**Construction**	Up to 3 years.
	Short term	Up to 5 years after construction (ie 2015).
	Medium term	Up to 20 years after construction (ie 2035).
	Long term	More than 20 years after construction.

Table 6: Definition of significance ratings

SIGNIFICANCE RATINGS	LEVEL OF CRITERIA REQUIRED	
High	•	High magnitude with regional extent and long term duration.
	•	High magnitude with either a regional extent and medium term duration or a local extent and long term duration.
	•	Medium magnitude with a regional extent and long term duration.
Medium	•	High magnitude with local extent and medium term duration.
	•	High magnitude with regional extent and short term duration or a site specific extent and long term duration.
	•	High magnitude with either a local extent and short term duration or a site specific extent and medium term duration.
	•	Medium magnitude with any combination of extent and duration except site specific and short term or regional and long term.
	•	Low magnitude with a regional extent and long term duration.
Low	•	High magnitude with a site specific extent and short term duration.
	•	Medium magnitude with a site specific extent and short term duration.
	•	Low magnitude with any combination of extent and duration except site specific and short term.
	•	Very low magnitude with a regional extent and long term duration.
Very low	•	Low magnitude with a site specific extent and short term duration.
	•	Very low magnitude with any combination of extent and duration except regional and long term.
Neutral	•	Zero magnitude with any combination of extent and duration.

Table 7: Definition of probability ratings

PROBABILITY RATINGS	CRITERIA
Definite	Estimated greater than 95% chance of the impact occurring.
Probable	Estimated 5 to 95% chance of the impact occurring.
Unlikely	Estimated less than 5% chance of the impact occurring.

Table 8: Definition of confidence ratings

CONFIDENCE RATINGS	CRITERIA
Certain	Wealth of information on and sound understanding of the environmental factors potentially influencing the impact.
Sure	Reasonable amount of useful information on and relatively sound understanding of the environmental factors potentially influencing the impact.
Unsure	Limited useful information on and understanding of the environmental factors potentially influencing this impact.

Table 9: Definition of reversibility ratings

REVERSIBILITY RATINGS	CRITERIA
Irreversible	The activity will lead to an impact that is permanent.
Long term	The impact is reversible within 2 to 10 years after construction.
Short term	The impact is reversible within the 2 years of construction.

8 REFERENCES

Reports

Davies, K (2008) The eThekwini Industrial/ Business Park Land Market And Its Implications For The Planned Developments Of Moreland

eThekwini Industrial Spatial Strategy (2009) (http://devplan.kzntl.gov.za/idp_reviewed_2011_12/IDPS/Durban/Adopted/ETHEKWINI%20INDUSTRIAL%20SPATIAL%20STRATEGY%20V04.pdf

Kerry Seppings Environmental Management Services: Draft Scoping Report uShukela Highway Development, eThekwini Municipality, November 2010, EIA Number: 12/12/20/2013

Legislation

Development Facilitation Act, Act No. 67 Of 1995

Kwazulu-Natal Planning and Development Act, 2008, Act No. 06 Of 2008

KwaZulu-Natal Provincial Roads Act, Act No. 4 of 2001 (Provincial Road Transportation Act 1994 as amended 1997)

Local Government Municipal Systems Act, Act No. 32 of 2000 and Municipal System Act Regulations 2001 (Department of Provincial and Local Government)

National Land Transport Transition Act, Act No. 22 of 2000

Regulations linked to the National Environmental Management Act, Act No. 107 of 1998

Restitution of Land Rights Act, Act No. 22 of 1994

Subdivision of Agricultural Land Act, Act No. 70 of 1970

Policy Documents

iLembe District Municipality Integrated Development Plan Review (2011/2012)

eThekwini Municipality (June 2011) eThekwini Municipality Integrated Development Plan 5 Year Plan: 2011-2016 (2011)

Northern Urban Development Corridor (2011)

The New Growth Path Framework for South Africa launched on 23 November 2010

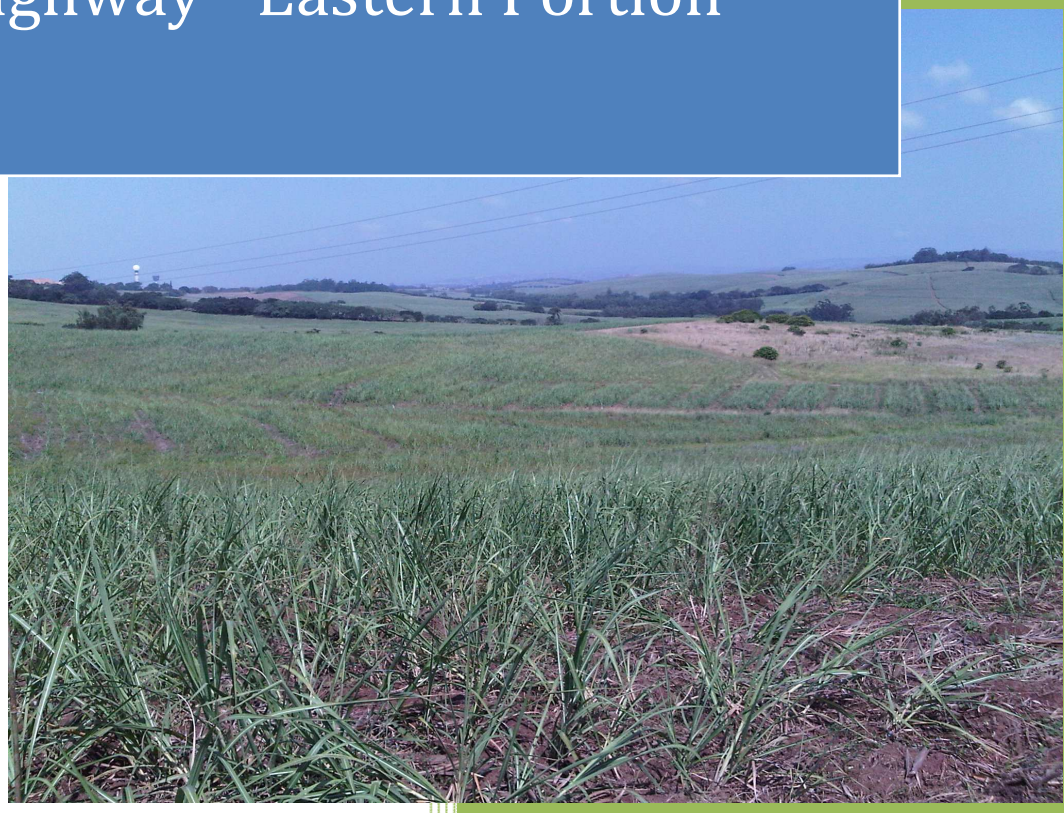
The Provincial Growth and Development Strategy (2011)

The Provincial Spatial Economic Development Strategy (2010)

Appendix 8: Assessment of Freshwater Ecosystems, uShukela Highway

Assessment of Freshwater Ecosystems

uShukela Highway - Eastern Portion



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Executive Summary

To inform the development planning adjacent to the King Shaka International Airport and the Dube Trade Port in KwaZulu-Natal, assessments of the current health status of the identified freshwater ecosystems were undertaken within Tongaat Hulett Development's Inyaninga and Amanzimnyama-South farms.

The wetland habitat assessment tools highlighted that modification to the wetland habitat as a result of sugarcane cultivation, urban infrastructure development and other impacts have had an adverse effect on the systems integrity and the supply of ecosystem services. The wetlands are supplying the specified ecosystem services at ***Intermediate*** to ***Moderately High*** levels, but these scores are mostly determined by the opportunities that exist for these systems to supply ecosystem services within the landscape rather than the effectiveness. The Present Ecological State (PES) score ("**E**") for the wetlands within the development site highlights that "the change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognizable." This PES score illustrates that the ~54 ha of wetland habitat assessed is considered to be the equivalent to ~18 ha of intact wetland habitat.

Assessment of riverine habitats that are present onsite highlights that the riparian and instream habitats associated with these systems have become modified largely as a result of sugarcane cultivation and resulting impacts. Consequently, and from an ecological perspective, the riverine systems are considered to have a **Low** Ecological Importance and Sensitivity (EIS) with limited potential to support significant biodiversity assets. Results from the Index of Habitat Integrity (IHI) analyses highlights that the riverine systems, in general, are **Moderately Modified**. Thus in terms of general ecology of the site, the riverine systems have generally maintained higher levels of habitat integrity compared to that of the wetland systems.

While these systems are modified, they are supplying ecosystems goods and services that would be important within the post-development landscape. The development planning should therefore attempt to ensure "no-net-loss" of functioning or integrity of the identified freshwater ecosystems. Where possible the development should include the protection, rehabilitation and management of the wetland and riverine habitat to further enhance the level of ecosystem service delivery.

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1. Introduction

The development of the King Shaka International Airport (KSIA) and the associated Dube Trade Port (DTP), on the North Coast of KwaZulu-Natal, has prompted development planning in the areas adjacent to the site. Tongaat Hulett Developments have identified the the portion of Amanzimnyama Farm south of Watson Highway for the development of infrastructure and facilities to support KSIA and DTP (**Figure 1**).

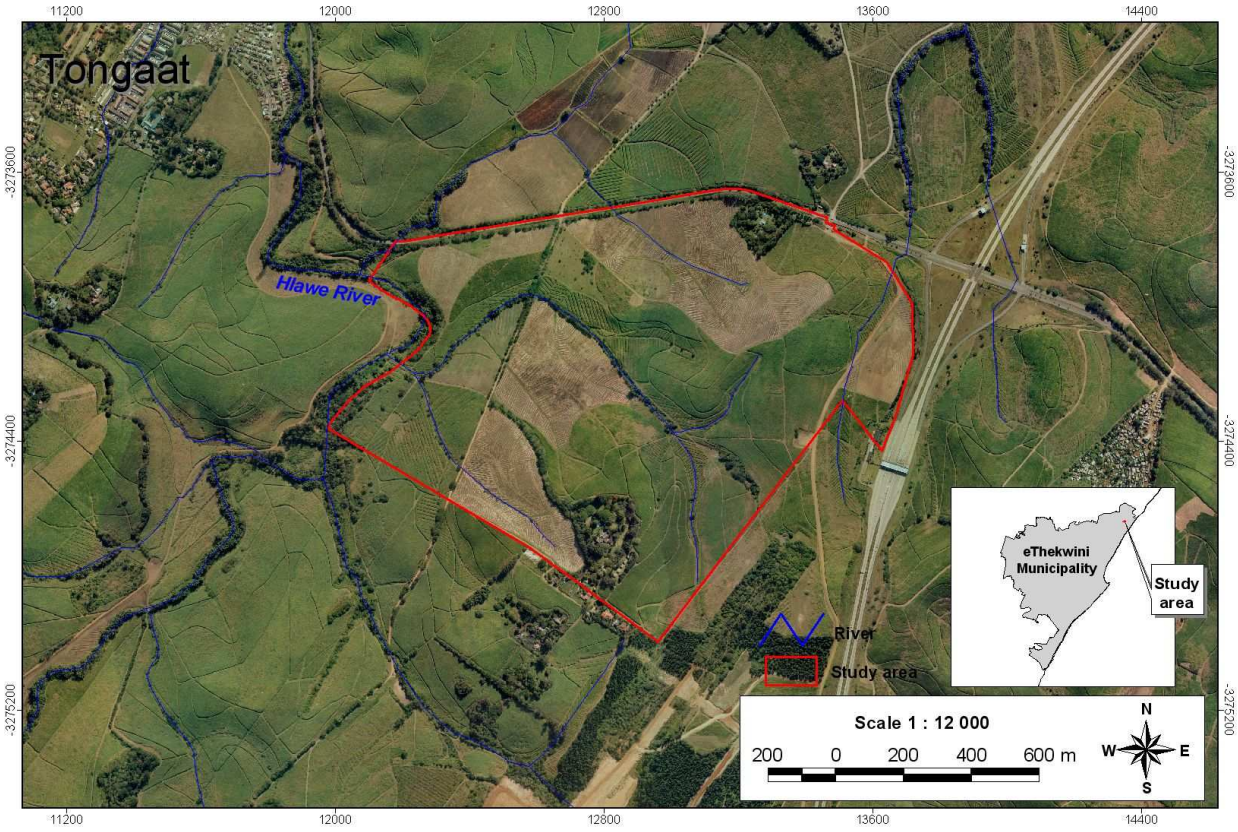


Figure 1: Extent of the study area near Dube Trade Port (south) and Tongaat (north-west), KwaZulu-Natal

In order to inform the proposed development and minimise impacts on the freshwater ecosystems, identified during a previous study, the freshwater ecosystems need to be assessed in terms of their importance within the landscape and their ecological integrity. The aim of this study is to:

- Determine the ecological importance and health of the identified wetland systems;
- Determine the ecological importance and health of the identified river systems; and
- Provide recommendations in terms of priority freshwater ecosystems within the development site to inform subsequent planning.

2. Methodology

The wetland and riverine systems within the study area were delineated during a previous study undertaken by Land Resources International (LRI Report L03010/290409/01) in April 2009. The wetland and riverine systems identified during the delineation exercise was divided into hydrogeomorphic (HGM) units and stream lengths respectively, and assessed using the following techniques.

2.1 Project Team

Due to the nature of the study, with multiple aspects needing to be monitored, the project team consisted of a number of team members:

- Craig Cowden;
- Gary de Winnaar; and
- Brad Graves.

All team members have experience in freshwater ecosystem studies within KwaZulu-Natal (**Table 1**).

Table 1. Team members roles, experience levels and qualifications

Practitioner	**Role in the Study**	**Experience Levels**	**Qualifications**
Craig Cowden	• Infield data collection; • Wetland assessments; and • Reporting	10 years experience, with input into various wetland studies, including: • delineation, • assessments, • rehabilitation planning, monitoring & evaluation; and • mitigation & offset requirements	B.Sc. (Agric) Pr.Sci.Nat – Ecological Science
Brad Graves	• Infield data collection; and • Desktop mapping to inform wetland assessments	5 years experience, with input into various wetland studies, including: • delineation, • assessments, and • rehabilitation planning.	B.Sc. (Hons)
Gary de Winnaar	• Infield data collection; • River habitat assessments; and • Reporting	5 years experience, with input into aquatic studies, including: • Aquatic Biomonitoring (eg. Diatoms, SASS 5) • Ecological assessments (including river habitats)	B.Sc. (Zoology & Hydrology) M.Sc (Hydrology)

2.2 Site Visit

An initial field visit was undertaken by the three personnel on the 19th March 2010 to collect the relevant field data to inform the assessments.

2.3 Wetland Habitat Assessments

In order to assess the wetland habitat within the study area, assessment techniques from the Water Research Commission's Wetland Management Series were adopted to assess the ecological importance and sensitivity (EIS) and present ecological state (PES). To inform the assessments the wetland habitat within the development site was divided into hydrogeomorphic (HGM) units as outlined in Kotze *et. al.* (2007):

- Floodplain;
- Channelled valley bottom;
- Unchannelled valley bottom;
- Hillslope seep feeding a water course;
- Hillslope seep not feeding a water course; and
- Depressions or pans.

2.3.1 Assessment of Ecological Importance and Sensitivity

To quantify the level of functioning of the wetland systems, and to highlight their relative importance in providing ecological benefits and services at a landscape level, a WET-EcoServices (Kotze *et. al.,* 2007) assessment was performed for each hydrogeomorphic unit. The assessment technique focuses on assessing the extent to which a benefit is being supplied by the wetland habitat, based on both:

- the opportunity for the wetland to provide the benefit, and
- the effectiveness of the particular wetland in providing the benefit.

Ecosystem services, which include direct and indirect benefits to society and the surrounding landscape, were assessed by rating various characteristics of the wetlands and their surrounding catchments based on the following scale:

- Low (0);
- Moderately Low (1);
- Intermediate (2);
- Moderately High (3); and
- High (4)

The scores obtained from these ratings for each wetland hydrogeomorphic unit were then incorporated into WET-EcoServices scores for each of the fifteen ecosystem services:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;

- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Biodiversity maintenance;
- Water supply;
- Source of harvestable goods /resources;
- Source of cultivated goods /resources;
- Socio-cultural significance;
- Tourism and recreation; and
- Education and research.

2.3.2 Assessment of Present Ecological State

To determine the level of ecological integrity, a WET-Health (MacFarlane *et al*., 2007) assessment was performed for each hydrogeomorphic unit. The WET-Health assessment technique gives an indication of the deviation of the system from the wetland's natural reference condition for the following biophysical drivers:

- Hydrology;
- Geomorphology; and
- Vegetation.

The impacts on the wetland, determined by features of the wetland and their catchments, were scored based on the impact scores and then represented as Present State categories as outlined in WET-Health (**Table 2**).

Table 2: Impact scores and Present State categories for describing the integrity of wetlands (MacFarlane *et al.*, 2007)

Impact category	Description	Impact score range (0-10)	Present State category
None	Unmodified, natural.	0-0.9	**A**
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place.	1-1.9	**B**
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	**C**
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	**D**
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	**E**
Critical	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	**F**

2.4 Riparian Habitat Assessments

Appropriate methodology developed specifically for river systems was employed in order to assess the riverine habitat within the study area, specifically ecological importance and sensitivity (EIS) and present ecological state (PES).

2.4.1 Assessment of Ecological Importance and Sensitivity

DWAF (1999) defines ecological importance of a water resource as an expression of its importance in terms of maintaining ecological diversity and functions, and ecological sensitivity as a system's ability to resist disturbance and its capacity to recover from disturbances. EIS information as derived from the classification of Quaternary Catchments within KZN was used to define, from a regional perspective, the importance and sensitivity of the river systems within the study areas. The determinants used to determine regional EIS were then adopted in order to determine the EIS on a local scale. This procedure was informed using information obtained from desktop analyses and observations noted during the site visit. The following determinants presented in **Table 3**, based on Ecological Reserve determination protocol, were used for defining the EIS of the respective riverine systems.

Table 3: Determinants for classifying Ecological Importance and Sensitivity (EIS) of riverine habitats (riparian and instream) according to DWAF (1999)

Biota
Rare and endangered species
Populations of unique species (endemic, isolated, etc.)
Intolerant species (flow and flow related water quality)
Species/taxon richness
Riparian and Instream Habitats
Diversity of habitat types
Availability of refugia for biota
Sensitivity to changes in the natural hydrological regime
Sensitivity to water quality changes
Migration route/corridor for species (instream and riparian)
Importance of conservation and natural areas

2.4.2 Assessment of Present Ecological State

Habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics that are comparable to the characteristics of natural habitats of the region (Kleynhans, 1996). IHI therefore incorporates biological responses to driver changes (hydrological, geomorphological, etc.) as well as integrates driver state or condition. Consequently, the IHI method is particularly useful for EcoClassification and refers to the determination and categorisation of river health or integrity based on various biophysical attributes of river systems relative to the natural reference condition. Hence, information obtained from IHI assessments provides the necessary information to derive desired ecological objectives for river systems as well as for identifying areas needing attention in terms of mitigating impacts and informing the rehabilitation planning.

The Present Ecological State (PES) of riverine systems draining the Inyaninga and Amanzimnyama-South properties was determined using the Index of Habitat Integrity (IHI) method as described by Kleynhans *et al.* (2009). The IHI method was used to assess present ecological state (PES) based on impacts from present drivers and pressures based on the intensity and extent of anthropogenic activities. Separate IHI assessments were conducted for each of the river systems and their respective catchments defined according to the study area. Each IHI assessment is based on the assessment of several metric groups (e.g. hydrological, physico-chemical, bed, bank, and connectivity modification) with distinction between instream and riparian habitats. The IHI model functions in an integrated way whereby the results from the assessment of metric groups, or metrics within a metric group, are used to inform the assessment of other metric groups (Kleynhans *et al*., 2009).

An examination of current land use within 500 meters on either side of the rivers and streams was undertaken in order to inform the IHI model. These land use activities were used essentially to define the drivers and pressures that are likely to impact the integrity of riverine habitats. Land cover spatial information was obtained using the KZN land cover database (DEAT and EKZNW, 2008) as opposed to using the CSIR national land cover database as required according to the IHI methodology. The reason for this was due to the higher resolution and level of detail obtained from the KZN land cover relative to the extent of the study area. The land cover classes from the KZN land cover dataset were redefined according to the national land cover classification systems so as to align the former land cover classification with the IHI method.

Suitable IHI sites were determined for each of the homogenous assessment units characterising each of the river systems. Field-based surveys were then carried out at each of the sites to assess and record information defining the status of instream and riparian habitats. General catchment-based observations were also noted to verify details pertaining to land use impacts that are having an effect on the riverine systems within the study area. Further verification was obtained following an interrogation of aerial imagery for the site. The IHI model was executed once the necessary information and data requirements had been properly collected and collated according to the methodology as described by Kleynhans *et al.* (2009).

The following interpretative table defines the various habitat integrity classes output from the IHI model, and as undertaken for each of the rivers and respective catchments.

Table 4: Index Habitat Integrity category descriptions (after Kleynhans *et al*., 2009)

Habitat Integrity Category	Description	Rating (% of total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0-19

3. Assumptions and Limitations

Studies that focus on the potential impacts of a proposed development rely on various assumptions, with the following assumptions being made during the assessment of this particular wetland system:

- The reference/benchmark vegetation of the wetland was considered to be herbaceous, based on the vegetation composition of wetlands along the KwaZulu-Natal coastal region;
- Excluded wetland areas where a small portion (<0.5ha) was within the study area and the majority of the wetland was outside of the proposed development site;
- Small (<0.5ha) isolated wetland areas were grouped with the associated riparian areas rather than being assessed as separate hydrogeomorphic units; and
- The entire hydrogeomorphic unit was assessed even if it extended beyond the boundary of the development site.

Limitations and uncertainties often exist within the approaches and techniques used to assess the condition of natural systems, with the following limitations applying to the studies undertaken for this report:

- The extent of hydrogeomorphic units that extended beyond the study area was derived from aerial imagery, but due to level of modification and the inability to verify the historical extent of the system, the accuracy of the derived information is limited.
- The wetland assessment techniques used in this study were developed relatively recently and in some instances, such as highly modified/transformed systems, they may have shortfalls. These techniques, however, have been compiled based on international best practice to apply to South African conditions, undergoing a peer review process during their development. These assessment techniques should therefore be seen as the most appropriate tools for wetland assessments at this time.
- The artificial export of sediment from wetlands, especially for excavation and sand mining, is not adequately addressed in the WET-Health assessment methodology. However, the excavation of the drainage canals and ridge-and-furrow agriculture is not recorded as an impact on the sediment movement within the wetland, as the sediment is considered to be retained/redistributed within the system rather than exported, as is the case with erosion.
- Methodology for assessment of riverine systems (i.e. IHI) differs to wetland assessment methods (i.e. WET-Health). The most significant difference relates to the fact that IHI determination is based on the assessment of homogenous river sections as opposed to the full extent of HGM units as used for wetland-based assessment protocol. As a result the IHI assessments do not take into account the downstream situations outside of the study boundary whereas as WET-Health evaluations incorporate external catchment drivers and pressures. Therefore outcomes from wetland habitat assessment may differ significantly from riverine assessments primarily due to the former approach including impacts from urbanisation associated with Tongaat. Without a doubt, urbanisation would further compromise habitat integrity as well as the functionality and processes of the wetland systems beyond the extent of the Amanzimnyama-South and Inyaninga properties.

4. Results

The results of the assessment of ecological importance and sensitivity and present ecological state of the wetland and riverine systems within the study area are outlined in the following sections.

4.1 Wetland Habitat Assessments

The division of the identified wetland habitat into HGM units resulted in the classification of four HGM units comprising of:

- Seepage wetlands linked to watercourses, including valley-head seeps;
- Channelled valley-bottom wetlands; and
- Unchannelled valley-bottom wetlands.

All of the HGM units fall within the Quaternary Catchment U30D and drain into the Hlawe River and eventually into the Tongaati River (**Map-GTW012-201210-04-02)**.

4.1.1 Ecological Importance and Sensitivity

The current levels of ecosystem service delivery provided by the various HGM units across the study area are shown in **Table 5**[2]. For ease of interpretation, these scores are also represented in diagrams within **Appendix 2** for each HGM unit. The WET-EcoServices score for each ecosystem service represents the likely extent to which that benefit is being supplied by the specific HGM unit and was interpreted based on the following rating outlined by Kotze *et al*. (2007):

- <0.5 Low
- 0.5-1.2 Moderately low
- 1.3-2.0 Intermediate
- 2.1-2.8 Moderately high
- >2.8 High

Generally, the HGM units within the study area are supplying the specified ecosystem services at ***Intermediate*** to ***Moderately High*** levels. However, the ***Moderately High*** scores are mostly determined by the ***High*** opportunities that exist for these systems to supply ecosystem services within the landscape due to the surrounding catchment conditions and land use. The effectiveness with which these wetlands are able to supply services is generally ***Intermediate*** due to the modified nature of the systems, linked to the alteration of the hydrological regime and vegetative cover. The systems' provision of direct benefits and

[2] Where applicable the scores for opportunity and effectiveness have been presented to ensure understanding of effectiveness of these systems due to their modified state.

services, such as resource harvesting, is limited due to the wetlands being situated within private property with controlled access.

Within the post-development landscape, the opportunity scores for the provision of ecosystem services by the wetlands within the site is likely to change, with more opportunities existing for flood attenuation, toxicant removal and erosion control. However, without rehabilitation of the wetlands, the effectiveness of these systems within the landscape is unlikely to increase. The rehabilitation of these wetlands is therefore an important consideration, especially if the proposed development consists of semi-industrial and business centres, maximising the benefits to the aquatic ecosystems downstream.

Table 5: Summary sheet of WET-Ecoservices scores

Wetland name/reference number	U30D-115	U30D-116	U30D-117	U30D-118
Flood attenuation	**2.11**	**2.17**	**2.01**	**1.71**
Score for effectiveness:	1.43	2.14	1.43	1.43
Score for opportunity:	2.80	2.20	2.60	2.00
Stream flow regulation	**2.00**	**1.33**	**1.50**	**1.50**
Sediment trapping	**2.44**	**2.62**	**2.44**	**2.44**
Score for effectiveness:	1.21	1.57	1.21	1.21
Score for opportunity:	3.67	3.67	3.67	3.67
Phosphate trapping	**2.15**	**2.57**	**2.15**	**2.15**
Score for effectiveness:	1.30	2.14	1.30	1.30
Score for opportunity:	3.00	3.00	3.00	3.00
Nitrate removal	**2.25**	**2.43**	**2.18**	**2.22**
Score for effectiveness:	1.50	1.87	1.37	1.43
Score for opportunity:	3.00	3.00	3.00	3.00
Toxicant removal	**2.12**	**2.36**	**2.29**	**2.29**
Score for effectiveness:	1.24	1.71	1.24	1.24
Score for effectiveness:	3.00	3.00	3.33	3.33
Erosion control	**1.58**	**1.71**	**1.63**	**1.54**
Score for effectiveness:	1.33	1.33	1.33	1.33
Score for opportunity:	1.83	2.08	1.92	1.75
Carbon storage	**0.33**	**0.00**	**0.33**	**0.33**
Biodiversity maintenance	**1.44**	**1.50**	**1.25**	**1.25**
Score for noteworthiness:	2.00	2.00	2.00	2.00
Score for integrity:	0.88	1.00	0.50	0.50
Water supply	**0.75**	**0.33**	**0.63**	**0.63**
Source of harvestable goods /resources	**0.67**	**0.67**	**0.67**	**0.67**
Source of cultivated goods /resources	**0.67**	**0.67**	**0.67**	**0.67**
Socio-cultural significance	**0.00**	**0.00**	**0.00**	**0.00**
Tourism and recreation	**0.29**	**0.29**	**0.29**	**0.29**
Education and research	**0.50**	**0.50**	**0.50**	**0.50**

4.1.2 Present Ecological State

The Present Ecological State (PES) of the wetlands within the development site was assessed for the hydrology, geomorphology and vegetation components. The results for these three components and a summary are outlined in the following sections.

Hydrology

The impact scores recorded for the hydrological component of the wetlands were generally greater than **8**, translating into a Present Hydrological State (PHS) category of **F** – "Modifications are so great that the hydrological functioning has been drastically altered. 80% or more of the hydrological integrity has been lost" (**Table 6**). The modifications to the wetlands' PHS is linked primarily to the following factors:

- Alterations to water flow patterns and retention within the wetlands by means of efficient drainage using herringbone drains and ridge-and-furrow agriculture;
- Alterations to the water inputs linked to the cultivation of sugarcane within the majority of the wetlands and their catchments; and
- Infilling and excavation of wetlands linked to historical housing and infrastructure development.

One of the wetlands was less modified, recording PHS values of **E** – "Modifications clearly have an adverse effect on the hydrological integrity. 51% to 79% of the hydrological integrity has been lost" (**Table 6**), but this wetland is small and thus requires less extensive drainage to modify its hydrological conditions.

Table 6: Impact scores for the hydrological integrity of the wetlands

HGM Unit	Area (Ha)	HGM unit extent (%)	HGM unit magnitude of impact score	Area weighted impact score	Present Hydrological State Category
U30D-115	30.83	57.02	9.0	5.13	
U30D-116	1.06	1.96	6.5	0.13	
U30D-117	16.09	29.76	9.0	2.68	
U30D-118	6.09	11.26	9.0	1.01	
Total		**100**	**Overall weighted impact score**	**8.95**	**F**

Geomorphology

The impact scores recorded for the geomorphological component of the wetlands were generally less than **1**, translating into a Present Geomorphic State (PGS) category of **A** – "Unmodified, natural." (**Table 7**). In this instance the modifications to the wetlands' PGS was limited due to a lack of impacts on the erosional and depositional processes within the systems.

The impacts identified in those wetlands that were not recorded as being near-natural were primarily linked to the following factors:

- Incision of the channel within the wetland;
- Alterations to the water inputs linked to urban housing and infrastructure within the wetlands' catchments; and
- Infilling and excavation of wetlands linked to historical housing and infrastructure development.

Table 7: Impact scores for the geomorphic integrity of the wetlands

HGM Unit	Area (Ha)	HGM unit extent (%)	HGM unit magnitude of impact score	Area weighted impact score	Present Geomorphic State Category
U30D-115	30.83	57.02	0.0	0.00	
U30D-116	1.06	1.96	0.0	0.00	
U30D-117	16.09	29.76	0.3	0.09	
U30D-118	6.09	11.26	0.3	0.03	
Total		**100**	**Overall weighted impact score****	**0.12**	**A**

Within the current landscape setting, the wetlands' geomorphology is considered to be generally intact, but the proposed development is likely to change the landscape considerably. Due to the nature of the proposed development, with extensive hardened surfaces, it is likely that the velocity of water entering the wetlands will be increased. The geomorphic vulnerability of the wetlands within the development site is therefore an important consideration (**Table 8**). While limited erosion was identified within the wetlands, the vulnerability scores suggest that the formation of erosional features is likely to progress slowly should it develop within the systems, rather than the systems remaining stable.

Table 8: WET-Health geomorphic vulnerability scores

HGM Unit	Vulnerability*
U30D-115	5
U30D-116	2
U30D-117	5
U30D-118	2

*A score of 0 suggests that no change is likely, a score of 2 or 5 indicates that change may proceed slowly and dissipate a relatively short distance upstream, while a score of 8 or 10 suggests that erosion headcut advance will be rapid (Macfarlane *et. al.,* 2007)

Vegetation

The impact scores recorded for the vegetation component of the wetlands were all greater than **8**, translating into a Present Vegetation State (PVS) category of **F** – "Vegetation composition has been totally or almost totally altered, and if any characteristic species still remain, their extent is very low" (**Table 9**). The modifications to the wetlands' PVS is linked primarily to the following factors:

- Removal and clearing of vegetation for the cultivation of sugarcane, with wetland vegetation being limited to the drainage canals;
- Alterations to hydrological conditions within the wetlands resulting in remnant wetland vegetation being dominated by ruderal and disturbance indicator species;
- Encroachment of alien vegetation into areas not planted to sugarcane; and
- Infilling and excavation of wetlands linked to historical housing and infrastructure development.

It is important to note that with the restoration of hydrological integrity and management of alien invasive plant species within the wetlands, more natural wetland vegetation will dominate the systems, improving PVS.

Table 9: Impact scores for the integrity of the wetlands' vegetative component

HGM Unit	Area (Ha)	HGM unit extent (%)	HGM unit magnitude of impact score	Area weighted impact score	Present Vegetation State category
U30D-115	30.83	57.02	**9.9**	5.64	
U30D-116	1.06	1.96	**9.7**	0.19	
U30D-117	16.09	29.76	**10.0**	2.98	
U30D-118	6.09	11.26	**9.8**	1.10	
Total		**100**	**Overall weighted impact score**	**9.91**	**F**

4.1.3 Present Ecological State Score and Hectare Equivalents

For ease of interpretation the scores for hydrology, geomorphology and vegetation are able to be simplified into a composite score, the Present Ecological State (PES) score using a predetermined ratio for the three components of 3:2:2 respectively. This score is then used to calculate hectare equivalents, which are often the basis for offsets in the event that the wetland habitat within the development site is unable to be fully protected within the proposed post-development landscape.

The overall PES scores recorded for the wetlands generally ranged from 4.0-7.9 translating into the following PES categories:

- **D** - "A large change in ecosystem processes and loss of natural habitat and biota and has occurred"; and
- **E** - "The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable."

The PES score for the wetlands within the development site shown in **Table 10** are used to derive hectare equivalents. Based on the PES scores, the approximately 54 ha of wetland habitat assessed is considered to be the equivalent to 18ha of intact wetland habitat.

Table 10: Present Ecological State scores and Hectare Equivalents of the wetlands

HGM Unit	PHS Score	PGS Score	PVS Score	PES Score	Hectare Equivalents
U30D-115	9.0	0.0	9.9	6.69	10.21
U30D-116	6.5	0.0	9.7	5.56	0.47
U30D-117	9.0	0.3	10.0	6.79	5.16
U30D-118	9.0	0.3	9.8	6.73	1.99
Hectare Equivalents					**17.84**

4.2 Assessment of riverine habitats

The assessment of habitats associated with the river systems comprised two approaches, namely EIS and PES according to river assessment methodology. These assessments are based entirely on the current development scenario to reflect the drivers and pressures that are affecting the available riverine habitats. The riverine habitats assessed are shown in **Map-GTW012-201210-01-02** as defined according to the previous freshwater ecosystem delineations.

4.2.1 Ecological Importance and Sensitivity

The study area coincides with Quaternary Catchments U30D and forms part of the Tongaati River system. According to the regional EIS classification, U30D is classed as having a **moderate** EIS. This is largely because of important biodiversity assets associated with these two systems, for example, presence of rare and endangered species as well as unique species (endemic, isolated, etc. species) and supporting species/taxon richness. Implementing the EIS principles and determinants at the local scale presents a slightly different situation whereby both riverine assessment units were determined as having a **low** EIS (**Table 11**). The EIS categories for each of the respective riverine assessment units are illustrated in **Map-GTW012-201210-02-02**.

Table 11: Summary of determinants describing biota and habitats

Biota	Assessment unit	
	U30D-119	U30D-121
Rare and endangered species	0	0
Populations of unique species (endemic, isolated, etc.)	1	1
Species/taxon richness	1	1
Habitats		
Diversity of habitat types	3	1
Availability of refugia for biota	2	1
Sensitivity to changes in the natural hydrological regime	1	3
Sensitivity to water quality changes	1	2
Importance of conservation and natural areas	1	0
Total	**11**	**9**
Median	**1.0**	**1.0**
EIS score	**1.0**	**1.0**

EIS categories Very high = 4; High = 3; Moderate = 2; Marginal/Low = 1; None = 0

4.2.2 Present Ecological State

The PES or heath/integrity classification of instream and riparian habitats for each of the riverine units, as derived from the desktop assessments and field surveys, is summarised in **Table 12**. These results are displayed graphically in **Map-GTW012-201210-03-02**. Interpretation of these results is based on the IHI categories as described in **Table 4**.

Table 12: Index of Habitat Integrity (IHI) - summarised instream and riparian habitat integrity categories

Assessment unit	Instream category	Riparian category	Integrated category
U30D-119	**C/D**	**C**	**C**
U30D-121	**C**	**C/D**	**C**

With reference to **Table 4**, assessment unit U30D-119, namely the Hlawe River, was found to be in a fair condition (i.e. moderately modified to largely natural with few modifications). Possibly the greatest contributing instream habitat disturbance factor for the riverine units relates to degradation of river bed substrate due to erosion and sedimentation. This is essentially the consequence of land use transformation (notably sugarcane) and resulting hydrological alterations. Factors contributing to the degradation of riparian habitat, bank structure modification due to erosion and alien plant infestations is considered the primary factor resulting in the modification of riparian habitat integrity.

The riverine units have also been subjected to habitat fragmentation, notably U30D-121, largely as a result of the encroachment of sugarcane fields into sensitive riparian areas. Consequences of riparian fragmentation result in the modification of longitudinal and lateral connectivity, which essentially opens up riverine systems to impacts associated with natural and anthropogenic processes from the surrounding landscape.

The smaller riverine system of U30D-121 has been more susceptible to stress from changing hydrological processes, particularly increased frequency of no flow conditions, and in some cases the natural flow regimes would have become severely altered. Although hydrological impacts such as these are, to some degree, also relevant for the larger U30D-119 system given the amount of channel incision that was observed. Such impacts would have caused a reduction in baseflows that otherwise sustain river flows during dry periods. Physico-chemical modifications within the site, with the exception of turbidity and suspended solids, are regarded to be less of an issue in terms of affecting the integrity of riverine habitat. However, it is likely that other water quality modifications, such as nutrient and toxin loading would be considerable as a result of activities associated with sugarcane cultivation, for example application of fertilisers and biocides (e.g. herbicides, insecticides, etc.).

5. Recommendations

It is evident from the abovementioned assessments of the wetland and riverine habitat that the freshwater ecosystems within the study area have been modified, in some instances seriously modified. The assessment of ecological importance and sensitivity, however, suggests that these systems are nevertheless providing valuable ecological goods and services within the landscape and to downstream systems. However, considering the loss of wetland and riparian habitat within KwaZulu-Natal, especially the coastal regions, it is recommended that the planning and implementation of the proposed development should adopt a 'no-net-loss' approach, which would include the following options for the proposed development:

- Maintaining the current levels of ecosystem integrity and service delivery of the systems within the study area; or
- Mitigating and offsetting impacts of the proposed development on the systems by rehabilitating the habitat within the study area; or
- In those cases where the impacts of the proposed development cannot be appropriately mitigated or offset onsite, to rehabilitate habitat offsite.

The following sections outline recommendations and considerations for the planning of the proposed development within the study area.

5.1 Buffer Zones

To protect the freshwater ecosystems from the proposed development, appropriate buffer zones should be adopted. Buffer zones are often determined as 'blanket' recommendations for all watercourses surrounded by a particular land use. Generally, buffers are adopted to protect ecosystems from physical disturbance and to protect the water resource from pollution within an altered landscape.

For example, the following buffer zones have been advocated for the following land uses:

- In an urban setting : 15m to 30m (KZN Department of Environmental Affairs, Agriculture and Rural Development, KZN Department of Water Affairs and Forestry, & Ezemvelo KZN Wildlife);
- In a plantation forestry setting : 20m; and
- In an agricultural setting : 10m from edge of the river (CARA, Act 84 of 1983)
- In an urban landscape : 30m (Gauteng Department of Agriculture, Conservation and Environment)
- In a rural landscape : 50m (Gauteng Department of Agriculture, Conservation and Environment)

In this instance the buffer zones would need to be rehabilitated, with the removal of sugarcane and alien invasive vegetation and the active replanting of indigenous plant, shrub and tree species, to ensure a multilayered, undisturbed vegetative community develops. The buffer zones are likely to assist in reducing the risk of impacts associated with runoff

from the proposed development, which is likely to include semi-industrial areas. The buffer zones would also serve as corridors for the maintenance and movement of faunal species within the landscape. This is significant from a biodiversity conservation perspective as it would improve ecological connectivity across the site through connecting various aquatic and terrestrial habitats.

5.2 Development Planning

Due to modifications to the freshwater systems within the study area, the level of ecosystem services delivery between HGM units is relatively similar. Generally, the large continuous valley bottom systems were identified as supplying higher levels of ecosystem goods and services, which is further enhanced by the extensive areas covered by these systems:

- U30D-119; and
- U30D-115 (to a lesser degree).

The importance of these systems within the landscape should be taken into consideration during the development planning, with protection and additional buffering allocated to these systems.

Generally, the wetlands within the study area are adapted to receiving water from both surface and sub-surface inputs rather than solely surface runoff. As described by the geomorphic vulnerability scores, the potential increase in runoff intensity from the development is likely to pose a risk to the integrity and functioning of the systems within the landscape. To limit the impacts of stormwater runoff on the freshwater ecosystems, the discharge of stormwater runoff into the identified systems should be managed by means of:

- Multiple discharge points that are reasonably spread out across the development adjoining the wetland habitat;
- Flow through the buffer zone should be via diffuse flow and concentrated flow should be avoided (Cornelius-Carolina, 2004; Valparaiso City, 2004). This would assist in reducing the concentration of flows and hence the risks of erosion and further degradation of the receiving environments;
- Accompanying each discharge point should be suitable baffle structures (e.g. gabion mattresses) that will dissipate the energy of storm flow and encourage infiltration, thus reducing the likelihood of erosion;
- The runoff entering the buffer zone should not exceed 1.5m/sec as this is considered to reduce the pollutant removal performance of the buffer area (Valparaiso City, 2004); and
- It is also recommended that these outflow points incorporate a best management practice approach to trap excess suspended solids and other pollutants originating from the proposed development before entering the freshwater ecosystems. These will need to be regularly serviced and maintained to ensure adequate functioning and efficacy.

5.3 Wetland/Riparian Rehabilitation

As discussed previously, the effectiveness with which the freshwater ecosystems within the study area are able to supply ecological goods and services has been reduced by the level of modification to these systems. Without intervention, in the form of rehabilitation, the level of service delivery is unlikely to increase in the post-development landscape. The assessment of the wetlands' ecological integrity highlighted that the alteration of the hydrological and vegetative components of the wetlands has resulted in loss in system health, rather than impacts on the geomorphology. This is congruent with the key drivers noted during the assessment of the riverine habitat, i.e. erosion and sedimentation with limited protection provided from poorly connected riparian and instream habitats. The rehabilitation of the wetlands and riverine systems should therefore focus on addressing these two components as follows:

- Levelling of ridge-and-furrow agriculture and the deactivation of the drainage networks, restoring near-natural hydrological conditions;
- Removal of sugarcane and alien invasive vegetation and re-establishing representative wetland/riparian vegetation;
- Plugging incised channels and drainage lines to restore natural base-levels and reduce further erosion and scouring of soils; and
- Securing the geomorphological integrity of the wetland habitats which will receive increased flows as a result of the development, to ensure erosion of wetland habitat does not occur.

6. References

Cornelius-Carolina, 2004. Land Development Code. Chapter 9: Environmental Protection. North Carolina.

DEAT and EKZNW. 2008. KZN Province land-cover mapping, version 2.0 (from SPOT 2/4 Satellite imagery 2005 - 2006). KZN Department of Agriculture and Environmental Affairs and Ezemvelo KZN Wildlife.

DWAF. 1999. Resource Directed Measures for Protection of Water Resources. Volume 4: Wetland Ecosystems, Version 1.0. Department of Water Affairs and Forestry, Pretoria.

DWAF 2005. A Practical Field Procedure for Identification and Delineation of Wetland and Riparian areas*. Edition 1, September 2005*. Department of Water Affairs and Forestry, Pretoria.

Kleynhans, C.J., Louw, M.D. and Graham, M. 2009. Module G: EcoClassification and EcoStatus determination in River EcoClassification: Manual for Index of Habitat Integrity. WRC Report no. TT 377/09, Joint Water Research Commission and Department of Water Affairs and Forestry Report, Pretoria, South Africa.

Kotze DC, Marneweck, GC, Batchelor, AL, Lindley, DS and Collins, NB 2007. *WET-Ecoservices: a technique for rapidly assessing ecosystem services supplied by wetlands.* WRC Report no TT 339/08, Water Research Commission, Pretoria.

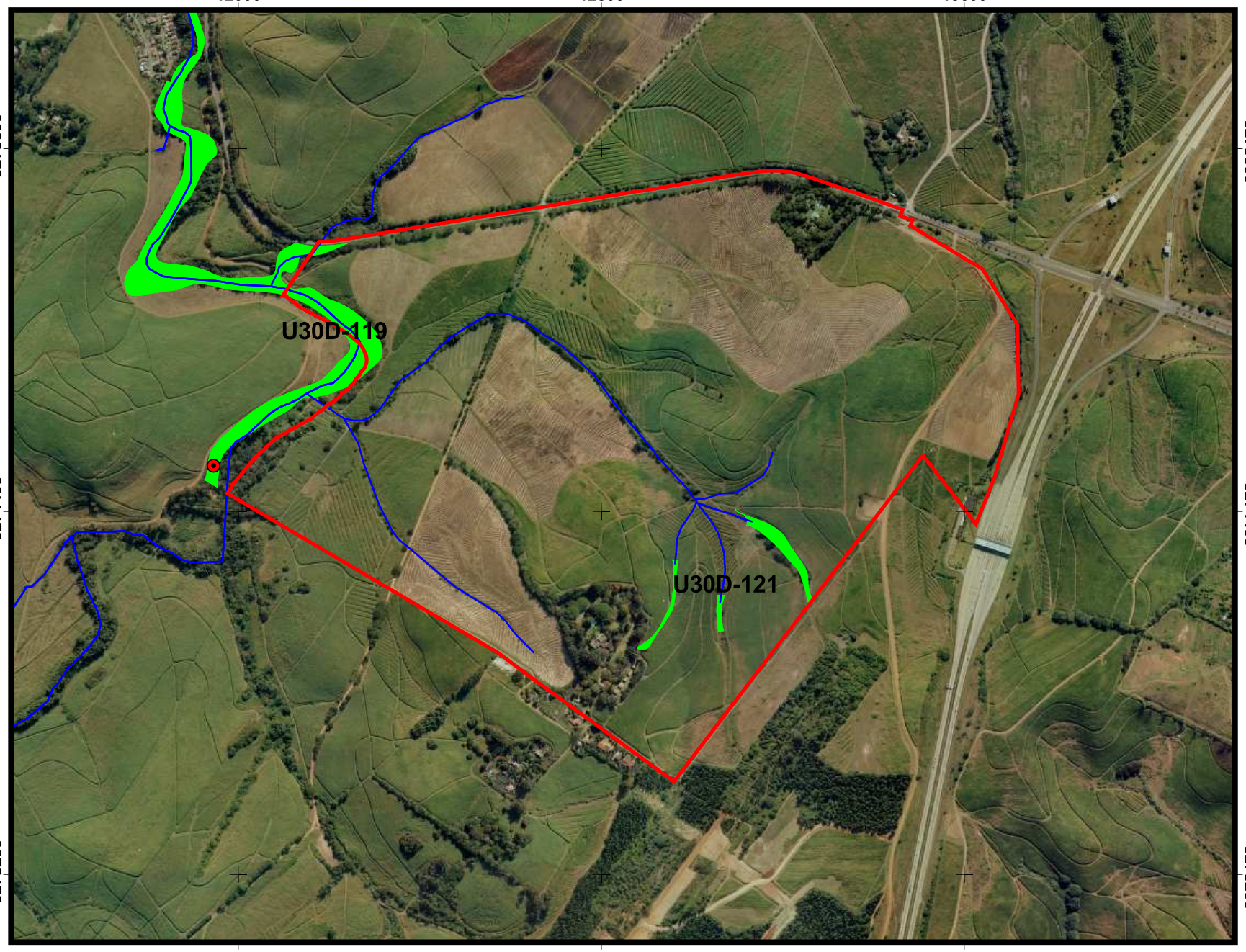
Macfarlane DM, Kotze DC, Ellery WN, Walters D, Koopman V, Goodman P and Goge C (2007) *WET-Health: a technique for rapidly assessing wetland health.* WRC Report no TT 340/08, Water Research Commission, Pretoria.

Valparaiso City. 2004. Stimson Drain Guidebook. Best Management Practice No. 18: Filter Strips. Indiana.

7. Appendices

APPENDIX 1: Supplementary maps produced from the assessment of wetland and riverine habitats, namely **Map-GTW012-201210-01-02**, **Map-GTW012-201210-02-02, Map-GTW012-201210-03-02**, and **Map-GTW012-201210-04-02**.

APPENDIX 2: Selection of graphs illustrating the degree of service delivery for each of the HGM units assessed (**GTW012 WET-Ecoservices Graphs**).



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uShukela Highway (eastern portion)

IHI ASSESSMENT UNITS

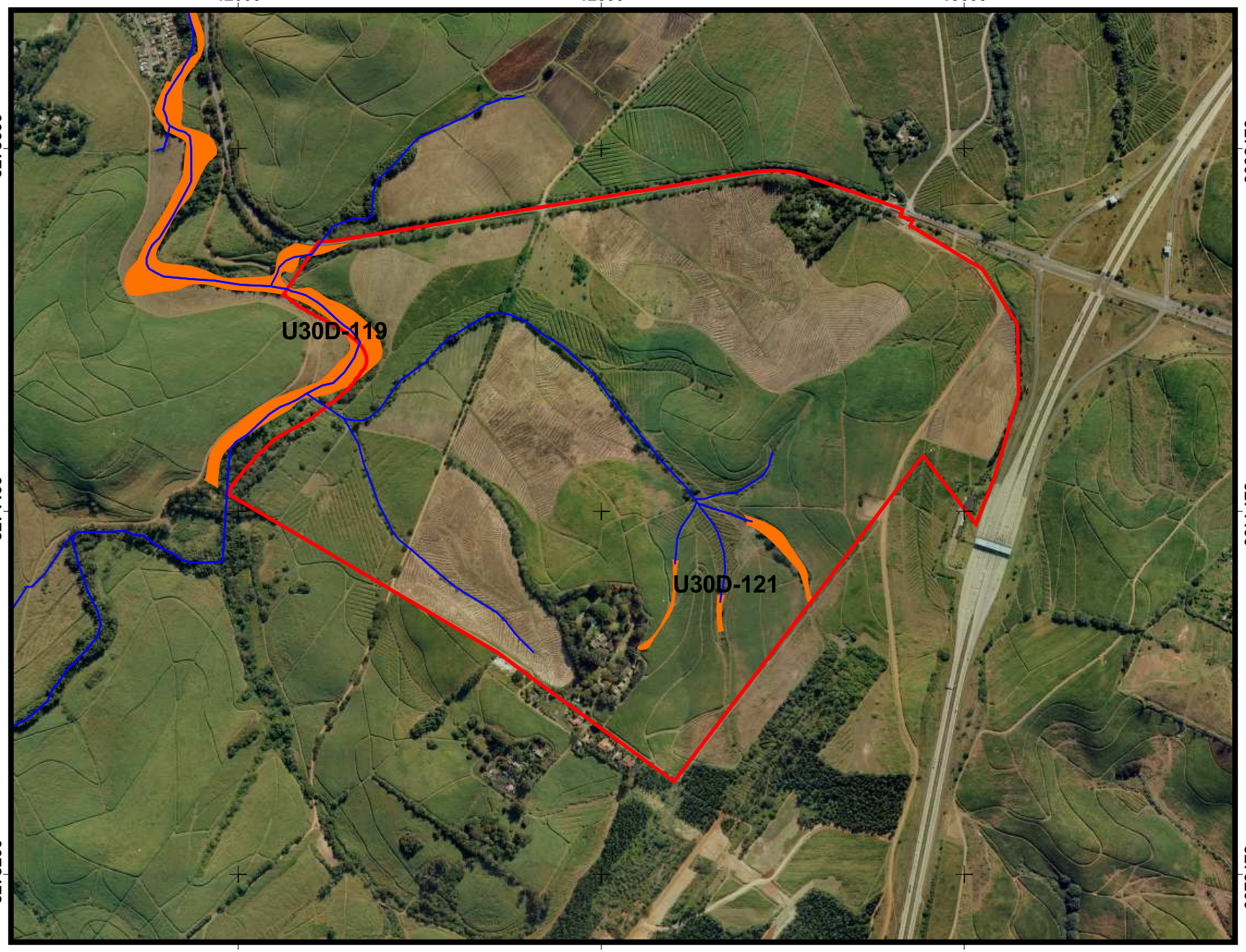
LEGEND

- IHI site
- Study area
- River
- Assessment unit

Map: GTW012-201210-01 02
Datum : Tranverse Mercator
Projection : WGS 84
Meridian: Lo 31
Scale: 1: 12 000

N

75 0 75 150 m



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uShukela Highway (eastern portion)

Ecological importance and sensitivity (EIS)

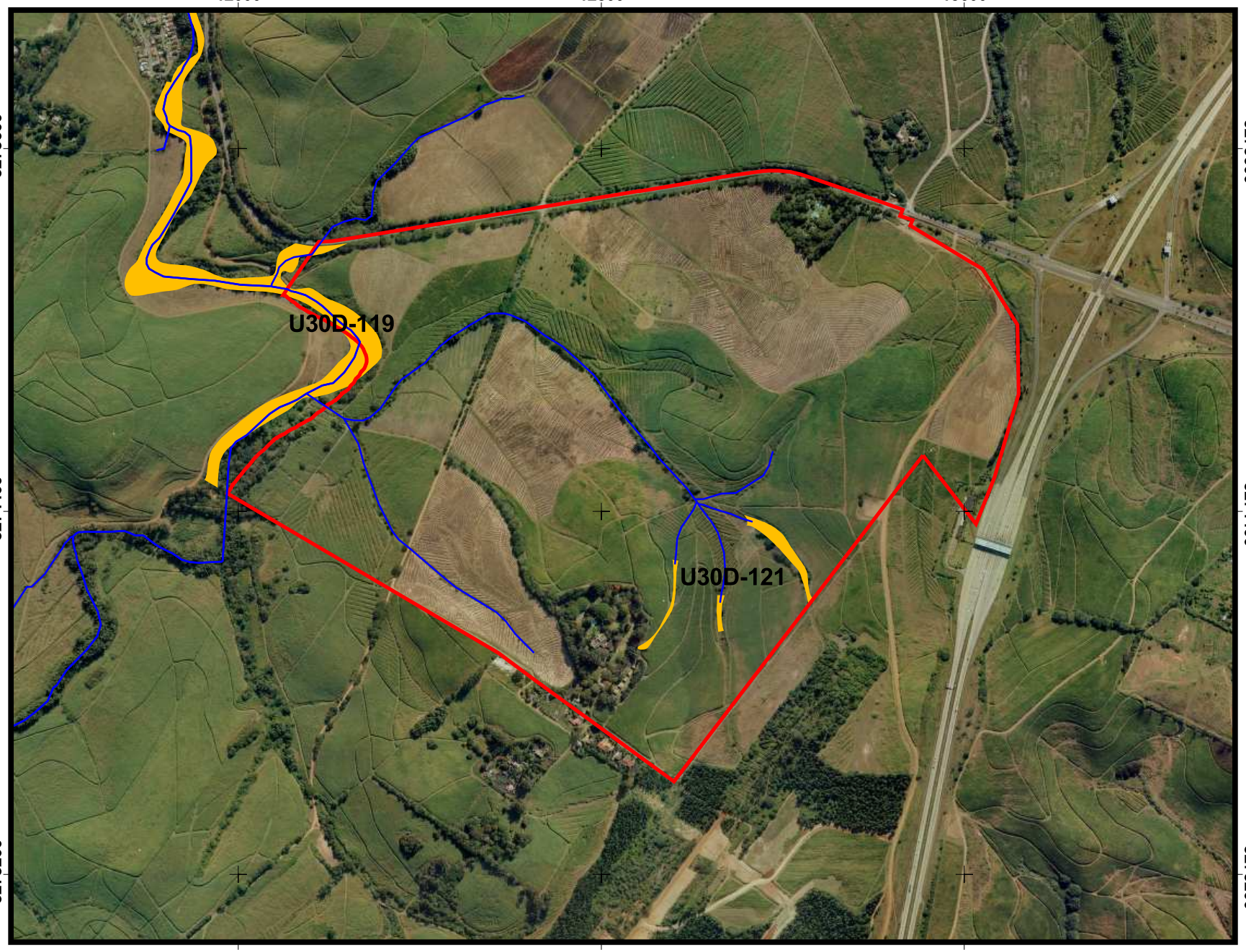
LEGEND

- Very high
- High
- Moderate
- Marginal/Low
- None

Map: GTW012-201210-02 02
Datum : Tranverse Mercator
Projection : WGS 84
Meridian: Lo 31
Scale: 1: 12 000

N

75 0 75 150 m



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uShukela Highway (eastern portion)

PRESENT ECOLOGICAL STATE (PES)

LEGEND

- Unmodified
- Unmodified/Largely natural
- Largely natural
- Largely natural/Moderately modified
- Moderately modified
- Moderately modified/Largely modified
- Largely modified
- Largely modified/Seriously modified
- Seriously modified
- Seriously modified/Critically modified
- Critically modified

Map: GTW012-201210-03 02
Datum : Tranverse Mercator
Projection : WGS 84
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N

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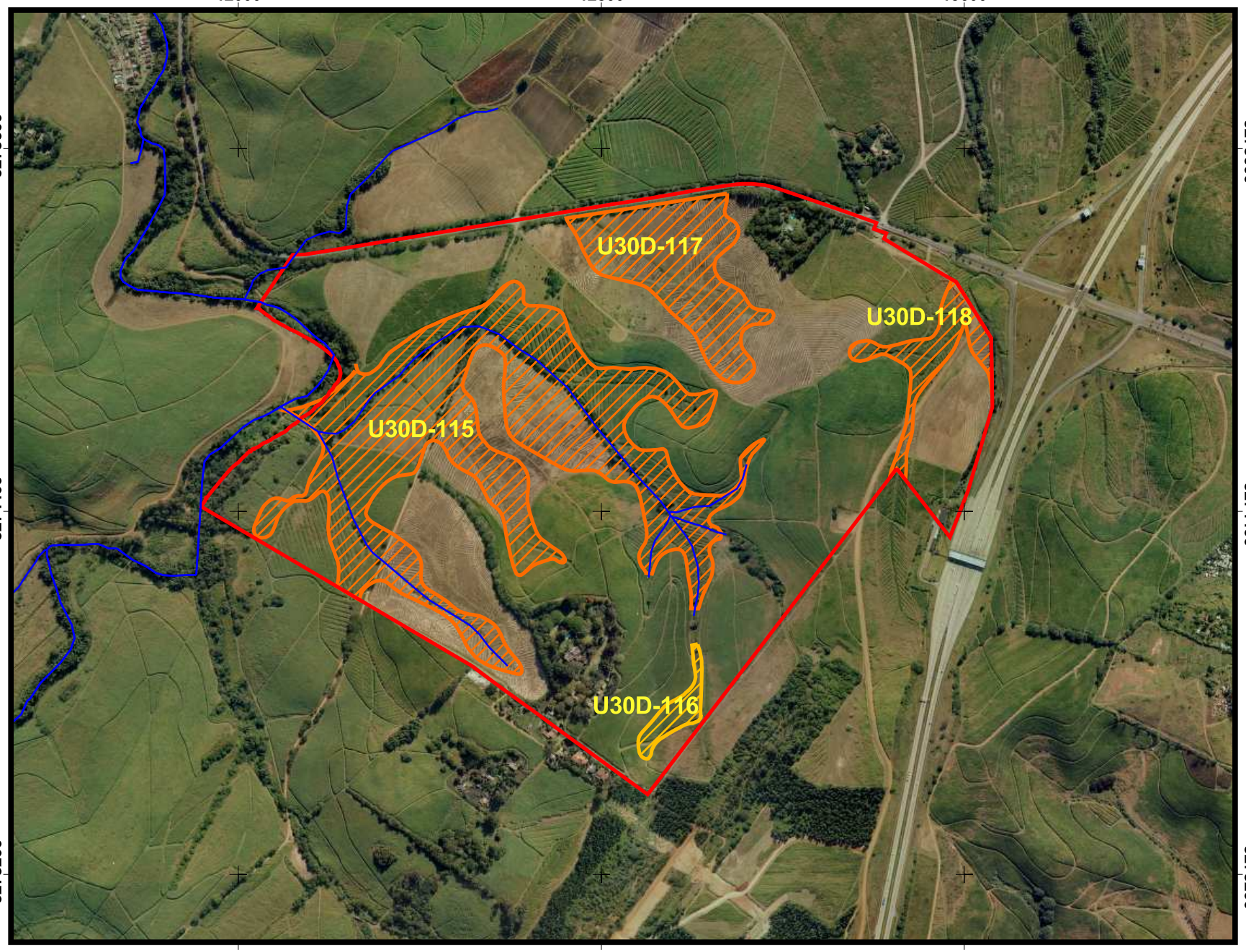

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uShukela Highway (eastern portion)

Wet-Health Scores

LEGEND

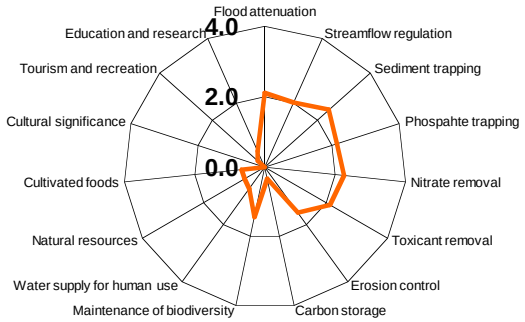
- A - Natural
- B - Largely natural
- C - Moderately modified
- D - Largely modified
- E - Seriously modified
- F - Critically modified

Map: GTW012-201210-04 02
Datum : Tranverse Mercator
Projection : WGS 84
Meridian: Lo 31
Scale: 1: 12 000

N

75 0 75 150 m

HGM Unit U30D-115



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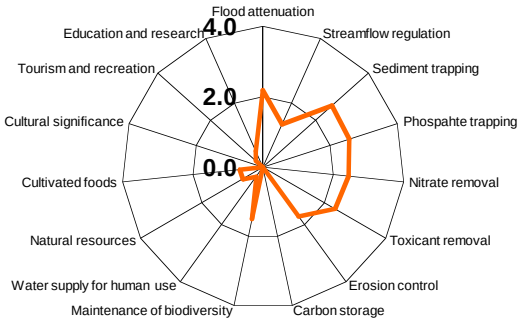
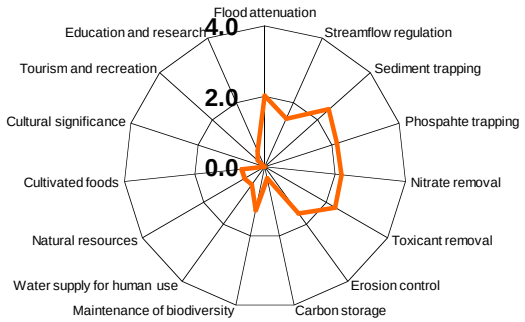
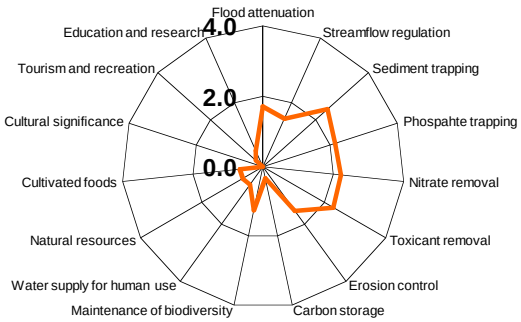


HGM Unit U30D-117



HGM Unit U30D-118



Appendix 9: Watson Highway Light Industrial and Office Park Development Site: Wetland and Riparian Assessment Report

Watson Highway Light Industrial and Office Park Development Site: Wetland and Riparian Assessment Report Draft

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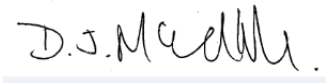
SIGNATURE: 	SIGNATURE:	SIGNATURE:
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The primary land use within the study site is currently commercial sugarcane cultivation, facilitated within the wetland areas by the historical implementation of artificial drainage and ridge-and–furrow agricultural practices. With the exception of the exception of the riparian habitat and a small section of secondary grassland adjacent to the bricked access road, all of the indigenous vegetation has been replaced by sugarcane (refer to **Figure 3.6**). The riparian areas are generally dominated by forest species such as *Rauvolfia caffra, Syzigium cordatum* and *Albizia adianthifolia* although there has been widespread infestation by alien plant species such as *Lantana camara, Melia azedarach, Schinus terebinthifolius, Chromalaena odorata* and *Ricinus communis*. Most of the temporary wetland zone habitat has been transformed by sugarcane, leaving seasonal zone habitat characterised by hygrophilous species such as *Leersia hexandra, Cyperus latifolius, Typha capensis* and *Ischaemum fasciculatum*.

Figure 3.6 Overview of the vegetation of the project area

3.2 Wetland and Riparian Habitat Distribution

The freshwater ecosystems within the development site cover an area of approximately 54ha, and consist of:

- Six hillslope seep wetlands driven predominantly by subsurface seepage through the soils in the surrounding catchment;
- Ten naturally unchannelled valley bottom wetlands, mostly located on the deep sands in the eastern half of the project area. These are also predominantly driven by subsurface seepage from the sandy catchment soils, although the hydrological regime has been significantly altered by ridge-and-furrow within the wetland and extensive sugarcane cultivation in the catchment;
- One channelled valley bottom wetland, by far the largest HGM unit and dominating the site. This wetland may originally also have been unchannelled, but the channel, whether created by excavation and subsequent erosion or by erosion alone

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associated with the change in catchment landuse, has become well established with associated riparian vegetation. It is, however, unlikely that overbank topping is a key driver of the system which would point to its probable unchannelled origin. The key drivers are:

- Subsurface seepage both from the surrounding slopes and wetland tributaries;
- Lateral surface inputs from via the drain network within the wetland tributaries; and
- Longitudinal surface flow from the four riparian units in the upper reaches of the system.

o One riparian C-channel, the *Hlawe* River, characterised by perennially flowing base-flow; and

o Six riparian B-channels containing seasonal contact with base-flow and exhibiting signs of temporary to seasonal inundation in the channel bed.

Figure 3.7 shows the distribution of the respective aquatic units within the site, and indicates the labelling used in the subsequent assessments.

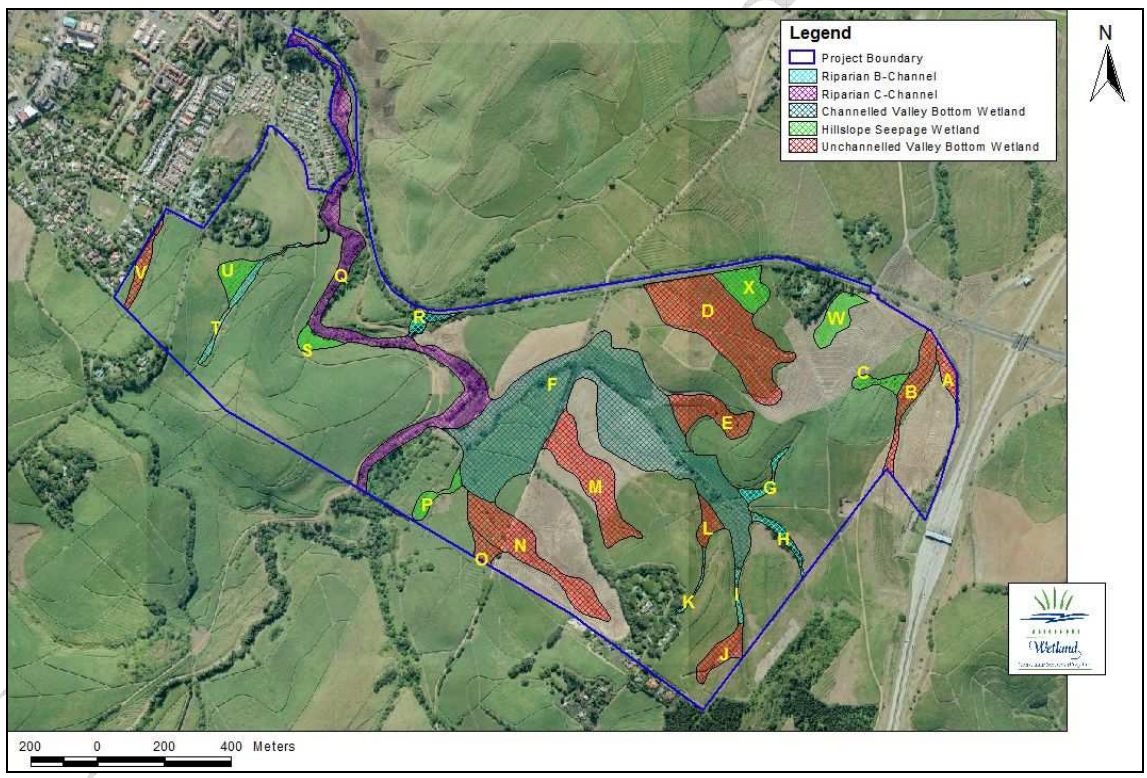

Figure 3.7 Wetland/riparian habitat identified within the development site

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3.3 Wetland Functional Assessment

The general features of each wetland HGM unit were assessed in terms of functioning, which allowed the most important benefits provided by the respective wetlands to be identified and the overall importance of each HGM unit to be determined at a landscape level. The level of functioning supplied by the wetland units for various ecological services is shown in **Table 3.1.** These results are graphically represented in **Appendix 1.**

Note: The ecosystem services supplied by the wetland systems are ranked according to the following scoring method:

- 0 - Low
- 1 – Moderately Low
- 2 - Intermediate
- 3 – Moderately High
- 4 - High

The important points to note are:

- With the exception of unit F, all of the wetland HGM units are either unchannelled valley bottom wetlands or hillslope seeps. The primary ecological driver for both of these system types is subsurface seepage, and hence the types of ecological services provided will be similar; and
- All of the wetlands have been severely impacted by human-induced changes to the wetland hydrology in the form of:
  - The complete removal of indigenous vegetation;
  - The excavation of a comprehensive network of herring-bone drains, encouraging the rapid removal of water from the habitat (**Figure 3.8**);

Figure 3.8 Excavated drain network

- Cultivation of all of the respective watersheds to sugarcane. This introduces a period of a year immediately after harvesting of very little vegetative cover of the soils, leading to

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soil surface compaction and sheet erosion which, in conjunction with the limited surface roughness offered by the rows of young sugarcane, results in increased surface flow at the expense of soil infiltration. This translates into an increased rate of passage of water through the wetland, increased soil erosion potential and an overall loss in wetland functioning.

It is therefore necessary to recognise that the level of ecosystem delivery for all of the identified wetlands within the development site has been severely compromised by historic disturbances associated with the current landuse.

The scores for all of the fifteen recognised ecological services across all seventeen wetland units ranged from ***Low*** to ***Intermediate***. Based on the results obtained from the respective assessments, the dominant common ecological services provided by the wetland network are flood attenuation and sediment trapping, which generally returned ***Intermediate*** scores. Unit V returned the highest score for flood attenuation, however this is artificially boosted by the presence of floodable property downstream, which raises the *opportunity* for the wetland to perform this function, but not necessarily its *effectiveness* as indicated by the confined nature of this wetland.

Due to their topography, size and position in the landscape, units F and M would be expected to be the most important in attenuating floodwaters, and returned scores marginally less than that of unit V. It is, however, evident that the effectiveness of these wetlands to fulfil this function is being severely undermined by the drain network, which is preventing diffuse flow, and the removal of surface roughness associated with natural wetland vegetation. Unit F was the most important wetland in trapping sediment, although this was also an ***Intermediate*** score.

Unit J was found to be the most important unit in terms of enhancing water quality, returning an ***Intermediate*** score for the three components of phosphate, nitrate and toxicant removal, as opposed to the ***Moderately Low*** scores returned by the other wetlands. This is primarily because the wetland has not been drained extensively and diffuse flow conditions prevail, allowing nutrient and toxicant particles to be adsorbed within the soil profile.

It was expected, due to the dominance of subsurface flow through the sandy catchment soils, that streamflow augmentation would be one of the most important ecological services provided especially by the wetlands in the eastern part of the study area. This is, however, not the case with ***Moderately Low*** scores returned for all of the wetlands. This is attributed, again, to the extensive network of drains excavated within the wetland habitat facilitating rapid surface drainage of water from the landscape. The wetlands within the study site currently make a poor contribution to the provision of direct benefits such as water and natural resources, although the importance of wetland associated cultivated foods has received a slight boost from the employment provided by sugarcane production within the wetland habitat. None of the wetlands within the site currently make any notable contribution to the maintenance of local biodiversity.

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Table 3.1. Ecological Services supplied by each identified wetland unit within the proposed development.

Ecosystem Services	Unit A	Unit B	Unit C	Unit D	Unit E	Unit F	Unit J	Unit L	Unit M	Unit N	Unit O	Unit P	Unit S	Unit U	Unit V	Unit W	Unit X
Hydrogeomorphic Type	**V***	**V**	**HW****	**V**	**V**	**VC*****	**V**	**V**	**V**	**V**	**V**	**HW**	**HW**	**HW**	**V**	**HW**	**HW**
Area (ha)	**0.54**	**1.58**	**0.57**	**6.99**	**1.85**	**19.4**	**0.96**	**0.6**	**3.49**	**3.58**	**0.5**	**0.56**	**0.53**	**0.79**	**0.68**	**1.15**	**1.15**
Flood attenuation	2.1	2.5	2.2	1.8	2.2	2.3	2.2	2.5	2.3	2.2	2.3	2.3	2.3	2.6	2.7	2.0	2.1
Streamflow regulation	1.7	1.7	1.7	1.7	1.7	1.7	1.5	1.3	1.7	1.6	1.6	1.4	1.8	1.5	1.7	1.7	1.7
Sediment trapping	2.5	2.5	2.1	1.9	2.4	2.9	2.5	2.0	2.4	1.7	1.8	1.9	2.4	1.9	2.1	1.8	1.6
Phosphate trapping	1.7	1.8	1.7	1.4	1.8	1.9	2.3	1.5	1.8	1.2	1.2	1.8	1.9	1.9	1.7	1.8	1.8
Nitrate removal	1.7	1.8	1.6	1.6	1.7	1.7	2.1	1.5	1.7	1.4	1.4	1.9	1.5	2.1	1.4	2.1	2.2
Toxicant removal	1.7	1.8	1.7	1.4	1.8	1.9	2.1	1.5	1.7	1.2	1.3	1.6	1.8	1.7	1.7	1.7	1.7
Erosion control	2.1	2.5	1.8	2.0	2.1	1.7	2.3	2.1	1.9	1.8	1.9	2.1	1.7	2.0	1.6	2.1	2.3
Carbon storage	0.3	0.3	0.3	0.3	0.3	0.3	0.0	0.3	0.3	0.3	0.3	0.0	0.3	0.0	0.3	0.3	0.3
Maintenance of biodiversity	0.8	0.8	1.2	1.6	1.9	1.0	1.4	2.0	1.8	1.6	1.7	1.9	2.0	1.9	1.3	1.5	1.5
Water supply for human use	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.2	0.5	0.3	0.4	0.4	0.4
Natural resources	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Cultivated foods	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Cultural significance	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tourism and recreation	0.6	0.6	0.6	0.6	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.0	0.6	0.0
Education and research	1.0	1.0	1.0	1.0	0.5	1.0	0.3	0.3	0.0	1.0	1.0	0.3	0.3	0.5	0.8	1.0	1.0

Legend			
	Highest Score for Ecosystem Service		Lowest Score for Ecosystem Service

* V – Unchannelled Valley Bottom Wetland
** HW - Hillslope Seep Connected to a Watercourse
*** VC - Channelled Valley Bottom Wetland

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3.4 Ranking of Wetland HGM Units

In terms of ecosystem benefits and services Unit J stands out as the most important unit. However, when distinguishing between units it is useful to examine their value in the context of their size and spatial relationship to other wetland units and the main river system. The larger the wetland unit, the greater its importance, and all other factors being equal, the more directly connected the wetland is to the main river system, the more important it would be. For example, a wetland immediately adjacent to an important river would be "the last line of defence" in terms of trapping sediment and assimilating pollutants being carried into the system.

The following ranking attempts to show the relative importance in terms of wetland benefits and services of each of the HGM units within the development site taking into consideration their WET-Ecoservices scores and their size:

Table 3.2. Ranking of the HGM units

HGM Unit	Rank	HGM Unit	Rank	HGM Unit	Rank
Unit F	1	Unit W	7	Unit O	13
Unit M	2	Unit B	8	Unit C	14
Unit J	3	Unit X	9	Unit L	15
Unit E	4	Unit S	10	Unit V	16
Unit D	5	Unit P	11	Unit A	17
Unit U	6	Unit N	12		

3.5 Riparian Ecological Integrity Assessment

Seven hydrologically important riparian systems were identified within the project area. The ecological integrity of a riparian system is defined as its ability to support and maintain a balanced, integrated composition of physico-chemical and habitat characteristics, as well as biotic components on a temporal and spatial scale that are comparable to the natural characteristics of ecosystems of the region (Kleynhans, 1996). The eight key criteria considered were:

- Indigenous vegetation removal;
- Exotic vegetation encroachment;
- Bank erosion;
- Channel modification;
- Water abstraction;
- Inundation;
- Flow modification; and
- Water quality

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Each of these factors was assigned a score, or rating, in which the observed or deduced condition of each factor is compared to what it could have been under undisturbed conditions. The following scoring classes were used:

- ***None*** (0);
- ***Small*** (1 to 5);
- ***Moderate*** (6 to 10);
- ***Large*** (11 to 15);
- ***Serious*** (16 to 20); and
- ***Critical*** (21 to 25)

The scores were weighted with a value that reflected the perceived importance of that particular criterion in determining habitat integrity, allowing this to be numerically expressed in relation to the perceived benchmark. These values are then summed to produce a score that reflects the overall habitat integrity of the riparian unit. The results of the assessment are shown in **Table 3.3**.

Table 3.3: Results of Riparian Habitat Integrity Assessment

Riparian Zone	**Unit G**	**Unit H**	**Unit I**	**Unit K**	**Unit Q**	**Unit R**	**Unit T**
Criterion	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**
Water Abstraction	0	0	0	0	10	0	0
Flow Modification	18	18	18	18	21	22	18
Channel modification	10	25	15	15	21	25	5
Water Quality Modification	15	10	15	15	18	15	12
Inundation	0	0	0	0	5	0	0
Vegetation Removal	25	15	25	25	22	20	25
Exotic Vegetation Encroachment	15	10	5	5	20	20	17
Bank Erosion	15	10	18	10	15	25	5
Score (% of Total)	**50.2**	**55.9**	**50.9**	**55.3**	**33.6**	**35.6**	**58.7**
Habitat Integrity Class	**D**	**D**	**D**	**D**	**E**	**E**	**D**

Based on the above scores, each riparian unit was then assigned to a habitat integrity class, according to **Table 3.4**.

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Table 3.4: Habitat Integrity Assessment Classes

Class	Description	Score (% of total)
A	Unmodified	100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-99
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions have occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions are extensive.	20-39
F	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0-19

The most important riparian unit from a hydrological perspective is the perennially flowing *Hlawe* River, unit Q. This is considered to have undergone ***extensive loss of natural habitat, biota and ecosystem functioning*** as a result of both of direct and indirect impacts associated with agricultural and urban development. The following impacts undermining ecological integrity were identified:

- The flow regime of water through the system is likely to have been impacted by runoff from the extensive sugarcane lands in the entire catchment;
- The altered flow regime has resulted in substantial incision and erosion of the channel bed;
- The extensive agricultural landuse, and associated nutrient and sediment loads associated with it, is likely to have detrimentally affected water quality;
- A large proportion of the indigenous riparian vegetation has been removed;
- There is substantial encroachment from alien invasive species such as *Lantana camara, melia azedarach* and *Solanum mauritianum*.

Unit R, a deeply incised riparian B-channel flowing directly into unit Q, has sustained similar impacts and as a consequence is considered to fall within the same habitat integrity class.

The remaining four riparian units share marked similarities in size, catchment landuse and consequent impacts, and are considered to be ***Largely Modified***, with a considerable loss in habitat and biota although the basic ecosystem processes are still operating. The major consistent impact is the removal of indigenous riparian vegetation.

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4. POTENTIAL IMPACTS OF THE DEVELOPMENT

The proposed development entails a change in landuse from cultivated agriculture to urban development, and as such the primary impact is likely to be the change in runoff characteristics from diffuse discharges in the undeveloped state to point source piped discharges in the transformed state with additional changes to volumes and discharge rates. Typically the runoff characteristics associated with urbanisation lead to increased peak discharges and runoff volumes, decreased response time, increased frequency and severity of flooding, and a change in the characteristics of urban waterways from ephemeral to perennial streams (Wong *et al.,* (2000). Using data from the paired Giralang and Gungahlin catchments near Canberra, Codner *et al.,* (1988) found that average runoff from the urban Giralang catchment was six times that from the rural Gungahlin catchment, and ***the peak flow from a one year Average Recurrence Interval (ARI) event was ten times as large.*** Rainfall-runoff plots indicate an impervious area of 25% on the urban catchment.

Additionally , the effect of urbanisation is larger for more common rainfall events, because under undeveloped conditions common events typically generate no to very little runoff. Following urbanisation the change in the behaviour of rainfall and runoff due to the increase in impervious surfaces is large. The much larger rare events lead to saturation of the pervious areas followed by significant runoff, so a change to impervious makes much less difference. Using simulation modelling it was shown that a highly urbanised catchment (60% impervious) increased peak flow by a factor of 5 for the 100 year ARI event, but by ***a factor of 30 or more for the most common events*** (ARI < 1 year). Wong et al., (1999) concluded that the hydrologic effects of urbanisation were ultimately due to the increase in impervious area and an increase in the degree of connection between the impervious area and the receiving waters.

The distribution, type and extent of wetlands in a particular landscape is influenced by the behaviour of water moving through the landscape (hydrology), with drainage patterns being influenced by the geomorphology and the derived soils which is in turn influenced by the geology (Pidwinny, 2006, Nag & Chakraborty, 2002). Soil in particular is an important regulator of a catchments response to rainfall as it absorbs, retains, redistributes and releases rain falling on it (Schulze, 1985a, 1985b). At the local scale in an undeveloped catchment given the same climate, soils, the vegetation and the general slope of the topography play an important role in regulating the behaviour of rainfall, ultimately the source of water contributing to the presence of and types of wetlands likely to be encountered.

In summary, the consequences of the increase in hardened surfaces within the development site are likely to be:

- Increased runoff volumes and flow rates, both into the wetland and through the wetland. This may result in further erosion, gully incision and an overall loss in wetland functioning;

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- Increased erosion within the riparian units as the greater flow volumes and velocities manifest themselves in the form of channel scouring;
- Increased point-source erosion from road culverts and storm-water discharge points, which may not-only contribute to the elevated flow velocity within the receiving environment, but also result in exacerbated lateral gully erosion within the highly erodible soils particularly on the eastern side of the study area;
- Elevated sediment deposition into the *Tongati* estuary, with the associated detrimental impacts on estuarine ecosystem functioning;
- A potential decrease in water quality of water entering the wetland systems from hydrocarbons washed in from the road network;

In considering the impacts of the development, and ways in which to mitigate them, it is necessary to note the following:

- The impacts are likely to be more severe on the wetlands in the sandy soils of the eastern half of the development site because subsurface seepage is a dominant driver of these systems;
- The water within the development will have to be carefully managed if the objective is to maintain these wetlands in their current state; and
- The wetlands are currently severely degraded. They therefore provide a valuable opportunity for rehabilitation to improve the overall degree of ecological functioning within the landscape. The provisor is, again, that the water within the site is carefully managed. To illustrate this, functional assessments were carried out on the three spatially most important wetlands on the site under both current and hypothetical rehabilitated conditions, the results of which are provided in section 5.

5. BROAD RECOMMENDATIONS

The use of buffer zones is a commonly applied practice for reducing the impact of products derived from landscapes on receiving water bodies or to provide opportunities to protect the ecotones between “upland” and riparian/wetland habitats. Functions associated with buffer zones include (summarised from international literature by Macfarlane *et al* (2009)):

- Sediment removal;
- Nutrient removal;
- Toxic removal;
- Control of microclimate and water temperature;
- Provision of habitat for wildlife;
- Screening of adjacent disturbances;
- Habitat connectivity;
- Channel stability and flood attenuation;
- Groundwater recharge; and
- Aesthetic appeal.

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The application of buffer zones in the South African context has been advocated as a means of affording protection to wetlands, in the context of screening the systems from adjacent disturbances and protecting water quality by intercepting nutrients and sediments. In addition as wetlands and riparian systems are generally linear systems creating linkages between upslope/upstream and downslope/downstream environments, buffer zones afford opportunities for corridors to facilitate linkages between habitats, and ecotones between the aquatic and terrestrial environments. ***Unfortunately buffer zones as generally applied do not protect wetlands from changes in hydrology or water quality brought about by changes in land use in the catchment, whether this be upstream of or adjacent to a particular wetland or riparian zone***.

For example a buffer zone separating agricultural land from a wetland or riparian system would generally intercept diffuse runoff or subsurface flows from the adjacent landscape. This would afford an opportunity for intercepting sediments (change in roughness) as well as for trapping and transforming nutrients. ***Given the above, it could be argued that the application of buffer zones in the absence of any other measures would be unlikely to offer any protection to either the wetlands, streams or riparian areas.***

In summary, buffer zones, ranging from 20m to 30m although the actual width is still a subject of much debate, are ecologically sound concepts because they:

- Provide a cushion between terrestrial and more dynamic aquatic ecosystems,
- Make an important contribution to ecological connectivity within the landscape; and
- Most importantly they provide space in which to work if the post-development landscape creates unforeseen environmental problems which require physical intervention.

They are, however, unlikely to protect the aquatic habitat on their own. An alternative and/or rather complimentary approach, and the one that we would advocate, is to identify sensitive and important habitats/and or stream reaches that could be affected by changes in hydrology and then apply at different scales in the landscape measures to ensure that for specified return event storms that flows do not exceed pre-development flows and volumes by >10%.

There are a number of strategies that can be deployed at different scales to attempt to achieve this, examples being:

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5.1 Porous pavements

Porous pavement is an infiltration system where storm water runoff is infiltrated into the ground through a permeable layer of pavement or other stabilized permeable surface. These systems can include porous asphalt, porous concrete, modular perforated concrete block, cobble pavers with porous joints or gaps or reinforced/stabilized turf (Urbonas and Strecker, 1996). Permeable pavement can be used in parking lots, roads and other paved areas and can greatly reduce the amount of runoff and associated pollutants leaving the area. Typically, porous pavement can only be used in areas that are not exposed to high volumes of traffic or heavy equipment. They are particularly useful for driveways and streets in residential areas, and in parking areas in commercial areas (**Figure 5.1**).

Figure 5.1 Installation of a porous pavement
(Source: Eicker, in the Urban Greenfile, December 2007).

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5.2 Grassed swales/infiltration trenches

The use of grassed swales in association with infiltration trenches should be encouraged to convey storm water. Vegetated swales are broad, shallow channels with a dense stand of vegetation covering the side slopes and channel bottom. Vegetated swales are designed to slowly convey storm water runoff, and in the process trap pollutants, promote infiltration and reduce flow velocities.

An infiltration trench or well is a gravel-filled trench or well designed to infiltrate storm water into the ground. A volume of storm water runoff is diverted into the trench or well where it infiltrates into the surrounding soil. Typically infiltration trenches and wells can only capture a small amount of runoff and therefore may be designed to capture the first flush of a runoff event. The advantages of these systems have been discussed previously but are repeated here and include:

- That runoff is treated both by passing over the grass as well as filtration through the soil and rock packed trench;
- The water percolating into the soils reduces the irrigation demand of roadside trees and shrubs;
- The attenuation provided by the system reduces the requirement to provide alternative attenuation facilities;
- Sediment transport into the water courses is obviated as the grass lined swales effectively trap sediment;
- Increasing flow path lengths;
- Decreasing road gradients as far as possible within the constraints of good design practice and site topography; and
- Retaining water on the road surface as long as possible.

An example is presented in **Figure 5.2**.

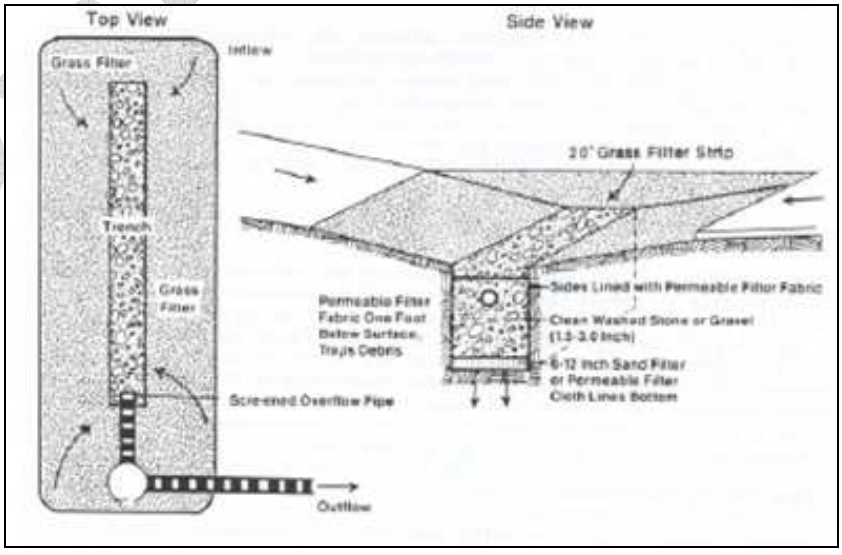

Figure 5.2:Schematic of a median swale/trench system

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The combination of swale and infiltration trench is a useful combination in that it provides opportunities for both filtration and flow retardation.

5.3 Wet Detention Ponds

Finally, consideration could be given to the construction of wet detention ponds together with these other options to create areas of extended wetness, to provide the functions associated with the existing wetland areas on the site. A schematic of a wet detention pond is illustrated in **Figure 5.3**.

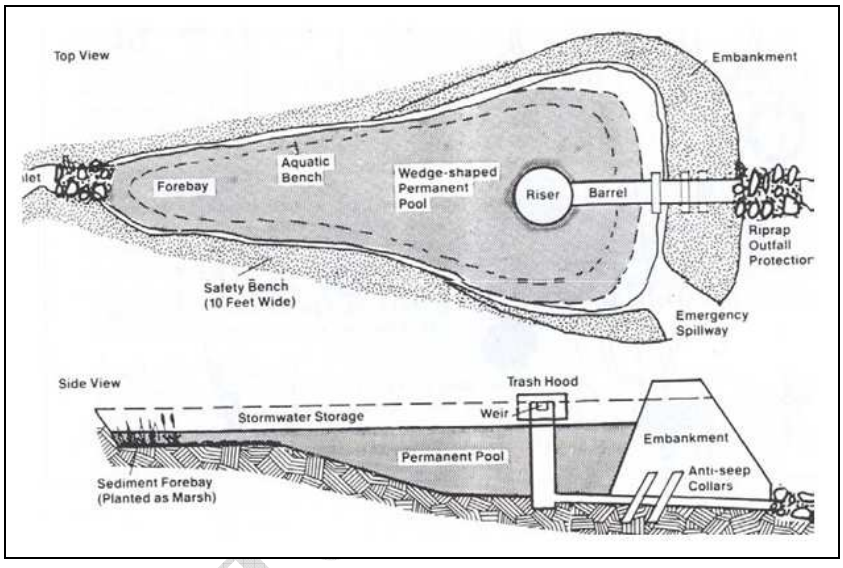

Figure 5.3. Schematic of plan and cross section through a wet detention pond

5.4 Road Works

Runoff off the road surface should be directed into grass lined channels, stone filled infiltration ditches etc. rather than into an underground piped systems. The advantages associated with this approach are:

- That runoff is treated both by passing over the grass as well as filtration through the soil and rock packed trench;
- The water percolating into the soils reduces the irrigation demand of roadside trees and
- shrubs;
- The attenuation provided by the system reduces the requirement to provide alternative
- attenuation facilities;
- Sediment transport into the water courses is obviated as the grass lined swales effectively trap sediment;
- Increasing flow path lengths;
- Decreasing road gradients as far as possible within the constraints of good design practice and site topography, and

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- Retaining water on the road surface as long as possible.

Of these strategies and systems outlined above the following specific systems would appear to be appropriate for inclusion in the development plans for Ellingham, given the objectives of flow and water quality management and biodiversity support.

5.5 Potential for Wetland Rehabilitation

An issue that does require clarification is whether the environmental requirement is for the wetlands to be maintained in their current state, or whether they should be rehabilitated, which would mostly consist of removing, or deactivating, the drainage networks and re-establishing vegetation cover. This may have a significant bearing on the nature of the development, because successful wetland rehabilitation is inextricably linked with the catchment landuse.

As illustrated below (refer to **Table 4.1** and **Figures 4.4 to 4.6**), rehabilitation is likely to result in a substantial increase in most of the biological benefits provided by wetlands, if not the social benefits. These are mostly going to be associated with the restoration of natural diffuse flow conditions within the wetlands, and rehydration of the soil. The obvious exception to this is sediment trapping, although this is mostly associated with the removal of the sediment source, the assumption being that the development will take place under environmentally sound conditions.

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Table 4.1. Ecological Services supplied by three spatially important wetlands to illustrate the effects of rehabilitation measures on wetland functioning.

Ecosystem Services	Unit D- Pre	Unit D- Rehab	Unit F- Pre	Unit F- Rehab	Unit M- Pre	Unit M- Rehab
Hydrogeomorphic Type	1.8	2.0	2.3	2.2	2.3	2.5
Area (ha)	1.7	1.7	1.7	2.2	1.7	1.7
Flood attenuation	1.9	1.7	2.9	1.6	2.4	1.5
Streamflow regulation	1.4	2.1	1.9	2.1	1.8	2.0
Sediment trapping	1.6	2.2	1.7	2.4	1.7	2.2
Phosphate trapping	1.4	1.9	1.9	2.2	1.7	1.7
Nitrate removal	2.0	**3.0**	1.7	**3.3**	1.9	2.8
Toxicant removal	0.3	1.7	0.3	2.7	0.3	1.7
Erosion control	1.6	**3.0**	1.6	**3.8**	1.8	2.9
Carbon storage	0.4	0.4	0.4	1.0	0.4	0.4
Maintenance of biodiversity	0.4	0.4	0.4	0.4	0.4	0.4
Water supply for human use	1.4	0.4	1.4	0.4	1.4	0.4
Natural resources	0.0	0.0	0.0	0.0	0.0	0.0
Cultivated foods	0.6	0.6	0.6	0.6	0.3	0.6
Cultural significance	1.0	1.0	1.0	1.0	0.0	1.0
Tourism and recreation	1.8	2.0	2.3	2.2	2.3	2.5
Education and research	1.7	1.7	1.7	2.2	1.7	1.7

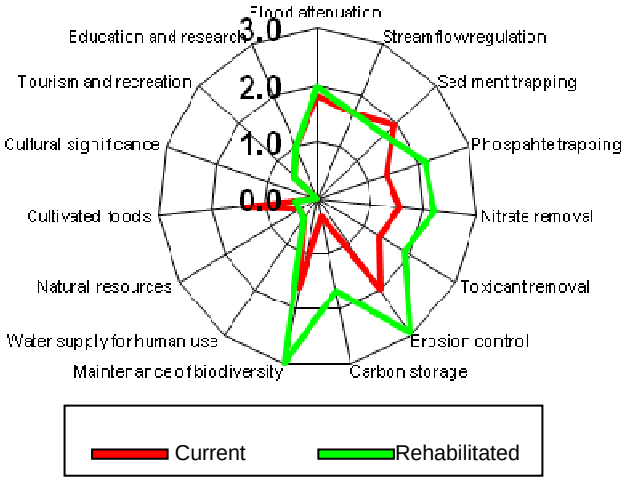

Figure 4.4 Unit D

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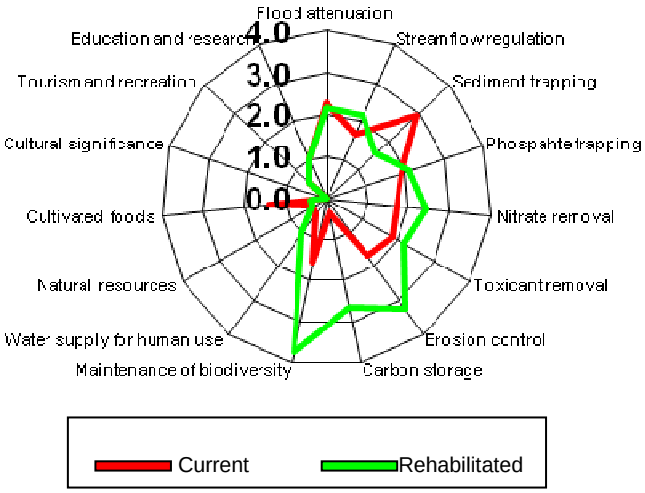

Figure 4.5 Unit F

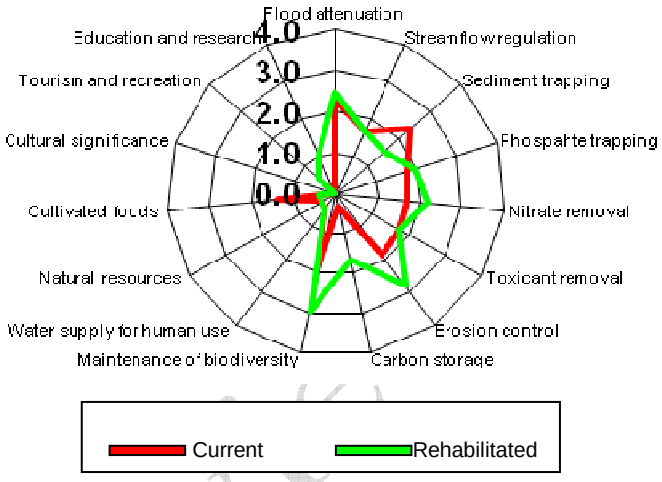

Figure 4.6 Unit M

6. REFERENCES

KLEYNHANS, C.J. 1996. A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhu River. *Journal of Aquatic Ecosystem Health* 5: 41-54**.**

KOTZE, D.C., MARNEWECK, G.C., BATCHELOR, A.L., LINDLEY, D.S. AND COLLINS, N.B. 2007. Wet-Ecoservices: A technique for rapidly assessing ecosystem services supplied by wetlands. Unpublished Water Research Commission Report.

Codner, G.P., Laurenson, E.M. and Mein, R.G. 1988, 'Hydrologic Effects of Urbanization: A Case Study', Hydrology and Water Resources Symposium, Canberra, IEAust, pp 201-205.

Nag, S K, and Chakraboty, S., 2003. Influence of rock types and structures in the development of drainage network in hard rock area. J. Indian Soc of Remote Sensing. 31 (1) 25-35 (viewed abstract)

Pidwirny, M. 2006. "The Drainage Basin Concept". Fundamentals of Physical Geography, 2nd Ed. http://www.physicalgeography.net/fundamentals/10aa.html Prince George's County. 1993. Design Manual for Use of Bioretention in Stormwater Management. Department of Environmental Resources, Prince George's County, Landover, MD.

Schueler, T. 1987. Controlling Urban Runoff: A Practical Manual For Planning and Designing Urban BMPs. Metropolitan Washington Council of Governments. Washington, DC.

Draft for Review

Schulze R E., 1985. Hydrological characteristics and properties of soils in Southern Africa 1. Runoff Response. Water S A 11 (3) 121-128.

Urbonas, B. and E.W. Strecker. 1996. Parameters to Report - Final Lists and Suggested Data Base Structure. Prepared for the ASCE National Stormwater BMP Database project. Unpublished. September 13, 1996. (Available on the ASCE website,http://www.asce.org/peta/tech/nsbd01.html)

Wong, T.H.F., Breen, P. and Lloyd, S. 2000, Water Sensitive Road Design - Design Options for Improving Stormwater Quality of Road Runoff, Cooperative Research Centre for Catchment Hydrology, Melbourne, Australia, Report 00/1.

Wong, T.H.F., Breen, P.F., Chesterfield, C. and Seymour, S. 1999, Short Course on Planning and Design of Stormwater Management Measures, Monash University, Melbourne, Australia.

USEPA, 1999. Preliminary Data Summary of Urban Storm Water Best Management Practices. EPA 821-R-99-012.

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Appendix 10: Ushukela Highway Development: Wetland Impact Assessment and Recommendation for Mitigation of Impacts

Ushukela Highway Development: Wetland Impact Assessment & Recommendations for Mitigation of Impacts

For:
Rory Wilkinson

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DRAFT FOR DISCUSSION

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1 INTRODUCTION

Dube Tradeport, in conjunction with Tongaat Hulett Developments, is proposing the development of a light industrial and office park complex near Tongaat on the KwaZulu-Natal north coast.

The Watson Highway forms the northern boundary of a site that is approximately 143ha and characterised by an undulating topography draining west into the *Hlawe* River, a tributary of the *Tongati* River.

A study conducted by Wetland Consulting Services (Pty) Ltd, Ref 642/2010 indicated that wetlands and riparian habitats occupy an area of approximately 54 ha. The level of ecosystem delivery for all of the identified wetlands within the development site has been severely compromised by historic disturbances associated with the current land use. It was suggested that the most important riparian unit from a hydrological perspective is the perennially flowing tributary to the Hlawe River. .All the systems are currently impacted by sugar cane farming, cut-off trenches and artificial drainage structures.

The extent of the wetlands, together with the current attitude of both regulators and the public towards the loss and/or alteration of wetlands, based on their perceived value, posed a challenge to accommodating the proposed development on the site, without unduly compromising the functions typically associated with wetlands. This document serves to summarise the in-depth investigation of a number of alternative scenarios aimed at minimising the environmental impact of the development on the aquatic resources, while at the same time achieving a potentially viable development. A final recommendation is provided.

2 ENVIRONMENTAL OBJECTIVES

The site has been entirely altered, with the primary land use being commercial sugarcane production. It is therefore considered to currently offer little biodiversity value, a situation unlikely to change given that sugar farming could theoretically continue.

It is considered that the current landscape value of the site lies in the climate coupled with the soils together with the hydrological processes currently active, that support the sugar cane and the riparian (predominantly planted) zones and the catchments' contribution to downstream river flow.

Most of the eastern portion of the site contains sandy soil ranging from 2 to 4m deep, based on Berea Red aeolian deposits (refer to **Figure 2**). With an estimated porosity of 30-40%, these are thought to constitute a substantial store of water as a consequence of the interception and subsequent transfer of water into the soil profile. Undoubtedly a considerable portion of water is lost to evapotranspiration and in the sugar cane itself when harvested. What is not "lost" contributes to interflow. This emerges as footslope seepage

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wetlands and what remains, after additional losses through the wetlands, contributes to streamflow. On the site most of the footslope and valley bottom wetlands have been channelled to reduce water levels to increase the area suitable for sugar cane production.

The proposed change in land use and corresponding change in land cover is likely to have an impact on the hydrology.

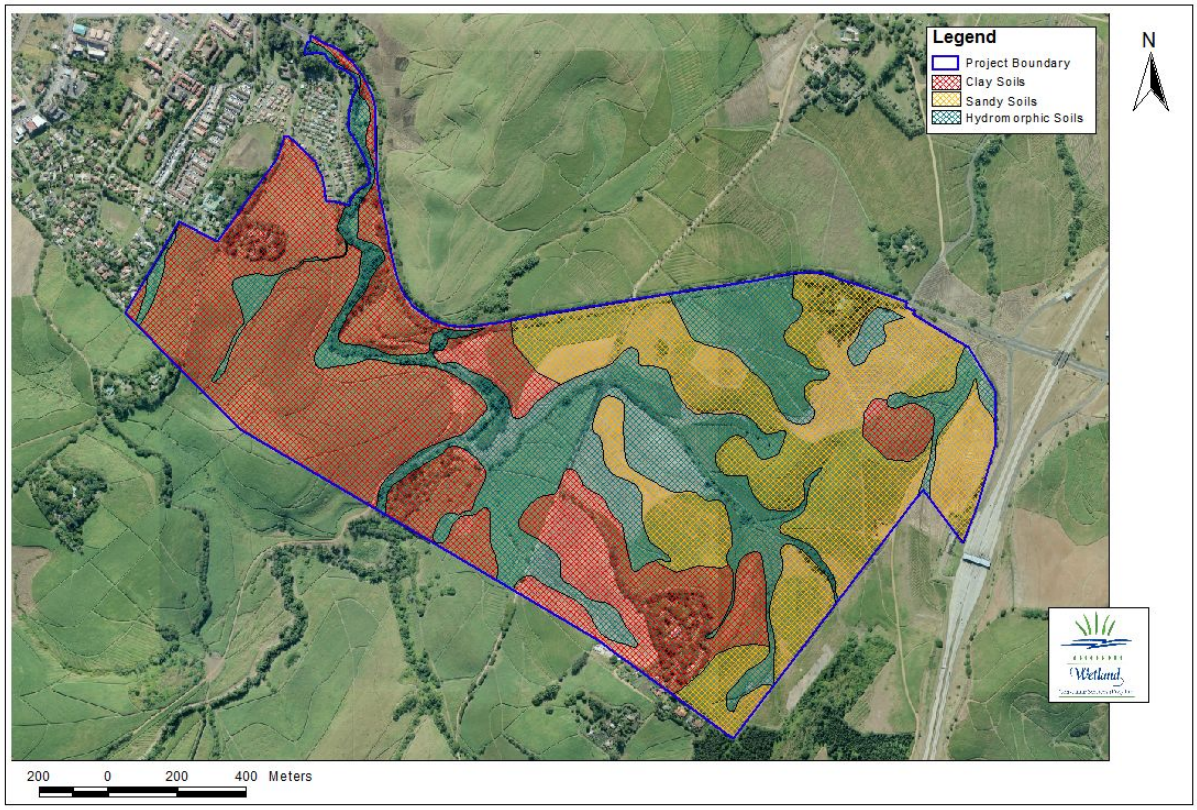

Figure 1. Soil distribution within the proposed development site

2.1 Urbanisation & Hydrology

The effects of urbanization on runoff hydrology are well established (Brown et al. 2005; Konrad 2003; Schueler 1987; Lull and Sopper 1969;Leopold 1968), with their magnitude being affected by climate, geology, soils, land use, and the nature of the proposed development.

Runoff characteristics are also affected by individual storm characteristics and temporally varying conditions within the watershed, including rainfall amount and duration, timing of peak rainfall intensity, seasonal changes to vegetative cover, antecedent soil moisture, and temperature. With the traditional emphasis on flood prediction and mitigation associated with large infrequent storms (Pitt 1999).

Smaller frequent storms typically play a more important role in maintaining the groundwater and base flow hydrology, bank full morphology and water quality of the receiving stream (Grable and Harden 2006; Bledsoe and Watson 2005; Rosgen 1996; Hollis 1975). However

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in South Africa and elsewhere there are very few studies that have been undertaken to calibrate models that are traditionally used to model pre and post development flows to inform appropriate measures for environmental protection. This is particularly true for smaller storms that generate greater than 12.5 mm in rainfall depth, but occur more frequently with return periods less than two years. An indication of the magnitude of the changes that can occur in the hydrology is illustrated in **Figure 2**.

This figure presents the results of a study conducted in Tennessee which to quantify the effects of urbanization given the runoff characteristics for the Cumberland Plateau and urban land use and stormwater management practices in Crossville, based on the SCS-CN concept, (Springburn LLC, 2008)

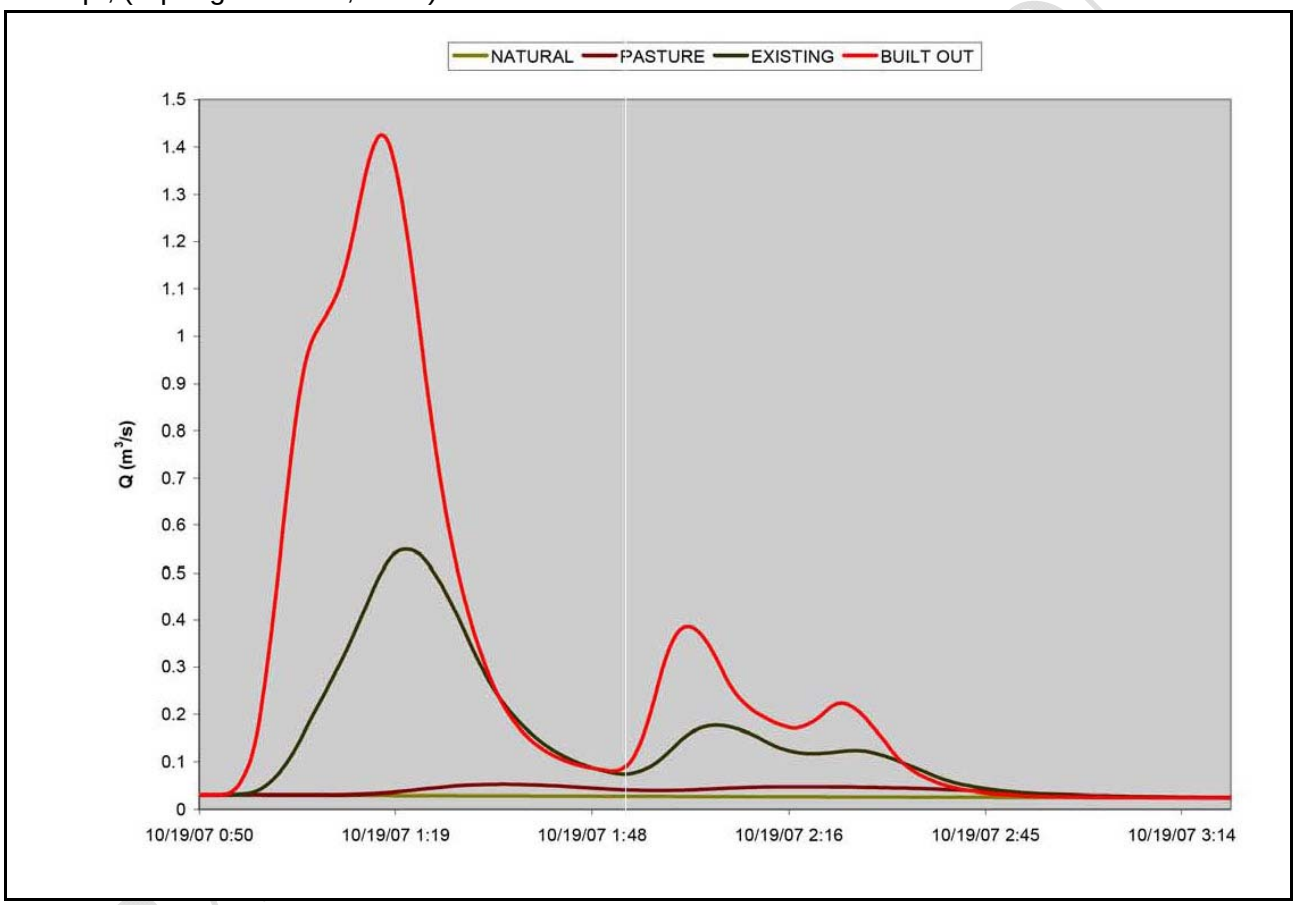

Figure 2. A figure reproduced from a report "Regional effects of urbanization on runoff hydrology for frequent storm events in the Cumberland Plateau" showing calibrated modelled flows associated with changes in landuse/landcover (Springburn LLC, 2008)

It is apparent from this plot that converting land cover from natural to urban has significant implications on the runoff characteristics of the site.

Given the above, it is almost certain that the hydrology of the site will change should a change in landuse as envisaged take place. Typically the hardened surfaces associated with the proposed changes in land use will intercept rainfall that previously was intercepted by the vegetation. This intercepted water will be converted to runoff which will result in:

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- A decrease in time to concentration resulting in higher peak flows;
- An increase in the actual volumes of water discharged off the site;
- A change from diffuse discharges to point source discharges.

The risk this poses to the water resources on the site relate primarily to the increased erosion of the water courses associated with higher flow rates, higher peak flows and increased frequency of bank full events. This will ultimately lead to the development of erosion gulleys with sediment deposition in the downstream environment as well as more frequent and extensive flooding of properties downstream of the site.

Any or all of the above would constitute environmental degradation, and as a point of reference the severely incised channels within the current riparian areas have developed due to the change from natural veld to sugarcane, a far more hydrologically benign landuse than commercial development.

3 DEVELOPMENT ALTERNATIVES

A number of site development options were considered as part of the process where the options were informed by the presence of wetlands and the risks posed to the water resources as well as the economic feasibility of the development.

The economic consequences of the options were communicated in meetings convened specifically to identify a compromise between the area of the development and the impact that this would have on the water resources.

During this process, the primary factors that were used to guide the outcome were:

- The zoning of the area being a natural extension of the Dube Trade Zone closely associated with King Shaka International Airport including the new link road between the Tradeport and Ushukela Highway.
- The impact that the change in land use would have on the hydrological characteristics of the site.
- The condition of the water resources on the site based on the WCS assessment.
- The overall intentions of the Water Act which recognises the balance between responsible water management and economic development.

It was recognised early during the process that the risk that the proposed change in land use would have on the on-site and downstream water resources relate primarily to the increased erosion of the water courses associated with higher flow rates, higher peak flows and increased frequency of bank full events, typically associated with urbanised and industrialized catchments.(Section 2.1))

This would ultimately lead to:

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- The development of erosion gulleys, with sediment deposition in the downstream environment, predominantly off site where there is a reduction in the gradient, as well as more frequent and extensive flooding of properties downstream of the site
- The loss of any wetlands and riparian areas and their associated fauna and flora as a consequence of erosion

In view of the above, the following alternatives were considered.

3.1 Alternative 1: Restrict Development activities to 30m outside wetland boundaries

A scenario which could be advocated is the one widely accepted by most environmental authorities where the wetland boundaries are delineated, and a 20 or 30m buffer zone placed around them, with the remainder of the site being available for development. This is depicted in **Figure 3**.

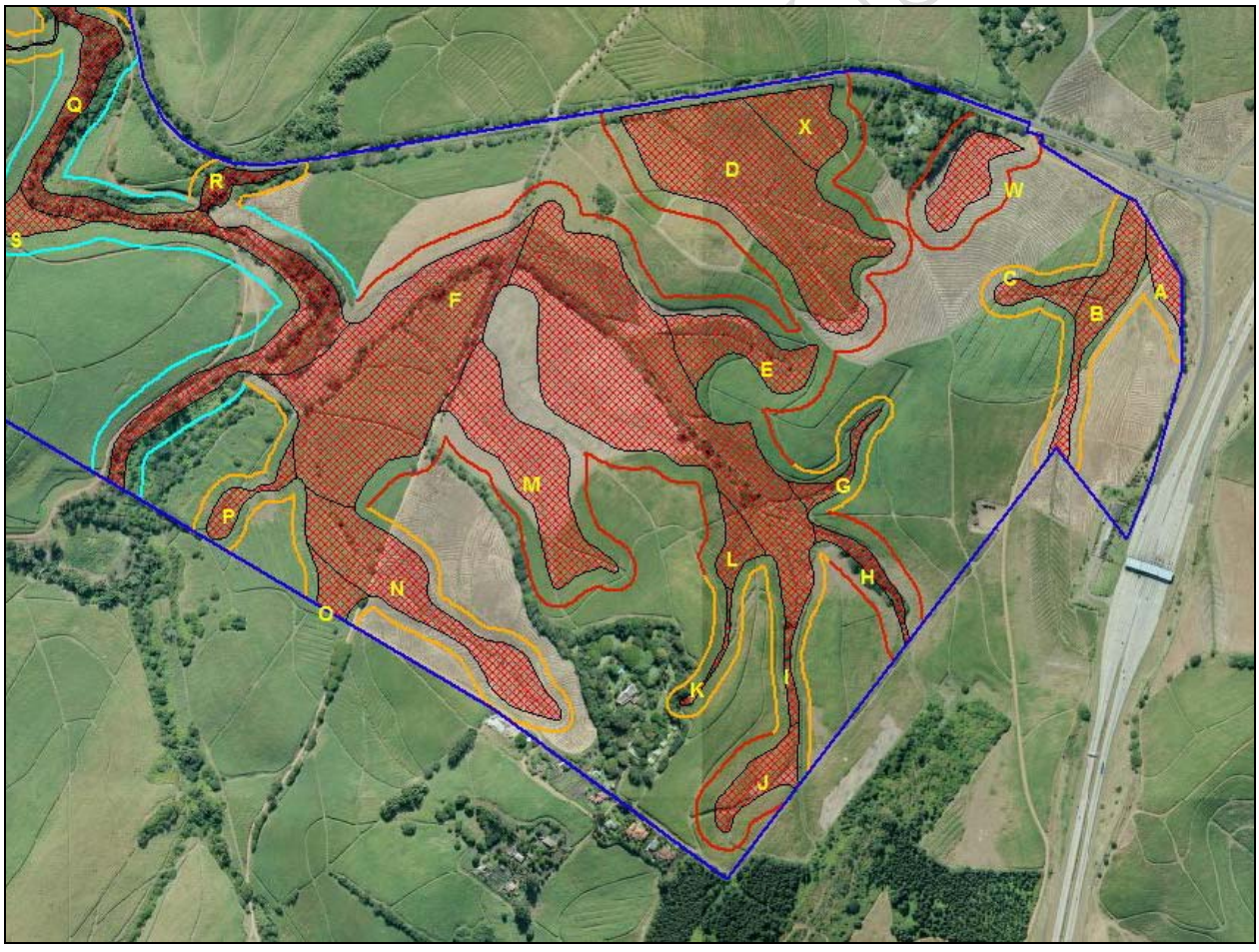

Figure 3: Wetland habitat within the site, showing 30m (red), 20m (orange) and negotiable (turquoise) buffer zones

The advantage of this approach is that it is:

- Administratively simpler to evaluate;

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- Absolves the need for a Water Use Licence, unless access roads and service servitudes are constructed across the wetlands and,
- Considered by the authorities to represent a reasonable compromise to maintain wetland functioning and biodiversity.

The premise is that by removing the footprint of the development from the wetlands and restricting it to outside a predetermined buffer, the impact on the wetlands will be minimal.

In this case however, as is the case in many other systems, this rationale and argument for buffer zones is difficult to support for the following reasons:

- Hillslope seepage wetlands cannot be separated from their localised catchments and associated soils as the perched groundwater and interflow which drive these systems is derived from outside the wetland.
- A pre-determined buffer zone is unlikely to cover the full extent of the area that comprises the source of water of such wetlands and as such is inappropriate where the change in land cover is associated with a dramatic change in the hydrology, for example from cultivated agricultural to urban/industrial use. This is particularly relevant in areas where the wetland catchments comprise deep sandy soils capable of storing and supplying considerable volumes of perched groundwater;
- Buffer zones are meant to protect wetlands against diffuse flow from catchment land uses. Development comprising hard surfaces will significantly alter the local hydrology resulting in concentrated point source discharges into the wetlands, resulting in erosion, irrespective of the presence or extent of a buffer;
- The hardened surfaces associated with this type of development will result mostly in pulsed surface inputs, rather than the current regime of subsurface seepage over extended periods of time. Water will therefore spend considerably less time in the landscape. Buffers are unlikely to negate this;
- The interception, confinement and rapid transport of water out of the catchment by hardened surfaces is also likely to deprive the wetlands of their natural extended water supply, resulting in desiccation of the wetland habitats. In effect each road can be seen as a tributary where none existed previously. A buffer is unlikely to prevent this unless it incorporates most of the catchment.
- Development of the site will require that platforms be constructed involving cut and filling to support the necessary infrastructure, similar to that depicted in **Figure 4**. The access roads as well as the platforms will have a marked influence on the behaviour of water.

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Figure 4 Platforms such as the one illustrated will be required to support the proposed infrastructure.

In view of the above, it is our opinion, and supported by observations in urban catchments, that the simple adoption of buffer zones, while bureaucratically expedient, is inappropriate to achieve wetland and/or watercourse protection.

3.2 Alternative 2: Off-site mitigation

The possibility of applying offsite mitigation entailing the rehabilitation of wetlands was considered as an option to compensate for the loss of any wetlands as a consequence of the development, and in so doing satisfying the principle of no net-loss of wetland habitat from the overall landscape.

However the "wetlands" on the site bear no resemblance to their original state, with the soil characteristics, the drains and the landscape position being the only features that lead to the areas being classified as "wetlands".
The advantage of this approach is that it is "secures" wetlands and wetland related functions which are interpreted as being of benefit to society. It could be argued that the mitigation measures proposed, (Section 3.4) largely compensate for the functions generally linked to wetlands.
There are a number of potential disadvantages associated with the implementation of offsets, some of which are :

- The dis-association of wetlands from the catchments and broader catchment related processes in which they exist;

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- The difficulty in defining the objectives of offsite mitigation measures;
- Associated with the above, the difficulty in defining measurable outcomes, and the risks to all parties associated with not achieving the outcomes;
- The practical implications of the long term management and maintenance of the rehabilitated wetlands, including expecting prospective clients to pay monthly fees for the maintenance of areas that they will not necessarily appreciate;
- The bureaucracy and legal implications involved in applying offsets on land owned by others;
- The long time period taken by authorities to process ecological offset projects;
- The constraints that rehabilitation will put on future opportunities within candidate wetland catchments;
- Scepticism within conservation bodies' regarding the potential for the success of ecological offsets.

Draft guidelines have recently been released that present an approach that could be considered if this option were to be pursued. (Macfarlane et al 2012).

3.3 Alternative 3: On-site mitigation

Potential onsite mitigation scenarios were also investigated including the reduction of the footprint of the developable area in order to reduce the impact on the hydrology of particularly the central drainage line and its associated wetlands. This would entail isolating individual catchments or a large part of a catchment and maintaining existing land use/landcover and/or restoring these to pre-current land use conditions within these isolated catchments. This is based on the premise that even a small change in the catchment, particularly where reshaping of the landscape is required, will have a significant impact on the hydrology.

The option of targeting the central drainage line and its associated catchment was considered as from biodiversity and functional perspective, the "value" derived from this would likely compensate for the loss of wetlands in the remaining sub catchments.

This option was not considered to be feasible as it:

- Divided the development into two sections, the development of which individually rendered the development un-economical

In addition the following were also offered in opposition to this approach:

- The increased risk to security
- Defining and justifying the intention of the offset to the satisfaction of all stakeholders, including investors
- The risk associated with defining and meeting environmental expectations.

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3.4 Alternative 4: Economically/Environmentally Sustainable Land-use Compromise Option

Given that the area has been zoned as "Industrial", and in order to reduce the risks posed by any landcover/landuse change on the site to the water resources on and downstream of the site, an approach which involves integrating hydrological controls throughout the proposed development was proposed as a means of meeting the goals of the proposed development with an acceptable "cost" to the water resources on the site. This approach was recommended based on the assessment of the site and the proposed change in land use including:

- The wetlands on the site are dominated by foot slope seepage wetlands that are linked to eroded valley bottom drainage lines.
- They receive water that moves through the vadose or unsaturated soil profile until it reaches an aquitard. The latter then intercepts the accumulated water which emerges where the aquitards pinch out in the valley bottoms and side slopes.
- The current valley bottom foot slope seepage systems have been drained through the construction of herring bone drainage systems to increase the area that can be planted to sugar cane. *Of the 43ha of wetlands delineated on the site only 1% or approximately 4 ha was not planted to sugar cane.*
- The vegetation in the wetlands is sugar cane
- The drainage lines have eroded over time due to increased runoff volumes concentration of flows over road crossings.
- The vegetation along the drainage lines comprises a range of planted trees and include *Albizzia sp., Syzigium sp Erythrina sp., and Ficus sp.*

Of the rainfall that falls on the property it is hypothesised, because flows off Berea Red sands are not measured, that they would be equivalent to that off a granite based landscape with deep soils and relatively step slopes. Given this the volume of runoff that converts to surface flow is expected to be about 6 – 9% of Mean Annual Rainfall. The balance is lost to evapotranspiration 1500 – 2500mm, groundwater recharge, as well as in the crop itself, sugar cane, that comprises 80% water. Yields can range between 70 -100 tons/ha. Groundwater recharge is expected to be low given that the underlying geology is predominantly sandstones, shales and siltstones of the Vryheid Formation of the Karoo Supergroup.

In order to reduce the risks posed by any landcover/landuse change on the site to the water resources identified on the site the following goals were proposed which would to a large extent compensate for the proposed rezoning of the land from Agriculture to Industrial, and meet the overall aims of the National Water Act:

- Manage the post-development hydrology to within 10% variance of the pre-development modelled flows;
- To facilitate the ingress of stormwater into the ground to replenish wetlands
- Prevent any further soil loss (reduce the erosion risk) from the site;
- Ensure that there is no net-loss of wetland functioning from the site;

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- Retain the lateral seepage into the central stream channel in order to maintain the riparian trees that have established and are stabilising the stream channel and banks.
- Improve the overall biodiversity of the site.

Using the above as the guiding principles a layout was developed, based on a number of layouts/hydrological modelling iterations, until and an ecological/economically "sustainable" option was developed. This option was accepted as being a compromise between all the options that preceded this layout and which had a high probability of meeting the hydrological and environmental objectives.

The requirement to compensate for:

- the loss of wetlands;
- the loss of biodiversity associated with the wetlands;
- the reduction in the capacity of the site to intercept rainfall;
- the loss of evapotranspiration capacity (carbon sequestration through photosynthesis);
- the requirement to reduce the time to concentration of flows

has been partially met in the overall landscape development plan, the details of which are covered in a separate report, Engineering Services Report, Contract #243/203; Landscape Master plan Philosophy, prepared by CNdV, while the hydrological aspects have been accommodated within the overall layout.
The result is that the post development landscape will comprise the following mix of habitats,

Open spaces:	21.6 Hectares
Areas along roads for swales/green infiltration/ indigenous planting:	11.5 Hectares
Embankments:	14 Hectares

totalling 47 ha, compared to the pre development landscape where a total of 54 ha of wetland and riparian habitat was recorded. ***Of this 54 ha less than 1% or approximately 4 ha was not planted to sugar cane.***

In addition to the landscape plan, provision has been made within the development itself to manage the post development hydrology for the frequent return event storms to within 10% of the modelled predevelopment flows, while individual property developers will be required to manage the first 25mm of rainfall on their own properties.

The impact of storm water runoff is mitigated by the creation of a greater number of smaller, localized catchments, depressions or check facilities (landscaping, fences, walls, road kerbing etc) and longer, more complex drainage lines in the urban environment. This is in contrast to the sugar cane agricultural environment, where effort is placed in land smoothing and direct drainage, to ensure limited ponding and good drainage of fields and the cane root zone. The details of the stormwater management plan are presented in Ushukela – Watson

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Highway Development site general stormwater management policy plan (Bosch Stemele (Pty) Ltd, Project no. 243/203

3.5 Development Layout

An impact assessment was conducted on this last option, **Figure 5**, as it was perceived to have the lowest acceptable environmental impact, as well as providing an acceptable level of economic return for the developers. The table below was developed using the concept of a hydrological landscape, which we have defined as:

- *A landscape that provides a range of societal benefits including economic returns linked to the presence of water, including productivity, biodiversity support, flow regulation, biogeochemical processes at the soil level as inferred from the presence, extent, type and condition of wetlands, which does not compromise the condition of the immediate downstream reach.*

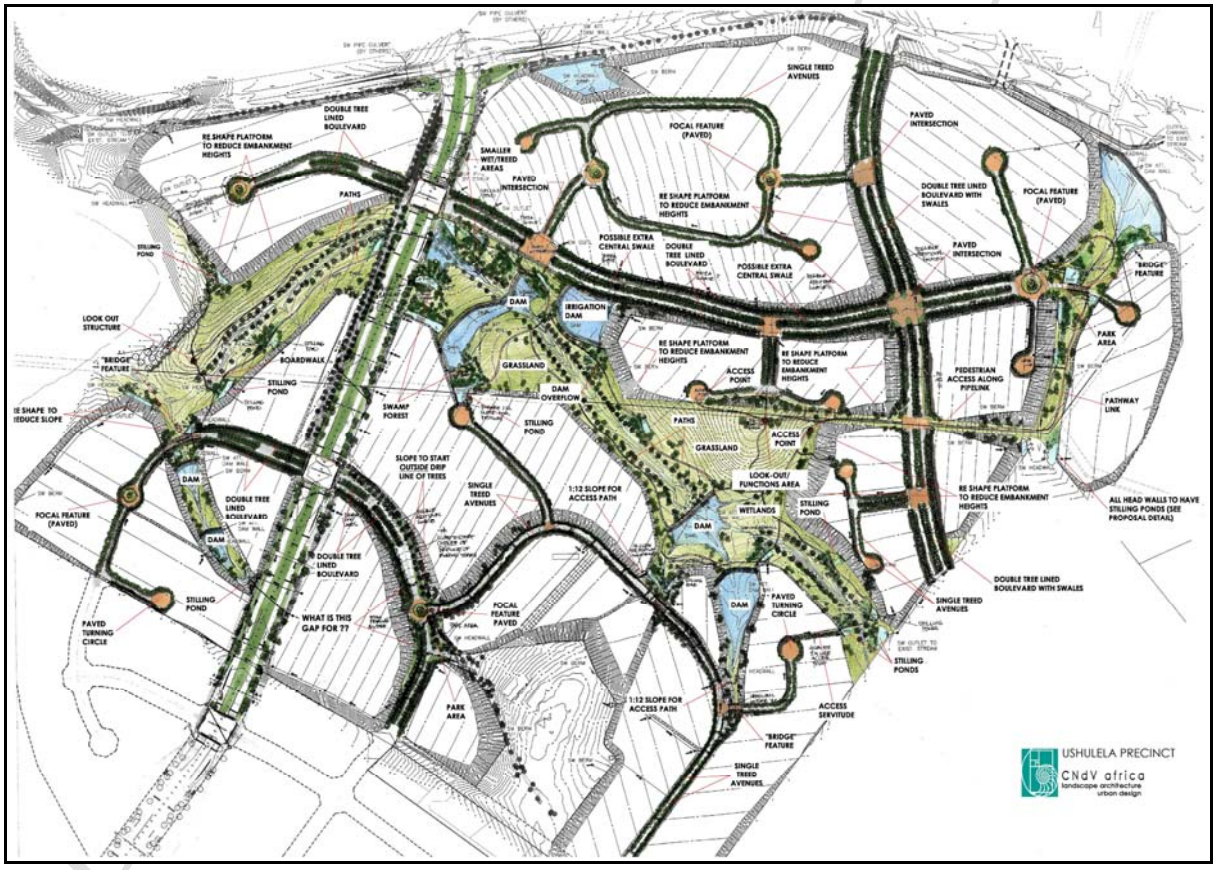

Figure 5. A schematic showing the layout together with the indication of the open space concept plan (CNdV Africa)

This is similar to concepts being developed and recently reviewed associated with landscape functionality by Bolliger& Kienast, 2010. They suggest that a tool is urgently needed to guide changes in land use if the maintenance of current landscape multifunctionality remains a long-term goal.

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The approach adopted in this study recognises that local landcover/landuse within a catchment will affect the hydrological processes on this site, but that the loss of water dependant ecosystems is compensated for by benefits gained by society together with ensuring the maintenance of the hydrological characteristics of the transformed site in a way that does not compromise the water (flow duration and availability) and the water dependant ecosystems immediately downstream of the site.

The focus on the water is intentional as it is recognised that water is essential for maintaining ecosystems and its "displacement" from a landscape where the hydrological characteristics are being fundamentally altered should not impact ecosystems downstream of the change in such a way that it reduces their capacity to continue to provide goods and services.

Table 1. An assessment of the environmental, social and economic risks associated with the alternative development layouts/scenarios, based on the probability of the outcome being achieved on a scale of 1 (unlikely) to 5 (Definite).

Environmental including socio-economic aspect	Alternative 1: Permit development outside of 30m buffer & rehabilitate wetlands by blocking agricultural drains and revegetating	Alternative 2: Rehabilitation of wetlands off site to compensate for functional loss of on site wetlands	Alternative 3: Limit footprint of development to exclude central drainage line & rehabilitate wetlands within this particular catchment	Alternative 4: Integrate stormwater management into the overall design with a view to maintaing "functional" landscape
Medium to long term on -site wetland protection	1	1	4	4
On Site-Biodiversity enhancement	1	1	3	5
Protection of downstream reach	1	1	2	3
Economic returns	1	1	2	3
Probability of positive ROD	5	3	3	2
Complying with NWA objectives(responsible management of Water & Water Resources)	1	3	3	4
Mean Score	1.7	1.7	2.8	3.5

From this assessment it is apparent that the approach that has a good chance of being accepted by the authorities with regards to ROD (Alternative 1), is not the same approach that is most likely to meet the environmental as well as socio economic benefits that could accrue from the project (Alternative 4).

It could be argued that Alternative 1 together with the implementation of storm water management principles proposed for Alternative 4, could well afford the existing wetlands on site with the necessary level of protection to enable them to continue to exist. This option was discussed but the areas needed to manage flows restricted the developable area to an extent that the viability of the project was severely compromised, implying that the current land use be maintained.

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4 ALTERNATIVE 4: IMPACT ASSESSMENT

The proposed development layout based on Altenative 4 is illustrated in **Figure 6** , where the development footprint is overlaid on the water resource (wetland/riparian) layer.

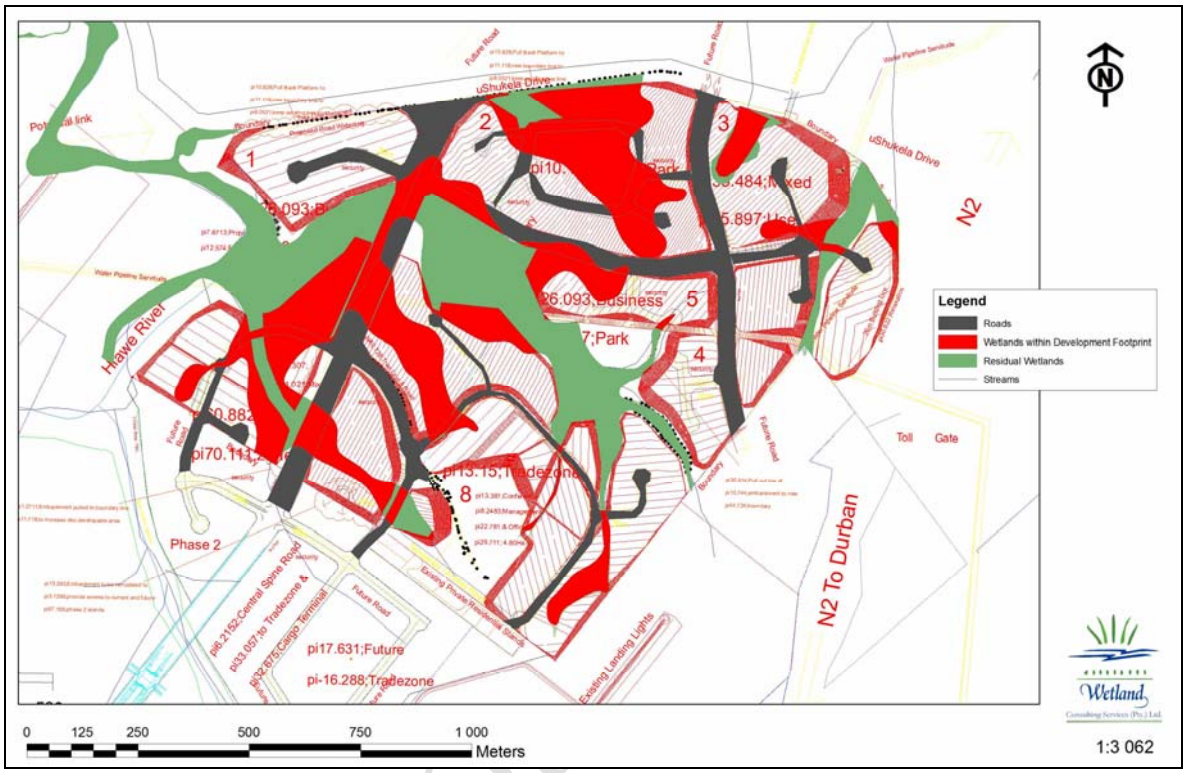

Figure 6. A figure showing the relationship between the proposed development and its relationship to the delineated wetlands on the site. Green areas show the areas where the wetlands that have been retained, while red areas are areas where the development footprint impacts wetlands**.**

This is the option on which the impact assessment is based. The level of the impact assessment is at this stage general as the method statements detailing the construction related activities were not available.

4.1 Impact Assessment methodology

To ensure uniformity, the assessment of potential impacts was addressed in a standard manner to ensure comparable treatment over a wide range of impacts. A clearly defined rating scale was used to assess the impacts on wetlands associated with the proposed development. Each impact identified was assessed in terms of probability (likelihood of occurring), extent (spatial scale), intensity (severity) and duration (temporal scale). To enable a rational approach and verifiable approach to the determination of the impact significance (importance), a numerical value was linked to each rating scale. The sum of the numerical values defined the significance. Each identified impact has been assessed both pre and post mitigation, where mitigation is possible.

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In compiling the impact assessment no data were available applicable to the water resources on the site, but use was made of the data collected as part of the environmental assessment of the site (WCS report # .?

The above-mentioned data was used for risk identification of the water uses on the water resource. The impact assessment will be based on the following key elements:

Probability of occurrence: this describes the likelihood of the impact actually occurring and is indicated as:

- Improbable, where the likelihood of the impact is very low;
- Probable, where there is a distinct possibility of the impact to occur;
- Highly probable, where it very likely that the impact will occur;
- Definite, where the impact will occur regardless any management measure.

Consequence of occurrence in terms of:

- Nature of the impact;
- Extent of the impact, either local, regional, national or across international borders;
- Duration of the impact, either short term (0-5 years), medium term (6-15 years) or long-term (the impact will cease after the operational life of the activity) or permanent, where mitigation measures by natural processes or human intervention will not occur;
- Intensity of the impact, either being low, medium or high effect on the natural, cultural and social functions and processes.

Significance level of the risk posed by the water use: this is determined through a synthesis of the probability of occurrence and consequence of occurrence.

The ranking of the risks is based on the quantitative assessment as described above and categorized into high, medium, or low risks.

Management measures were then identified to mitigate, prevent and / or reduce the risk. These measures primarily focused on the risks identified as high in the ranking matrix, but will also include measures for medium and low risks.

In order to assess each of the factors for each impact, the ranking scales as contained in **Table 2** were used.

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Table 2. Ranking Scales for impact assessment

PROBABILITY = P 5 – Definite / don't know 4 – High probable 3 – Medium probability 2 – Low probability 1 – Improbable 0 – None	**DURATION = D** 5 – Permanent 4 – Long-term (ceases after operational life) 3 – Medium-term (5 – 15 years) 2 – Short-term (0-5 years) 1 - Immediate
EXTENT = E 5 – International 4 – National 3 – Regional 2 – Local 1 – Site 0 – None	**MAGNITUDE = M** 10 – Very high / Don't know 8 – High 6 – Moderate 4 – Low 2 – Minor

Note: the magnitude is rated from 1 to 5, but this is done twice: Once for the environmental impact and once for the impact on society, thereby having a total weight of 10 points.

Once the factors had been ranked for each impact, the environmental significance of each impact is assessed by applying the SP formula. The SP formula can be described as:

SP = (**magnitude** (environmental + society) + **duration** + **extent**) x **probability**

The maximum value of significance points (SP) is 100. Environmental effects could therefore be rated as either high (H), moderate (M), or low (L) significance on the following basis:

- More than 60 points indicates high (H) environmental significance
- Between 30 – 60 points indicate moderate (M) environmental significance
- Less than 30 points indicates low (L) environmental significance

These impacts are rated prior to mitigation and again post mitigation so a comparison can be drawn.

4.2 Construction related impacts: Site Preparation

Impacts on the water resources on the site are likely to arise as a consequence of the following activities associated with the preparation of the site:

- Clearing and grubbing of the site
- Installation of subsurface drainage
- Preparation of sites for culverts/pipes at road crossings
- Bulk earthworks, creation of platforms
- Installation of services, outfall sewers, storm water drains

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These activities are likely to result in:

- The direct loss of fauna and flora associated with the water resources directly impacted by the construction related activities;
- The interception of perched water during platform shaping/trenching for internal services depriving the seepage wetlands of water;
- Increased sedimentation in the stream sections not affected by direct transformation linked to the clearing and shaping of the site, exposing the soil to erosion;
- Contamination of water

4.2.1 Direct loss of wetland and associated fauna and flora

The area of wetland lost, representing habitat, that occurs within the footprint of the proposed development is approximately 28ha, including the area lost to roads, an additional, equivalent to approximately 55% of the wetland area.

The loss of the wetlands in respect of the biota they support is definite, local, long term and of low magnitude due to the highly transformed nature of the wetlands with a **Moderate negative** significance.

Mitigation: The loss of biodiversity directly affected by the development cannot be mitigated due to the nature of the transformation of the site. However the inclusion of open space, as well as the provisions made in the storm water management plan of wet detention ponds, as well as a mosaic of habitats that were not present on the site prior to the development is regarded as a significant improvement compared with the sugar cane. This includes tree lined roads which could be seen as “riparian” areas, as the roads represent new “tributaries” that are designed to convey runoff. Provision has been made in the road designs to divert water off the roads into the tree lined verges so as to encourage water loss through infiltration and evapotranspiration.

Additionally, in order to protect areas not directly impacted by the footprint of the development, they should be protected by clearly demarcating these areas and access to and through these areas should be controlled and limited.

The loss of wetland biota, predominantly sugar cane, will be offset by the proposed landscape plan developed by CNdV. The impact post mitigation will be **Low to Moderate positive**.

4.2.2 Disruption of hydrology including the interception of perched water

During construction and after construction flows off the site will be markedly different from the predevelopment flows, in terms of flow duration, flow rates, volume of discharge as well as the points where water leaves the site. The impact of this on the morphology of the wetlands and drainage lines will be:

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- Loss of seepage wetlands as flows are intercepted off the roads and and other impermeable surfaces
- Erosion of the existing stream channels.

In addition groundwater/perched water is likely to be encountered during the shaping of the platforms. Where groundwater is intercepted it is likely to be collected in agricultural drains and discharged into the valley bottom open space or into the streams via the stormwater systems. The impact of this is difficult to assess with confidence as neither the points of interception nor the volumes of water are known, nor are the post development future volumes.

Given this and the protocol used for assessing the significance of the impacts associated with the anticipated changes in the hydrology will be **High negative**.

Mitigation: The measures introduced to manage flows off the site described in the uShukela Highway-Engineering Services Report, 234/2003 prepared by Bosch Stemele, as well as the Landscape plan developed by CNdV describe measures that will reduce the impact of the development on the drainage lines.

Groundwater intercepted during the construction phase should be conveyed into the footslopes and redistributed via a purposefully designed distribution system to promote interflow and support wetlands.

4.2.3 Erosion/Increased sedimentation in the stream sections

The removal of vegetation and the shaping of the platforms, as well as construction related activities associated with the culverts/piped stream crossings will expose soil to erosion. This will be transported into the valley bottom drainage lines.

The impact of this is considered to be highly probable, local, short term and of moderate magnitude equating to a **Moderate negative** pre mitigation impact.

Mitigation: Measures that will reduce the significance of this impact include:

- Restricting clearing and excavation and platform construction to one sub catchment at a time
- The construction of sedimentation basins, permeable barrier fences, fibre coils and/ or vegetated buffers between the exposed soil surfaces and the receiving streams.
- The implementation of structures associated with the stormwater management plan will assist in reducing the sediment load to the drainage lines.
- The rapid re-vegetation of the slopes associated with the platforms will considerably reduce the sediment load to the streams.

Once implemented the impact of sediment transport to the streams will be **Low negative**

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4.2.4 Contamination of water

There is a low risk of water contamination during the construction phase from oil/transmission and hydraulic fluids due to leakage and or servicing of vehicles.

The impact is of this is considered to be of low probability, local, occasional and of low significance.

Mitigation: Measures that should be included to reduce the probability of water contamination and its associated impact on aquatic biodiversity include:

- No servicing of vehicles on the site
- Regular inspection and servicing of vehicles
- Collection/removal and appropriate disposal of soils that are contaminated in the event of a leak or accidental spill.

4.3 Operation related impacts.

The impacts expected during the operational phase are not expected to be different from those that were described for the construction phase.

A summary of the impacts pre and post mitigation is presented in Table 3.

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Table 3. Summary of the impacts likely to affect the wetlands as a consequence of the changes in land use associated with the proposed development, for Alternativve 4

CONSTRUCTION PHASE/OPERATIONAL PHASE									
Description of impact		**Score**	**Impact Score**	**Significance pre mitigation**	**Mitigation measures**		**Impact Score**	**Impact Score**	**Significance post mitigation**
Loss of wetland fauna & flora	Probability	5	45	MODERATE	Provide barriers to restrict access into sensitive areas to limit extent of loss	Probability	4	36	MODERATE
	Extent	1				Extent	1		
	Duration	4				Duration	6		
	Magnitude	4				Magnitude	2		
Disruption of hydrology including groundwater	Probability	5	65	HIGH	Incoporate runoff management measures as described in the SWMP during the construction	Probability	3	30	LOW
	Extent	2				Extent	2		
	Duration	5				Duration	4		
	Magnitude	6				Magnitude	4		
Soil loss (erosion)	Probability	5	50	MODERATE	Construct low level water deflection berms, reduce clearing to a mininum to maintain vegetation cover	Probability	3	21	LOW
	Extent	2				Extent	1		
	Duration	2				Duration	4		
	Magnitude	6				Magnitude	2		
Contamination of water spills	Probability	2	10	LOW	Ensure that conditions in the construction EMP related to dust suppression, machinery storage and servicing are ad adhered to	Probability	2	14	LOW
	Extent	1				Extent	1		
	Duration	2				Duration	4		
	Magnitude	2				Magnitude	2		

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5 RECOMMENDATIONS

Based on the review of the alternative development scenarios, we would recommend that, should a change in land use and its associated land cover be authorised, that the option which formed the basis of the impact assessment be considered.

However we recommend that in order to assess more specifically the risks to the water resources, that method statements be developed covering the complete range of activities proposed for the site, and the sequence in which the activities will take place. This is proposed so as to be able to inform the necessary mitigation measures that will be required to protect the downstream water users from the effects of the construction and operational impacts.

The existing documentation provides a description of what is proposed to be done on the site, but detail is lacking on how this is to be going to be done. It is understood that this level of detail requires advancing the design to the construction phase, implying higher costs. The reluctance of the developer to advance to this next level of detail is understood in the absence of at least a conditional ROD indicating support for at least the change in landuse.

6 REFERENCES

Bledsoe B. P. and C. C. Watson (2001). "Effects of urbanization on channel instability." *Journal of the American Water Resources Association* 37(2): 255–270.

Bolliger, J., & Kienast, F., 2010. Landscape functions in a changing environment. Landscape Online 21, 1-5. **DOI:10.3097/LO.201021**

Brown, L. R., Robert H. Gray, Robert M. Hughes, and Michael Meador, editors (2005)Effects of Urbanization on Stream Ecosystems Published by American Fisheries Society Publication date: December 2005, 423 pages

Grable, J. L., and C. P. Harden. (2006). "Geomorphic response of an Appalacian Valley and Ridge stream to urbanization." Earth Surf. Process. Landforms. 31, 1707-1720.

Hollis GE. 1975. The effects of urbanization of floods of different recurrence intervals.*Water Resources Research* **11**: 431–435.

Konrad, Christopher P. and Derek B. Booth (2002). "Hydrologic Trends Associated with Urban Development for Selected Streams in the Puget Sound Basin, Washington," U.S.Geological Survey Water-Resources Investigations Report 02-4040, 40 p.(Not seen in the original)

Leopold, L.B. (1968). "Hydrology for urban land planning – A guidebook on the hydrologic effects of urban land use." USGS Circular 554, 18 pp.

Lull, Howard W., Sopper, William E. (1969). "Hydrologic effects from urbanization of forested watersheds in the northeast." Res. Pap. NE-146. Upper Darby, PA: U.S.Department of Agriculture, Forest Service, Northeastern Forest Experiment Station.31p.

DRAFT FOR DISCUSSION

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Macfarlane, D., von Hase, A., Brownlie., S. 2012. Towards a best practice guideline for wetland offsets in South Africa. Unreviewed Draft Final Report prepared for SANBI Grasslands Programme, Eco-Pulse Environmental Consulting Services.

Pitt, R. (1999). Small Storm Hydrology and Why it is Important for the Design of Stormwater Control Practices In: *Advances in Modeling the Management of Stormwater Impacts, Volume 7*. (Edited by W. James). Computational Hydraulics International, Guelph, Ontario and Lewis Publishers/CRC Press.

Rosgen, D. (1996). Applied River Morphology, Wildland Hydrology.

Schueler, Thomas. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs.* Metropolitan Washington Council of Governments,W ashington, DC.

Springburn LLc, 2008. Regional effects of urbanization on runoff Hydrology for frequent storm events in the Cumberland plateau. U.S. Forest Service, Roundtable on Sustainable Forest- Land Use Changes & Associated Impacts on Water Resources Contract No. SRS 06-DG-11330103-170.

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Appendix 11: Layout review: Ushukela-Watson Highway Development

Draft Final Layout Review
Ushukela-Watson Highway Development

For:
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By:
Wetland Consulting Services (Pty) Ltd

April 2013

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1. INTRODUCTION

Tongaat Huletts Developments and Dube TradePort are proposing a new light industrial development adjacent to the current Watson Highway to the immediate north of King Shaka International Airport. This would entail a change in landuse from commercial sugarcane. The proposed development site contains approximately 54ha of wetland and riparian habitat, mostly hillslope seepage wetlands driven by the subsurface seepage of water through the deep sandy soils that dominate the site. While all of the wetland and most of the riparian habitat has been transformed by commercial sugarcane cultivation, the development is likely to remove a substantial portion of these wetlands permanently from the landscape through:

- Direct transformation; and
- Modification of the catchment hydrology.

In so doing any future opportunity of regaining wetland functioning will be forgone.

Given the no net loss approach advocated by local and national environmental authorities, the removal of these wetlands represents the main environmental stumbling block to the development.

Wetland Consulting Services (WCS), via the late Alan Batchelor, presented a report to the clients in July 2012 (**WCS Report 642a2012**) in which he:

- Highlighted the environmental implications of the development;
- Provided a set of appropriate environmental objectives for the development;
- Analysed four realistic alternatives for the development, with specific regards to dealing with the wetlands issue;
- Provided a rationale for the development to be designed around the concept of the hydrological landscape; and
- Evaluated the potential long-term impacts of the four alternatives.

The report was the result of an exhaustive process of successive iterations based on the compromise between the environmental concerns of society at large and the economic feasibility of the development. Unfortunately Alan passed away before he could review the final development layout. This report should be seen as an addendum to his report of June 2012 (**WCS Report 642a2012**), and contains:

- A review of that report, highlighting pertinent points of consideration;
- A review of the most recent hydrological study;
- A review of the most recent development layout; and
- A formal representation of the types of measures to be implemented to achieve the stated environmental objectives;

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2. BACKGROUND: REVIEW OF PREVIOUS REPORT

Below is a brief summary of the most important points contained in WCS Report 642a2012. The reader is referred to this report for greater detail regarding the rationale behind our approach to this project.

2.1 Environmental Objectives

As per the wetland management report of 2012, the major concern associated with the development planned for the site is the increased runoff as a consequence of the increase in hardened surfaces. This is likely to lead to:

- A decrease in the time to concentration resulting in higher peak flows;
- An increase in the actual volumes of water discharged off the site;
- A change from diffuse discharges to point source discharges;

The risk this poses to the water resources on the site relate primarily to the increased erosion of the water courses associated with higher flow rates, higher peak flows and increased frequency of bank full events. This will ultimately lead to the development of erosion gulleys with sediment deposition in the downstream environment as well as more frequent and extensive flooding of properties downstream of the site. Any or all of the above would constitute environmental degradation.

In our opinion, the key environmental objectives for the site should be to:

- Manage the post-development hydrology to within 10% variance of the predevelopment scenario;
- Prevent any further soil erosion from the site;
- Ensure that there is no net-loss of wetland functioning from the site;
- Retain the lateral seepage into the central stream channel in order to maintain the riparian trees that have established and are stabilising the stream channel and banks;
- Improve the current biodiversity value of the wetlands that will be retained on site as an offset for the wetland area that will be lost due to the development of the site.

Pertinent considerations regarding the site and the development are:

- The site currently has very little biodiversity value as it has mostly been transformed to commercial sugarcane.
- This could in theory continue in perpetuity.
- A linear buffer applied to the wetlands, as currently favoured by authorities, is unlikely to maintain the wetlands in the landscape as the pattern of hydrological inputs from the catchment beyond the buffer will fundamentally change. The nature of the inputs into the wetland will change from diffuse to point-source discharge, regardless of the width of the buffer. We do not support this approach as, in our opinion, it is not a rational solution to the concerns raised, and is unlikely to succeed in meeting the environmental objectives.
- Wetlands form in response to the movement of water through a catchment. It is unrealistic to expect wetlands to remain unchanged if the catchment hydrology has changed fundamentally.
- The proposed change in landuse is permanent, forgoing the opportunity of future generations to choose to restore the wetlands that will be removed from the landscape.
- The area is destined to be rezoned as commercial, effectively ensuring that, for wetlands to remain as a feature in the landscape, they should be in forms compatible with the hydrology of urban development.

2.2 Development Alternatives

It was recognised early during the process that the risk that the proposed change in land use would have on the on-site and downstream water resources related primarily to the increased erosion of the water courses associated with higher flow rates, higher peak flows and increased frequency of bank full events, typically associated with urbanised and industrialized catchments. A number of site development options were considered as part of the process where the options were informed by the presence of wetlands and the risks posed to the water resources as well as the economic feasibility of the development. ***The economic consequences of the options were communicated in meetings convened specifically to identify a compromise between the area of the development and the impact that this would have on the water resources.***

The development alternatives considered were:

2.2.1 Alternative 1: Restrict development activities to 30m outside wetland boundaries;

The advantages of this approach are:

- It is administratively simpler to evaluate;
- It absolves the need for a Water Use Licence unless infrastructure is constructed across the wetlands;
- It is favoured by authorities as a reasonable compromise to maintain wetland functioning and biodiversity;

The premise is that by removing the footprint of the development from the wetlands and restricting it to outside a predetermined buffer, the impact on the wetlands will be minimal.

In this case however, this rationale and argument for buffer zones is difficult to support for the following reasons:

- Hillslope seepage wetlands cannot be separated from their localised catchments and associated soils as the perched groundwater and interflow which drive these systems is derived from outside the wetland;

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- A pre-determined buffer zone is unlikely to cover the full extent of the area that comprises the source of water of such wetlands. It is therefore inappropriate where the change in land cover is associated with a change in hydrological regime. This is particularly relevant in areas where the wetland catchments comprise deep sandy soils capable of storing and supplying considerable volumes of perched groundwater;
- Buffer zones are effective at protecting wetlands against diffuse flow from catchment landuses. Development comprising hard surfaces will significantly alter the local hydrology resulting in concentrated point source discharges into the wetlands, resulting in erosion, irrespective of the presence or extent of a buffer;
- The hardened surfaces associated with this type of development will result mostly in pulsed surface inputs, rather than the current regime of subsurface seepage over extended periods of time. Water will therefore spend considerably less time in the landscape. Buffers are unlikely to negate this;
- The interception, confinement and rapid transport of water out of the catchment by hardened surfaces is also likely to deprive the wetlands of their natural extended water supply, resulting in desiccation of the wetland habitats. In effect each road can be seen as a tributary where none existed previously. A buffer is unlikely to prevent this unless it incorporates most of the catchment.
- The platforms and roads associated with the development will have a marked influence on the behaviour of water.

In view of the above, it is our opinion, and supported by observations in urban catchments, that the simple adoption of buffer zones, while bureaucratically expedient, is inappropriate to achieve wetland and/or watercourse protection.

2.2.2 Alternative 2: Off-site mitigation;

The possibility of applying offsite mitigation entailing the rehabilitation of wetlands was considered as an option to compensate for the loss of any wetlands as a consequence of the development, and in so doing satisfying the principle of no net-loss of wetland habitat from the overall landscape. The advantage of this approach is that it is "secures" wetlands and wetland related functions which are interpreted as being of benefit to society. It could be argued that the mitigation measures proposed as part of the development layout largely compensate for the functions generally linked to wetlands. There are a number of potential disadvantages associated with the implementation of offsets, some of which are:

- The dis-association of wetlands from the catchments and broader catchment related processes in which they exist;
- The difficulty in defining the objectives of offsite mitigation measures;
- Associated with the above, the difficulty in defining measurable outcomes, and the risks to all parties associated with not achieving the outcomes;
- The practical implications of the long term management and maintenance of the rehabilitated wetlands, including expecting prospective clients to pay monthly fees for the maintenance of areas that they will not necessarily appreciate;

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- The bureaucracy and legal implications involved in applying offsets on land owned by others;
- The long time period taken by authorities to process ecological offset projects;
- The constraints that rehabilitation will put on future opportunities within candidate wetland catchments; and
- Scepticism within conservation bodies' regarding the potential for the success of ecological offsets.

2.2.3 Alternative 3: On-site mitigation;

Potential onsite mitigation scenarios were also investigated including the reduction of the footprint of the developable area in order to reduce the impact on the hydrology of particularly the central drainage line and its associated wetlands. This would entail isolating individual catchments or a large part of a catchment and maintaining existing land use/landcover and/or restoring these to pre-current land use conditions within these isolated catchments. The option of targeting the central drainage line and its associated catchment was considered as from biodiversity and functional perspective, the "value" derived from this would likely compensate for the loss of wetlands in the remaining sub catchments. This option was not considered to be feasible as it:

- Divided the development into two sections, the development of which individually rendered the development un-economical;
- Increased the risk to security;
- Was difficult to define and justify the intention of the offset to the satisfaction of all stakeholders, including investors; and
- Introduced risk associated with defining and meeting environmental expectations.

2.2.4 Alternative 4: Economically/ Environmentally sustainable landuse compromise option;

In order to reduce the risks posed by any landcover/landuse change on the site to the water resources on and downstream of the site, an approach which involves integrating hydrological controls throughout the proposed development was proposed as a means of meeting the goals of the proposed development with an acceptable "cost" to the water resources on the site.

In order to reduce the risks posed by any landcover/landuse change on the site to the water resources identified on the site the following goals were proposed, which would to a large extent, compensate for the proposed rezoning of the land from Agriculture to Industrial, and meet the overall aims of the National Water Act:

- Manage the post-development hydrology to within 10% variance of the predevelopment modelled flows;
- To facilitate the ingress of stormwater into the ground to replenish wetlands
- Prevent any further soil loss (reduce the erosion risk) from the site;

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- Ensure that there is no net-loss of wetland functioning from the site;
- Retain the lateral seepage into the central stream channel in order to maintain the riparian trees that have established and are stabilising the stream channel and banks;
- Improve the overall biodiversity of the site.

Using the above as the guiding principles a layout was developed, based on a number of layouts/hydrological modelling iterations, until and an ecological/economically "sustainable" option was developed. This option was accepted as being a compromise between all the options that preceded this layout and which had a high probability of meeting the hydrological and environmental objectives.

The requirement was to compensate for:

- The loss of wetlands;
- The loss of biodiversity associated with the wetlands;
- The reduction in the capacity of the site to intercept rainfall;
- The loss of evapotranspiration capacity (carbon sequestration through photosynthesis);

The requirement to reduce the time to concentration of flows has been partially met in the overall landscape development plan, the details of which are covered in a separate report, Engineering Services Report, Contract #243/203; Landscape Master plan Philosophy, prepared by CNdV, while the hydrological aspects have been accommodated within the overall layout.

The impact of storm water runoff may be mitigated by the creation of a greater number of smaller, localized catchments, depressions or check facilities (landscaping, fences, walls, road kerbing etc) and longer, more complex drainage lines in the urban environment. This is in contrast to the sugar cane agricultural environment, where effort is placed in land smoothing and direct drainage, to ensure limited ponding and good drainage of fields and the cane root zone. The details of the stormwater management plan are presented in the Ushukela – Watson Highway Development site general stormwater management policy plan (Bosch Stemele (Pty) Ltd, Project no. 243/203.

The concept of the hydrological landscape is introduced during this alternative, defined as:
A landscape that provides a range of societal benefits including economic returns linked to the presence of water, including productivity, biodiversity support, flow regulation, biogeochemical processes at the soil level as inferred from the presence, extent, type and condition of wetlands, which does not compromise the condition of the immediate downstream reach.

The approach recognises that local landcover/ landuses within a catchment will affect the hydrological processes on the site, but that the loss of water dependent ecosystems is compensated for by benefits gained by society together with ensuring the maintenance of

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the hydrological characteristics of the transformed site in a way that does not compromise the water (flow duration and availability) and the water dependent ecosystems immediately downstream of the site.

2.3 Evaluation of the various alternatives

The alternatives were evaluated objectively according to a set of environmental, social and economic criteria, and the following table produced. The scores are linked to the probability of the outcome being achieved on a scale of 1 (unlikely) to 5 (definite).

Environmental including socio-economic aspect	Alternative 1: Permit development outside of 30m buffer and rehabilitate wetlands by blocking agricultural drains and revegetating	Alternative 2: Rehabilitation of wetlands off site to compensate for functional loss of onsite wetlands	Alternative 3: Limit footprint of development to exclude central drainage line and rehabilitate wetlands within this particular catchment	Alternative 4: Integrate stormwater management into overall design with a view to maintaining "functional landscape"
Medium to long-term on-site wetland protection	1	1	4	4
On-site biodiversity enhancement	1	1	3	5
Protection of downstream reach	1	1	2	3
Economic returns	1	1.5	2	4
Complying with NWA objectives (responsible management of water and water resources	1	3	3	4
Totals	10	10.5	17	22
Mean score	1.7	1.8	2.8	3.7

Note: The authorities are likely to advocate Alternative 1, and the potential for a successful RoD is higher for this alternative although the table illustrates that this approach is, in our professional opinion, unlikely to achieved the desired environmental outcomes.

2.4 Impact Assessment

A detailed impact assessment was undertaken for Alternative 4. The reader is referred to **WCS Report 642a2012** for the outcomes of this evaluation. Development recommendations are also provided.

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3. REVIEW OF HYDROLOGICAL STUDY

An initial concern of WCS, based on our experiences elsewhere, was that the hydrological role of the soils in the catchment had been underestimated. In particular their functioning as a significant reservoir of, and slow decant mechanism for, rainfall which in turn is likely to reduce localised erosion and influence baseflow in the *Hlawe* River. For example, this storage could range between 350m^3 and 900m^3/hectare depending on the depth and porosity of the soils. The water storativity lost by the introduction of potentially impervious surfaces and roofs would therefore need to be replaced, either through attenuation ponds (which require space) or subterranean storage facilities. For example stormwater management guidelines in the City of Johannesburg require that a volume of 340m^3/ha be provided for in attenuation facilities in all new developments to cater for anticipated changes in the runoff characteristics (Allan Batchellor, *pers comm*.). The underestimation of this process in hydrological modelling has, based on our past experiences, been a major contributor to the erosion of watercourses within and downstream of urban landscapes and it was our intention to highlight this. We wished to draw the attention of the project engineers to it so that, if possible, the hydrology of the site could be modelled taking into account storage and interflow based on the soils rather than only on surface flow. Such an approach would provide a more accurate idea of the volumes of water that need to be managed within the post-development landscape.

The subsequent hydrological modelling report prepared by the engineers, "*Analysis of Site Catchment Hydrology and Influences of Development of Catchment Storage and Surface Run-off*" (Bosch Stemele) makes use of the various hydrological soils groups found in the site, and the impact these have on intercepting rainfall and runoff. The following key points are presented:

- The hydrologists have modelled pre-and post-development runoff for the 1 in 2 year event (our recommendation since these are the events that would normally be attenuated by infiltration).
- All roof run-off will be directed into soakaways, sized in accordance with Ethekwini Municipality's requirement of 1m^3 clear volume per 40m^2 of the site. The assumption is that this will be appropriate for the specific site;
- All paved areas on individual sites will make use of permeable paving, with an infiltration and attenuation function. Permeable paving will limit surface runoff to between 0% and 2% of the total outflow volume for storms with rainfall depths less than 50mm. Designing permeable parking areas to accept ponding would also contribute to attenuation;
- All potential stormwater will be attenuated and encouraged to infiltrate the sub-soils as either permanent paving or soakaways;
- Any overflows from large storm events will be piped down the embankment slopes and discharged at natural water course levels or piped to formalised stormwater reticulation within the road reserves;
- A series of stormwater attenuation structures are proposed throughout the development aimed at managing water runoff from large storms;

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- Energy dissipators will be utilised to discharge stormwater at natural watercourse level;
- 50% of the road reserve will consist of soft landscaping, with vegetated swales draining into attenuation features;
- Having considered in their modelling our concerns regarding the increased runoff and lost soil storage volume, Bosch/Stemele hydrologists are confident that they can achieve the discharge target of a 10% variance from the current scenario;
- The hydrologists also believe that the attenuation target of 10% variance is also achievable;

It is recommended that a protocol be designed to ensure that the means to quantitatively measure the discharge rates into the receiving environment in the post-development landscape, as well as the volume of flow leaving the site. This would form a fundamental part of the monitoring programme.

4. REVIEW OF DEVELOPMENT LAYOUT

The final layout produced during meetings, the result of careful consideration of all of the environmental, social and economic factors and the representing a compromise scenario, is provided in **Figure 1** below. The changes to the previous iteration are the access bridge over the *Hlawe* River in the west, and the construction of the water pipelinel through the centre of the central drainage system.

Regarding these adjustments to the development layout, the following comments are relevant:

1. The bridge across the *Hlawe* River is unlikely to pose insurmountable environmental challenges. The important environmental considerations are:
   - That there is no impediment to longitudinal flow;
   - That the height and dimensions of the bridge consider 1:100 year flood lines;
   - That no soil is mobilised from the river banks during and subsequent to construction. The environment within the structures sphere of influence should remain stable; and
   - There are likely to be ample opportunities adjacent to the bridge to offset any negative impacts on the vegetation at the point of crossing.

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Figure 1: 2013 Development Layout

2. The pipeline crossing poses a problem in that it obliquely crosses the central drainage area at two localities. Possible environmental problems are:
   - The impediment to longitudinal flow, and poor control of discharge downstream;
   - Preferential points of flow discharge, which may increase the erosion threat by confining flow;
   - Confinement of flow, particularly in the western section. The oblique nature of the crossings introduces conditions where water may accumulate and flow preferentially along the length of the pipeline, potentially resulting in gully erosion.

The pipeline belongs to Umgeni Water and is of strategic value in that it feeds all coastal areas from La Mercy in the south to Stanger/Blythedale in the north. It has been in place for 30 years, and was recently upgraded with the necessary environmental authorisation, which implies that all wetland impacts would have been taken into account. We merely wish to highlight it as a consideration in the development. The modification and management of the central open space system should consider not only potential impacts on the pipeline (as it no doubt will), but also on the drainage system.

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5. MITIGATION RECOMMENDATIONS FOR THE DEVELOPMENT

To reiterate, given the changes that are likely to occur in the hydrology within the site, it is proposed that the environmental management goals and objectives be refined as follows:
Goal:

To ensure that the functions associated with the original wetlands are maintained in order to protect downstream reaches from the impacts associated with the changes in the catchment and to continue to afford habitat to support biodiversity.

Objectives;

- Ensure that flow rates off the site do not exceed by more than 10% the pre development flows for the ***average annual*** return event storm;
- Ensure that the water quality leaving the site is conforms with the quality associated with pre development quality;
- The species richness of the system is improved upon compared to that in the pre development condition;
- To retain the lateral seepage into the central stream channel in order to maintain the riparian trees that have established and are stabilising the stream channel and banks;
- To prevent any further soil erosion from the site;

What is thus recommended is to use a combination of approaches that can be used to:

- Replace the loss of storativity of the soils as a consequence of the increase in impervious areas within the catchment, with surface storage.
- Manage, across the property, storm water discharges with consideration for both water quality and flow rates, and
- Introduce a range of techniques at all levels of the development with the objective of reducing both the volumes and rate of runoff from the developments proposed on the site itself and,
- In addition to the above it is important to include in the overall objective of the storm water management plan opportunities for supporting biodiversity.

There are a number of strategies that can be deployed at different scales in order to meet these objectives. These include:

- Channels/swales to convey storm water from their point of discharge safely across the property. These have been incorporated into the development plan;
- Maximising the permeable surface area within the site. Permeable areas have been designed to cope with inundation, and hence will also form an attenuation function;
- Wet detention ponds to serve both an attenuation function as well as to provide habitat for biodiversity. These have been mentioned in the stormwater report, but will require modification from the standard attenuation pond design;

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- Bio retention areas linked to the proposed infrastructure to intercept, store and treat storm water runoff generated on the site itself. These would in effect replace the proposed 30m buffer by providing a similar function, including that of biodiversity support. These would be key to ensuring that the objective of maintaining subsurface flow to the riparian vegetation in the central system is met.

Of these strategies and systems outlined above the following specific systems would appear to be appropriate for inclusion in the development plans for the uShukela development site, given the objectives of flow, water quality management and biodiversity support. It is acknowledged that these measures have been included in the development plan, and there may be repetition of information already conveyed. Our aim is to provide input on the ecology of the various measures, justifying our recommendation for their inclusion.

The storm water drains and other drains that discharge water onto the site should be formally connected to the central drainage system via purposefully designed channels:

- To prevent soil erosion;
- To improve water quality; and
- To create habitat;

An example of a system that could be considered is illustrated in **Figure 2**. The side slopes could be sloped and planted with indigenous grasses and trees as opposed to the armourflex that has been used in the example. It is however recommended that the channel bottom be protected. In this case, in keeping with the objective to prevent soil erosion, the developer intends to line the channels with a permeable but scour-resistant material such as grass blocks where flow velocities are expected to exceed the design norms of the natural material. Each channel will be designed for its grade and either vegetated or lined in accordance with its design velocity.

Figure 2. Photographs showing "formalised" storm water drains that attempt to include environmental considerations.

Runoff off the road surface should be directed into grass lined channels, stone filled infiltration ditches etc. rather than into an underground piped systems. The advantages associated with this approach are:

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- that runoff is treated both by passing over the grass as well as filtration through the soil and rock packed trench;
- the water percolating into the soils reduces the irrigation demand of roadside trees and shrubs;
- The attenuation provided by the system reduces the requirement to provide alternative attenuation facilities; and
- Sediment transport into the water courses is obviated as the grass lined swales effectively trap sediment;
- Increasing flow path lengths;
- Decreasing road gradients as far as possible within the constraints of good design practice and site topography, and
- Retaining water on the road surface as long as possible.

The use of grassed swales in association with infiltration trenches should be encouraged to convey storm water. The advantages of these systems are:

- That runoff is treated both by passing over the grass as well as filtration through the soil and rock packed trench;
- The water percolating into the soils reduces the irrigation demand of roadside trees and shrubs
- The attenuation provided by the system reduces the requirement to provide alternative attenuation facilities; and
- Sediment transport into the water courses is obviated as the grass lined swales effectively trap sediment;
- Increasing flow path lengths;

An example is presented in **Figure 3**.

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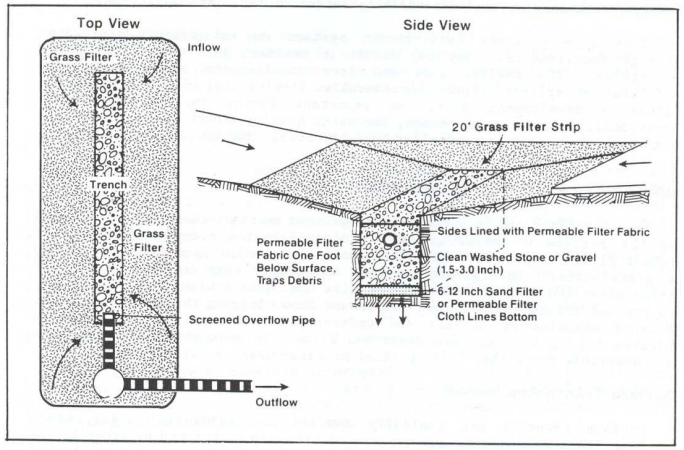

Figure 3. Schematic of a median swale/trench system (Scheuler, 1987)

Vegetated swales are broad, shallow channels with a dense stand of vegetation covering the side slopes and channel bottom. They are designed to slowly convey storm water runoff, and in the process trap pollutants, promote infiltration and reduce flow velocities. An infiltration trench or well is a gravel-filled trench designed to infiltrate storm water into the ground. A volume of storm water runoff is diverted into the trench or well where it infiltrates into the surrounding soil. Typically infiltration trenches and wells can only capture a small amount of runoff and therefore may be designed to capture the first flush of a runoff event. The combination of swale and infiltration trench is a useful combination in that it provides opportunities for both filtration and flow retardation.

The actual areas and volumes required to be attenuated will be a function of the density of the development (extent of impervious surfaces), and the application of storm water control systems within the footprint of the development itself.

5.1 *Recommendations for Wetland Attenuation Features*

In addition to the use of formal channels, attenuation facilities should be provided. We recognise that the hydrology of the catchment will change, and hence in order to maintain stable aquatic systems within the landscape the wetlands that remain would need to be modified to suit the new catchment hydrology. We forsee the wetland attenuation structures as fulfilling those wetland functions that currently exist on site, and would advocate them being built within the current wetland boundary.

A suggested design could entail a wet detention pond that consists of several levels, or terraces. The bottom would contain permanent open water, fringed by reeds and sedges,

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with a retention time for 1:2 year return event storms of approximately 48 hours, meaning that it would take 48 hours for the attenuation pond to drain down its base depth. This extended detention is advised to assist in meeting the water quality objectives. The release system could be a series of siphons or alternatively a staged release system to ensure that downstream velocities do not exceed by more than 10% modelled pre development flows.

Retention systems are designed to capture a volume of runoff and retain that volume until it is displaced in part or in total by the next runoff event. Retention systems can provide both water quantity and quality control. The main pollutant removal mechanism in retention systems is sedimentation. By retaining a permanent pool of water, retention systems can benefit from the added biological and biochemical pollutant removal mechanisms provided by aquatic plants and microorganisms, mimicking a natural pond or lake ecosystem. Also, sediments that accumulate in the pond are less likely to be re-suspended and washed out due to the presence of a permanent pool of water. In addition to sedimentation, other pollutant removal mechanisms in retention systems include filtration of suspended solids by vegetation, infiltration, biological uptake of nutrients by aquatic plants and algae, volatilization of organic compounds, uptake of metals by plant tissue, and biological conversion of organic compounds.

It should be reiterated that the rationale behind maintaining an area of shallow permanent water is to increase the ability of the attenuation features to operate as wetlands. The permanent water adds heterogeneity to the range of wetland habitats within the site, and contributes to nutrient cycling and enhancing water quality. The depth and area would have to be factored into the attenuation calculations, but the rationale is that it should be maintained at a depth too great for *Typha capensis* to colonise during the wet season, so possibly 1m.

The following sequence of terraces of any width could be constructed, progressing outwards with each increase in height:

- The next terrace up from the open water, approximately 30cm above the level of the water surface, would represent a permanent to seasonal wetland reed bed;
- Subsequently a seasonally wet sedge meadow. This level could be gently cambered outwards to trap water that inundates it following a flood event. The wetland community would therefore be driven by surface inundation rather than seepage, but the interval between inundation events would be such that the soil is allowed periods of aeration through drainage of the water through the profile, and evapotranspiration;
- The next level would be a temporarily wet grassland area, only inundated when the attenuation pond becomes full during peak rainfall events;
- The final terrace would be planted to swamp forest and riparian tree species.

This feature would, we feel, enhance wetland biodiversity considerably by creating a wetland vegetation community mosaic, attenuate flows from the development and contribute to water quality enhancement.

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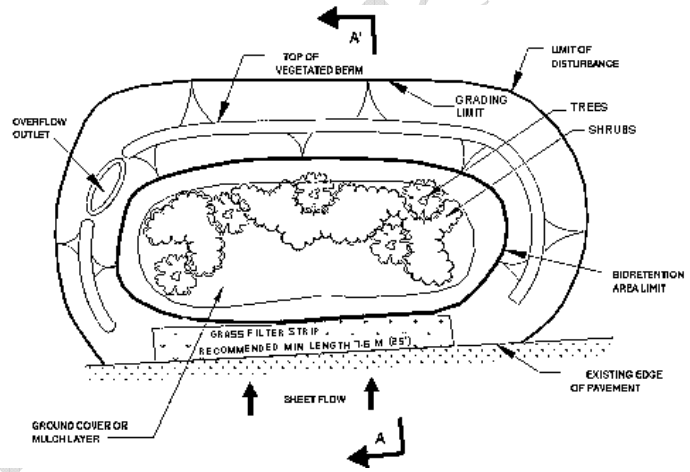
Please note that this is a suggested design in which we hope to present ideas that may be incorporated into the final design of the attenuation features. The intention is to aid the developer in achieving biodiversity and wetland functioning goals rather than creating a homogenous feature characterised by a monospecific stand of *Typha capensis* that fulfils its primary purpose of attenuating flows but underachieves in providing other wetland ecoservices.

5.2 *Recommendations for Bioretention Areas*

(Sourced from: Prince George's County. 1993. Design Manual for Use of Bio retention in Stormwater Management. Department of Environmental Resources, Prince George's County, Landover, MD.)

Bio retention areas consist of flow-regulating structures that process inflow passing through a shallow depressed planted area containing ground cover (low-lying plant growth or an organic mulch), a planting soil supporting a range of facultative plant types, and a bottom support soil layer. Each of these features has a specific role in storm water pollutant removal (refer to **Figure 4**).



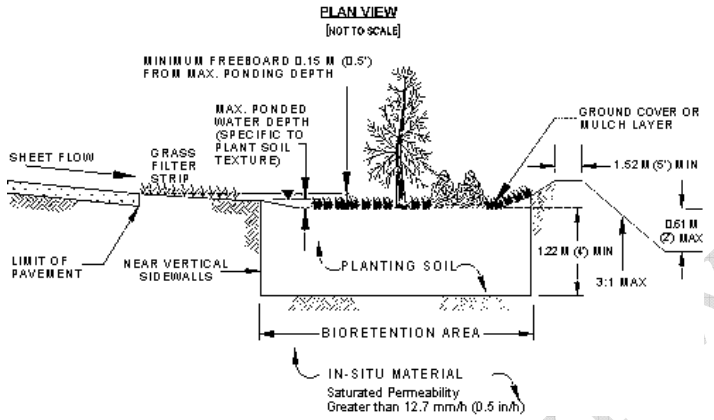


Figure 4. An example of a bio retention area. Parking edge and perimeter without curb. (Prince George's County, Maryland, 1993)

Bio retention areas have unique features that make them attractive for use:

- They have the ability to fit in existing or proposed medians or grassy areas along streets and parking lots;
- By disposing of a significant volume of annual rainfall on-site, they may reduce the infrastructure costs required to collect and convey the runoff off-site; and
- They also provide benefits other than storm water management, including creating green areas and natural habitat.

The land area requirement and cost can possibly be minimized if these areas can be considered as part of public open space.

We recommend that bio retention areas are constructed at the interface between the platforms that border on the central drainage line or 10m measured horizontally from the 1:100 year floodline whichever is the greater. We would forsee the seepage passing via these features as being important for maintaining the riparian tree community that has developed along, and is stabilising the sides of, the central drainage system.

6. CONCLUDING REMARKS

- The primary environmental goal of the development should be to ensure that the functions associated with the original wetlands are maintained in order to protect downstream reaches from the impacts associated with the changes in the catchment and to continue to afford habitat to support biodiversity.
- The site currently is of little biodiversity value. The most important functions associated with the wetlands on the site are hydrological, namely water storage, streamflow

augmentation, the provision of clean water, sediment trapping and soil erosion control and flood attenuation.

- The area is destined to be rezoned from agricultural to commercial/ light industrial. This implies a change in landuse that is likely to result in an unavoidable and fundamental change to the patterns of water movement through the landscape. It is important to recognise that it is not feasible to expect the wetland hydrogeomorphic units to remain unchanged, irrespective of the linear buffer distance applied.
- We do not feel that a linear buffer will be effective in meeting the environmental objectives of the site, and would rather advocate the application of a range of measures at a range of scales aimed specifically at fulfilling the same functions as the wetlands currently on the site do;
- Our main concerns relate to the removal of the water storage capacity of the deep Berea sands from the landscape, and the increased flow velocity and volume of water leaving the development site;
- The project hydrologists have acknowledged our concerns, and performed additional hydrological studies that consider these. They are confident that they can meet the objective of ensuring that flows leaving the site will be maintained within a 10% variance of the current flow regime. This being the case, it is likely that the incorporation of bioretention areas, swales and wetland attenuation features will be adequate to replace the hydrological functions currently being performed by the wetlands. However, it is recommended that a mechanism be put in place to quantitatively measure flows leaving the site following development. Should any form environmental degradation be identified, the developer should commit to implementing immediate remedial measures.
- We are confident that, with the appropriate design and implementation, wetland biodiversity will be substantially improved compared to the current scenario;

The overriding objective of managing wetland systems in urban environments should be the maintenance of the same wetland functions in the post-development landscape as those in the pre-development landscape, and at the same levels. It is our contention that it is unrealistic to expect wetlands to remain unchanged when their hydrological drivers are fundamentally transformed. The irreplaceable wetland functions are biodiversity, water supply to the landscape and water quality and the potential to replicate the current scenario should be carefully considered in evaluating a wetlands response to a development. The wetlands within the site have been completely transformed, to the detriment of their level of functioning and ecological health. In our opinion, engineered alternatives that perform the following wetland functions should be feasible ***provided the hydrological modelling is correct***:

- Water storage: in attenuation features, through infiltration encouraged by the network of swales, the permeable surfaces and bioretention ponds, and increased evapotranspiration from trees and vegetation planted within the site;
- Flood attenuation: via the attenuation features and bioretention ponds;
- Flow regulation: via the attenuation features and bioretention ponds;
- Enhancement of water quality: via the attenuation features;

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- Sediment trapping and soil erosion control: via the swales and attenuation facilities;
- Enhancement of biodiversity: across the site through introduction of indigenous wetland and forest vegetation communities.

Engineering wetlands to achieve environmental and ecological objectives, from managing stormwater to promoting biodiversity, is undoubtedly the future for wetland management in urban landscapes. It is however necessary to ensure that, in any such applications, the removal of wetland habitat from the landscape and the investigation of appropriate means to, at minimum, replace and maintain the catchments wetland functionality, is ***site-specific***, carefully considered and substantiated. The proposal under this specific development application has been subjected to such consideration and the rationale substantiated.

Wetland conservation should be a key criterion when authorities are considering rezoning an area from one landuse to another. If wetland considerations are paramount, then wetland-compatible landuses should be stipulated within the zoning requirements. If socio-economic considerations are paramount for a certain area, then it is suggested that the authorities recognise that this will result in a change in the wetland status-quo, and adopt an approach that will manage this change appropriately.

Prior to the development commencing, specific method statements for each mitigation structure and measure should be compiled, as stated in WCS Report 642a2012.

7. REFERENCES

Prince George's County. 1993. Design Manual for Use of Bioretention in Stormwater Management. Department of Environmental Resources, Prince George's County, Landover, MD.

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Appendix 12: Preliminary Geotechnical Investigation Report for Watson Highway Commercial and Residential Development

PRELIMINARY
GEOTECHNICAL INVESTIGATION REPORT

FOR

WATSON HIGHWAY
COMMERCIAL AND RESIDENTIAL DEVELOPMENT

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SEPTEMBER 2009

Copy No.: 1

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PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

WATSON HIGHWAY COMMERCIAL AND RESIDENTIAL DEVELOPMENT

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FIGURE 50765/01

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT
WATSON HIGHWAY COMMERCIAL AND RESIDENTIAL DEVELOPMENT

1. *INTRODUCTION*

TGC Engineers were appointed by Tongaat Hulett Developments to undertake a preliminary geotechnical investigation for the proposed Watson Highway Commercial and Residential Development. The Watson Highway site is shown in Figure 1 and is located along the southern boundary of Watson Highway, immediately seaward of Tongaat town and to the north of the new King Shaka International Airport. The project generally involves determining the potential geotechnical aspects of the site relevant to residential and commercial development, i.e.

- Potentially problematic soil types, i.e. heaving/collapsing/compressible and anticipated foundation types required;
- Excavatability, erodability;
- Steep slopes and potentially unstable slopes;
- Seepage zones;
- Construction material suitability, etc.

The investigation was broadly performed in accordance with the National Department of Housing requirements for Preliminary Geotechnical Site investigations as outlined in their "GFSH-2" Document of September 2002.

2. *METHODOLOGY AND INFORMATION USED*

The geotechnical appraisal initially involved a desktop study of available maps and literature, in particular:

- 1:50 000 topographical, 1:10 000 orthophoto coverage and 1:250 000 geological mapping of the area.
- Relevant geotechnical reports of nearby sites investigated in similar geology and topography, namely the KSIA Airport site and the Ballito - Hazelmere pipeline which traverses through the site.

This was followed by a site reconnaissance to:

- Obtain an indication of the subsurface geology relative to topography (i.e. terrain mapping) by viewing available exposures, i.e. cut slopes/trenches/borrow pits/rock outcrop, etc.
- Identify features likely to be associated with potential geotechnical problems, i.e.
  - Failed or hummocky profiles indicating potential instability.
  - The extent of steep slopes (> 1:3) or wet/marsh areas generally unsuitable for development.
  - Shallow hard rock/boulder areas which would hamper excavatability.
  - Potentially problematic soil types, i.e. active soils, compressible soils, erosive soils (dongas), collapsible soils.
  - The "crack" condition of existing housing structures in the area.

A map has been produced (Figure 1) highlighting the above where applicable. In addition, and based on our experience with these materials, this report comments on the:

- Anticipated suitability of the materials for road/housing fill platforms and for road layerworks.
- Anticipated foundation types required for structures relative to the prevailing conditions.

3. SITE DESCRIPTION AND HYDROLOGY

The accompanying Figure 1 (1:10 000 orthophoto 2931 CA 8) shows the boundary and topography of the Watson Highway site. The site is generally divisible; according to the topography, into a western half and an eastern half. The western portion generally comprises moderately steep topography with upper convex and lower concave slope conformations. The eastern half generally comprises gently rolling hills with flatter/planar topography.

A permanent stream tributary of the Hlawe River flows in a northerly direction through the west central portion of the site. Other than this permanent stream, the remaining valley depressions are expected to have subsurface permanent seepage zones even though the surface flow is only seasonal. The western half if generally characterized by narrow, well defined seepage zones, whereas the eastern half shows broad, poorly defined seepage areas relative to the more gentle topography. The majority of the site drains north and west toward the Hlawe and Tongaat Rivers.

Vegetation is mainly in the form of sugar cane with coastal bush following more prominent water courses or steeper terrain. Gravel cane access tracks service the area with few brick/tar roads servicing farm houses.

4. SITE GEOLOGY AND GEOTECHNICAL CONDITIONS

The site geology is shown in Figure 1 and generally comprises Recent Berea Red Formation sands in the eastern half of the site and Vryheid Formation Siltstone/Sandstone (subordinate mudstone) for the western site half. A large dolerite dyke has intruded the Vryheid Formation in the west-central portion of the site as shown in Figure 1. Further minor/associated dolerite intrusions are to be expected throughout the Vryheid Formation sandstone/siltstone. Following is a brief description of typical profiles and associated geotechnical conditions to be expected on developing in each of the above geological formations.

4.1. BEREA RED FORMATION

Typical Profile:

0 - 2,0 / 4,0m	:	Yellow/grey, loose, medium to fine sand, Hillwash and Recent Dune sand cover.
> 2,0 / 4,0m	:	Orange, red, soft/firm/stiff, clayey sand, Berea Red Formation.

Geotechnical Conditions:

- The upper loose sands overlying Berea Red Formation sands are known to have a collapse potential when wetted under load. The loose sands and soft clayey sands commonly have a moderate to high compressibility.
- The sands and clayey sands are highly erodible.
- Perched water tables are common in the sands overlying the less permeable clayey sands.
- Slopes are generally stable, provided instability is not introduced during the earthworks phase. Cut slopes are usually limited to a 1 in 2 in the sands and 1 in 1,75 in the clayey sands.
- Soft excavation (after SABS 1200D) is expected to considerable depth (> 5,0m).

4.2. VRYHEID FORMATION SANDSTONE/SILTSTONE

Typical Profile:

0 – 1.0/2,0m : Brown, orange, yellow, grey, soft/firm/stiff sandy clay and clayey silt, Hillwash and Residuum.

> 1,0/2,0m : Yellow, orange, brown, highly weathered to medium weathered with depth, medium to closely jointed, sub-horizontally bedded (generally dipping 10-20° SE on 140-160° dip direction), soft rock siltstone/mudstone interbedded with medium hard and hard rock sandstone.

Geotechnical Conditions:

- The sandy clay and clayey silt Hillwash and Residual Soils are expected to have a low to moderate heave potential and a low to moderate soil compressibility. In essence, the heave potential and compressibility is expected to be moderate to low on hilltops and sideslopes where soils are thin and more granular, however a moderate to high heave potential and compressibility is to be expected progressing down into valley bases where thicker, more clayey profiles are anticipated.
- The cohesive soils are expected to have a low to moderate erosion potential.
- Slope instability problems are commonly associated with the siltstone/mudstone horizons in the Vryheid formation, particularly where:
  - the bedding dips adversely out of moderate to steep slopes making south east and easterly facing slopes at this site susceptible to potential instability.
  - moderately to steep slopes are associated with dolerite intrusions and/or subsurface moisture.
- The adjacent King Shaka Airport site encountered slope failures on cutting into slopes in the Vryheid Formation under the above conditions. Figure 1 highlights areas deemed susceptible to potential instability due to the above factors, together with areas steeper than 1 in 3 generally unsuitable for development.
- Soft excavation is anticipated to moderate depth (2-3m) below which intermediate and hard excavation is expected (after SABS 1200D). Bedrock outcrop is localised.

4.3. JURASSIC AGE DOLERITE

Typical Profile:

0 – 1.0/3,0m : Brown, red, soft/firm/stiff sandy clay and silty clay, Hillwash and Residuum.

> 1,0/3,0m : Highly variable from shallow hard rock closely jointed dolerite, to deeply weathered gravelly sand soft rock (sugar) dolerite, to hard dolerite corestones in a silty/clayey matrix.

Geotechnical Conditions:

As shown above, areas underlain by dolerite will vary from deep clays/silts to localised areas of shallow hard bedrock/boulders/corestones. For the most part, areas underlain by dolerite will have deep clayey/silty soil profiles with:

- A moderate to high heave potential and moderate soil compressibility.
- A low to moderate erosion potential.
- A potential for slope instability on moderate to steep slopes, especially when associated with increased moisture.
- Soft excavation is anticipated to considerable depth (>3,0m), below which intermediate and hard excavation is expected (after SABS 1200D). Localised areas of shallow hard excavation and boulder excavation is to be expected.

5. ANTICIPATED MATERIALS SUITABILITY

Table 1 below has been produced to provide indication of the anticipated on-site material suitability (TRH 14-1985 rating) for use in road/housing platforms. The information provided is based on field inspection together with our experience and previous investigations in similar/nearby geology.

Table 1
Anticipated Material Suitability after TRH 14-1985

Profile	Berea Red Formation		Vryheid Formation Sandstone/Siltstone	Dolerite
	Upper Sands	Lower Clayey Sands		
Soil	G7 - G9	G9 - G10^{+}	G9 - G10^{+}	G9 - G10^{+}
Soft excavatable rock	-	-	G7 - G10	G6 - G10

There is expected to be abundant G7-G9 quality material in the form of the upper sandy Berea Red Formation/Recent Dune Sand covering the eastern half of the site. This material has also been used as building/plaster sand in the past.

Localised areas of G6 quality (and possibly even G5 quality) soft rock excavatable dolerite are also anticipated in the large dolerite intrusion intersecting the west central site portion. Potential G6 borrow sources may be detected during the detailed geotechnical phase. A possible source of G6 quality dolerite (sugar or dolerite) was observed in the cutting at the location demarcated with a red dot ● in Figure 1.

6. FOUNDING

6.1. BEREA RED FORMATION SANDS AND CLAYEY SANDS

In light of the collapse potential and moderate to high soil compressibility, single storey structures are commonly founded on reinforced strip foundations or widened pad footings with foundation base wetting/compaction and service/plumbing precautions. Multi-storey structures are commonly founded using raft/ground beam foundations supported by piles.

6.2. VRYHEID FORMATION SANDSTONE/SILTSTONE AND DOLERITE

In general, a moderate heave potential and moderate soil compressibility is expected. Slopes are also generally moderately sloping requiring cut to fill platforms.

Founding in these “western” areas are anticipated for the most part to require reinforced/articulated foundations and structures to allow differential movement, or stiffened raft/ground beam foundations supported by piles where necessary (i.e. fills >1,0m /compressible soils, etc.).

Portions of these western areas will encounter shallow bedrock lending itself to conventional strip footings or pads taken down to stable residuum or bedrock.

7. SITE SUITABILITY CONCLUSIONS AND RECOMMENDATIONS

The majority of the site is suitable for the proposed residential and commercial development. Figure 1 has been produced for preliminary planning purposes and highlights seepage zones, steep slopes and potentially unstable slopes (especially during earthworks), not recommended for development.

The “eastern” half of the site is underlain by Berea Red Formation sands and clayey sands with a collapse potential and moderate to high soil compressibility. Perched water tables are common in the sands overlying the less permeable clayey sands. G7-G9 quality material (after TRH 14-1985) is anticipated to be obtainable from the upper sands.

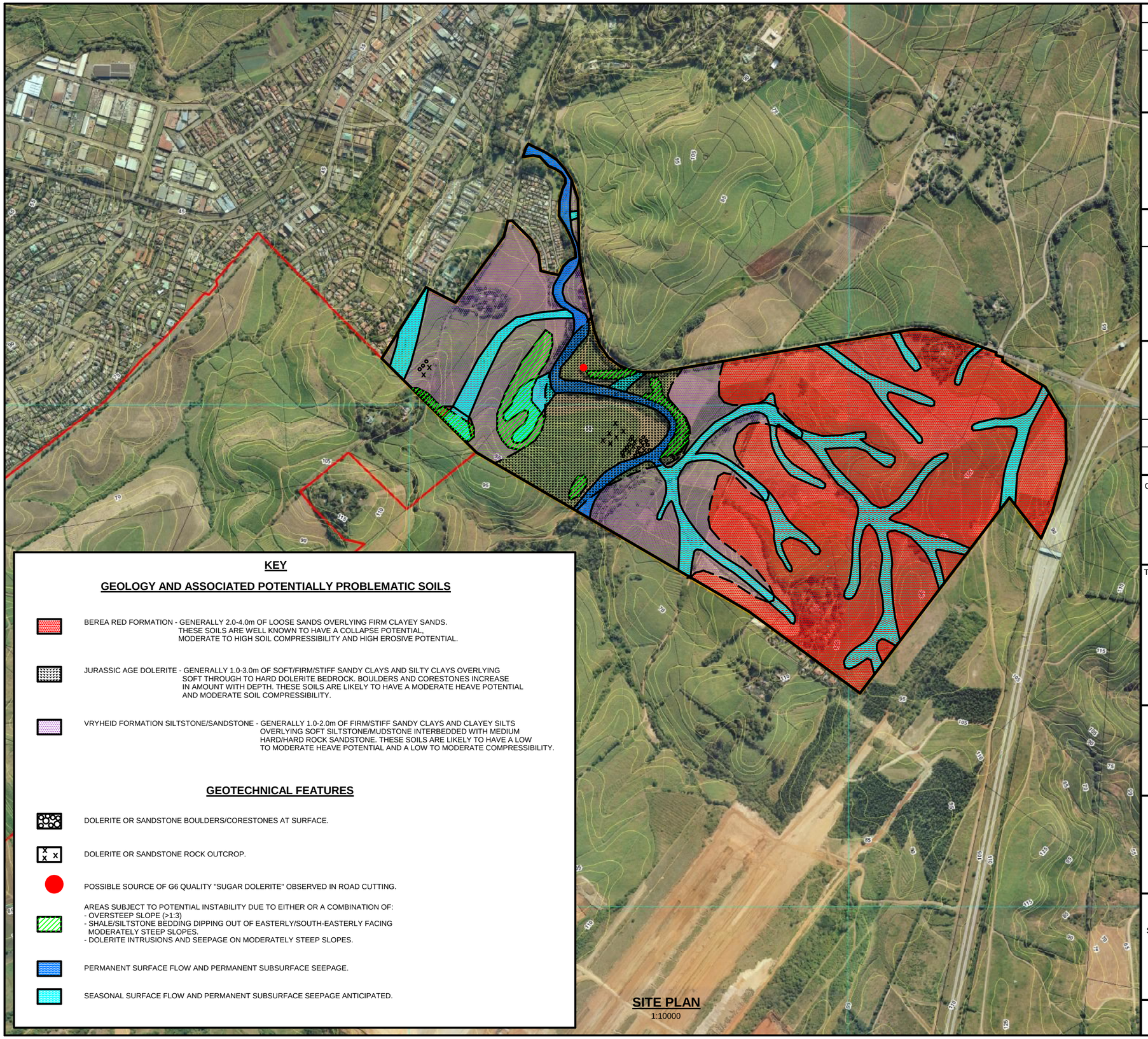
The “western” half of the site is underlain by Vryheid Formation sandstone/siltstone and dolerite. In general, a moderate heave potential and moderate soil compressibility is anticipated (becoming high in lower valley slopes). The dolerite is however highly variable in profile across the site. Slope instability problems are commonly associated with the siltstone/mudstone horizons in the Vryheid Formation, particularly where the bedding dips adversely out of moderate to steep slopes and/or when associated with dolerite intrusions/subsurface moisture. Localised areas of G6 quality “sugar dolerite may be encountered in the west central large dolerite intrusion, however this will be confirmed during the detailed geotechnical phase.

S. GOVENDER Pr. Tech.(Eng).

K. M. RIBBINK Pr. Sci. Nat.

FIGURE

50765/01



KEY

GEOLOGY AND ASSOCIATED POTENTIALLY PROBLEMATIC SOILS

BEREA RED FORMATION - GENERALLY 2.0-4.0m OF LOOSE SANDS OVERLYING FIRM CLAYEY SANDS. THESE SOILS ARE WELL KNOWN TO HAVE A COLLAPSE POTENTIAL. MODERATE TO HIGH SOIL COMPRESSIBILITY AND HIGH EROSIVE POTENTIAL.

JURASSIC AGE DOLERITE - GENERALLY 1.0-3.0m OF SOFT/FIRM/STIFF SANDY CLAYS AND SILTY CLAYS OVERLYING SOFT THROUGH TO HARD DOLERITE BEDROCK. BOULDERS AND CORESTONES INCREASE IN AMOUNT WITH DEPTH. THESE SOILS ARE LIKELY TO HAVE A MODERATE HEAVE POTENTIAL AND MODERATE SOIL COMPRESSIBILITY.

VRYHEID FORMATION SILTSTONE/SANDSTONE - GENERALLY 1.0-2.0m OF FIRM/STIFF SANDY CLAYS AND CLAYEY SILTS OVERLYING SOFT SILTSTONE/MUDSTONE INTERBEDDED WITH MEDIUM HARD/HARD ROCK SANDSTONE. THESE SOILS ARE LIKELY TO HAVE A LOW TO MODERATE HEAVE POTENTIAL AND A LOW TO MODERATE COMPRESSIBILITY.

GEOTECHNICAL FEATURES

DOLERITE OR SANDSTONE BOULDERS/CORESTONES AT SURFACE.

DOLERITE OR SANDSTONE ROCK OUTCROP.

POSSIBLE SOURCE OF G6 QUALITY "SUGAR DOLERITE" OBSERVED IN ROAD CUTTING.

AREAS SUBJECT TO POTENTIAL INSTABILITY DUE TO EITHER OR A COMBINATION OF:
- OVERSTEEP SLOPE (>1:3)
- SHALE/SILTSTONE BEDDING DIPPING OUT OF EASTERLY/SOUTH-EASTERLY FACING MODERATELY STEEP SLOPES.
- DOLERITE INTRUSIONS AND SEEPAGE ON MODERATELY STEEP SLOPES.

PERMANENT SURFACE FLOW AND PERMANENT SUBSURFACE SEEPAGE.

SEASONAL SURFACE FLOW AND PERMANENT SUBSURFACE SEEPAGE ANTICIPATED.

SITE PLAN
1:10000

DRAWING REFERENCE

DRAWING NO.	TITLE

NORTH POINT

NOTES

NO.	AMENDMENT	APPROVED	DATE

REVISIONS

CLIENT

Tongaat Hulett DEVELOPMENTS

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PROJECT

WATSON HIGHWAY

TITLE

PRELIMINARY GEOTECHNICAL INVESTIGATION

CONSULTING ENGINEER	DESIGNED :	K.R.	
SIGNATURE:.....	DRAWN :	K.M.	
PR. NO.:.....	CHECKED :	S.G.	
DATE:.....	SCALE :	1:10000	
	DATE :	07/09/2009	
REFERENCE NO. 50765	FIGURE NO. 1		REVISION

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Appendix 13: Ushukela Landscape Masterplan Philosophy

USHUKELA

LANDSCAPE MASTERPLAN PHILOSOPHY

DRAFT 2

To be read in conjunction with Urban Design Guidelines (by Architectural Design Associates)

May 2012

prepared for

Tongaat Hulett

and

dube tradePORT

prepared by

CNdV africa

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   - 1.1 Objectives
   - 1.2 General Style of Ushukela

2. Ushukela Master Landscape Plan
   - 2.1 Pedestrian Routes and Open Space Nodes
   - 2.2 Advertising and Signage

3. Specific Guidelines for Individual Plots/Erven
   - 3.1 Water
   - 3.2. Green/Soft Landscaping
   - 3.3 Soft Landscaping
   - 3.4 Hard Landscaping Materials
   - 3.5 External Lighting
   - 3.6 Accessibility for Wheelchairs and Bicycles
   - 3.7 Approved Hard Landscape Materials and Style

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1. INTRODUCTION

1.1 OBJECTIVES

The main objective of this document is to describe the overall landscape design ethos for Ushukela specifically with regards to landscaping of the site.

This document should be read in conjunction with:

A: The Ushukela Overall Landscape Master Plan
B: The Stormwater Management Document
C: Guidelines documents (to be drafted at a later stage)

1.2 GENERAL STYLE OF USHUKELA

The overall style of Ushukela can be described as a "green" industrial/retail development, closely integrated with open spaces together with accessible links for both pedestrians and cyclists.

An important component of the overall design is the incorporation of "urban drainage systems". All roads will have open drainage swales and on-site accommodation of infiltration areas and soft landscaping areas are required.

All roads will have swales carrying in stormwater. Access to sites over these swales need to ensure unhindered drainage by means of headwalls and pipes to ensure continuous functioning of any swales.

The soft landscaping and rehabilitated green spaces use only indigenous plants. The use of ample indigenous trees along avenues and with development is a strong theme. Accessibility to roads, open spaces and across the site is encouraged with the incorporation of a network of pathways and cycle routes.

Buildings are encouraged to "interact" with streets and pedestrian routes to encourage activity and surveillance onto outdoor spaces. This is especially necessary where sites face onto open spaces. The use of decks and balconies overlooking open spaces is strongly encouraged.

Courtyards / restaurants / outdoor areas / patios etc. are encouraged to "open up" onto the public areas to activate these spaces.

At least 10% of any development site shall be soft landscaping, preferably incorporating detention ponds/detention areas.

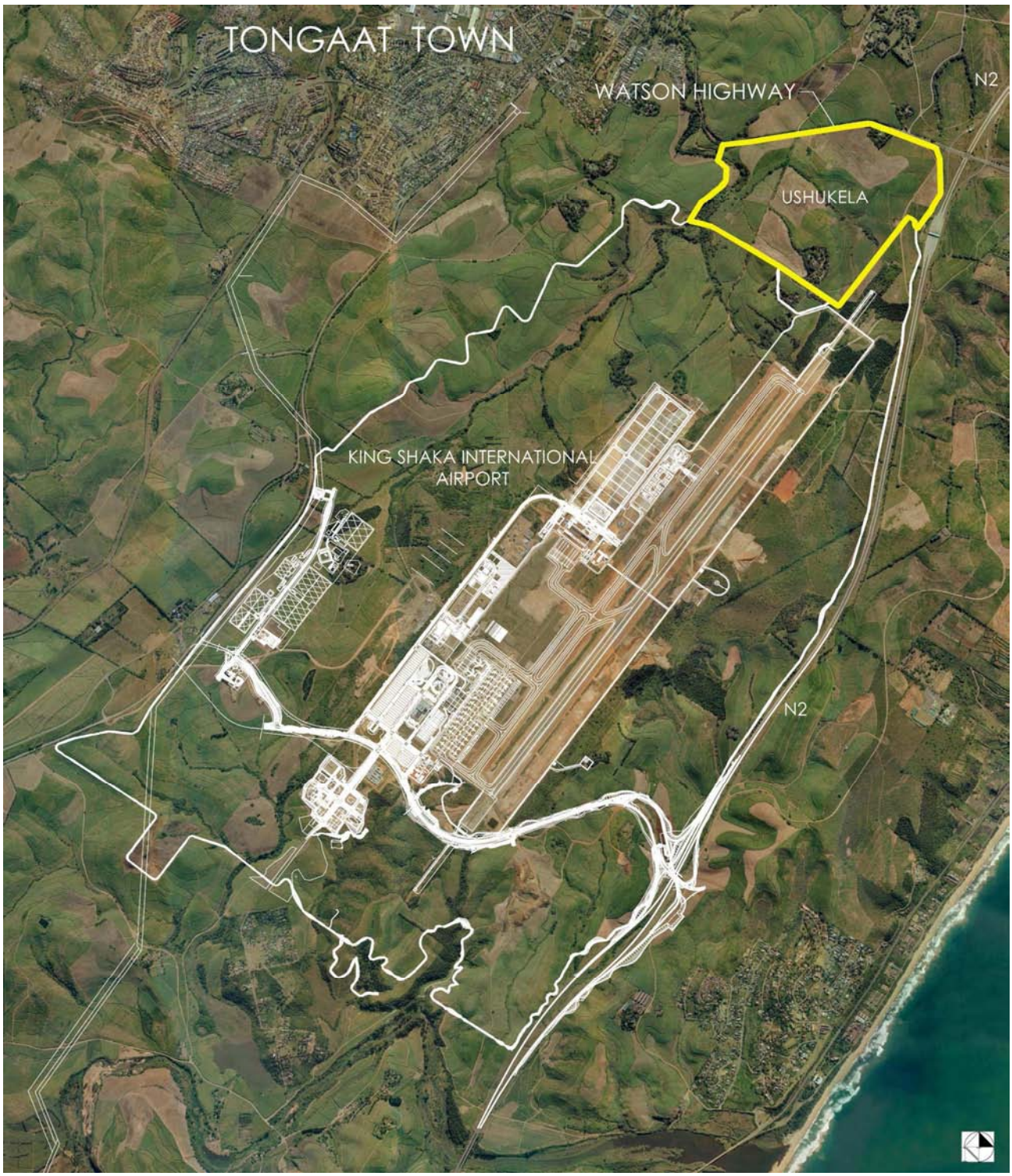

Figure 1 **Ushukela Location Diagram**

Figure 2 Overall Landscape Master Plan

2. USHUKELA LANDSCAPE MASTER PLAN

The Ushukela landscape plan is structured by various elements such as sidewalks, pedestrian routes, external walkways, multi-functional park areas and stormwater and detention facilities.

2.1 PEDESTRIAN ROUTES AND OPEN SPACE NODES

Figure 3 Pedestrian routes and open space nodes

Ushukela has been designed to accommodate a pedestrian/cycle network linking all public spaces and is intended to ensure ease of pedestrian (and cycle) movement throughout.

Primary pedestrian routes (indicated in blue in the diagram) have been accommodated on both sidewalks of major roads and one side of minor roads. Building entrances are to reiterate these movement lines and main entrances are to be placed along these lines. Pedestrian/cycle links must be accommodated onto/to link into individual erven.

The secondary pedestrian route is indicated in yellow.

Note: It is strongly encouraged that pedestrian links to open spaces are allowed for from all sites adjacent to the open spaces. Materials shall match/link into existing materials / paths.

2.2 ADVERTISING AND SIGNAGE

This will form part of the Guidelines document and will be strictly controlled, whether permanent or temporary (e.g. site signage).

3. SPECIFIC GUIDELINES FOR INDIVIDUAL PLOTS/ERVEN

The landscape at Ushukela must form a coherent urban system and is not an "add-on" to the architecture. It is advised that a landscape architect is brought on at the beginning of the project in order to have an influence on the concept design. The architecture must be driven by green building principles and must accommodate functions such as rain water harvesting and stormwater detention and solar water heating.

Any materials or street furniture must adhere strictly to the Ushukela palette. See 3.5.

Individual site landscaping is encouraged to relate to the general urban landscape framework of the public open spaces, roads, pedestrian routes and attenuation ponds/wetlands.

In general, a large proportion of landscaping, trees, vegetated facades, pergolas and shrub planting is encouraged.

3.1 WATER

Water is a scarce commodity and should be conserved wherever possible. Ushukela has made provision for stormwater to drain to and be collected for irrigation of the site and this sets the standard for the individual erven.

3.1.1 Storm water and rain water harvesting

It is proposed that 90% of on-site irrigation requirements are met with non-potable water stored in open ponds or in basement / roof tanks.

Engineering requirements from Council / Green Building Council of South Africa also require stormwater detention on site.

Attenuation ponds should form part of the landscaped area of the site (see engineering guidelines for requirements).

Attenuation ponds should ideally not be more than 1.5m deep and should ideally have no steeper than 1:3 slopes.

Detention ponds and swales should be planted with appropriate indigenous planting.

Rainwater may also be harvested and stored for reuse within the building (eg: flushing toilets).

3.1.2 Irrigation

It is proposed that, due to minimal soil depths, roof gardens and planters are irrigated by means of an automatic irrigation system. Irrigation installed should be designed so as to minimize loss of water due to evaporation or wind and should ideally be linked to moisture sensors and timers.

The use of indigenous plants and the addition of water use reduction substances, such as "Aquasoil" included into planting mixes, should minimize volumes required for irrigation.

Please note that all standpipes, nozzles and visible parts of the irrigation system must be black and PVC pipes must be orange, due to the water being non-potable.

3.1.3 Water features

Whilst water features are desirable from a comfort/cooling perspective, cognisance should be taken of evaporation, and water features should be added sparingly or shut off when non-potable top up sources have run dry.

It is encouraged that water features are filled using stored rainwater, if possible.

3.2. GREEN / SOFT LANDSCAPING

Ushukela requires that at least 10% of the area of the site is landscaped (fully planted or grassed area without any paving etc.).

Green landscape area is defined as any soil area fully planted up or grassed.

Permeable paving will not count as part of the green landscape area calculation. See engineering guidelines for minimum requirements for infiltration.

The sidewalk space between the road edge and site boundary, as well as embankments are not to be included in this minimum green landscaping area. Green landscape area may include any external planting or planters on any building level, open-air sky gardens and/or roof gardens, as long as these are within the site boundary.

Pergolas and vertical screens is encouraged, in addition to the 10% landscaped areas.

3.2.1 Roof gardens and green elevations

Should a roof garden be proposed, sufficient structural strength to support the weight of a roof garden with a minimum soil depth of 800mm (excluding any screed or other protective layers) is proposed.

Access to roof gardens for tenants / visitors is to be encouraged to ensure the ongoing maintenance and usability of these spaces.

Landscaped / vegetated elevations are strongly encouraged between floors with selectively located planters and trellises.

3.2.2 Parking areas and planting of these

Parking decks must incorporate trees and plants to soften the paved surfaces. This may require the addition of built planter boxes to accommodate soil. Plant boxes are to be minimum 1m wide and 800 deep to ensure sufficient growing medium for shrubs and trees. The addition of pergolas with trailing vines and shrub planting is also encouraged.

A minimum of 1 tree per 4 bays, preferably 1 tree per 2 parking bays (on average) is required in any parking areas.

3.3 SOFT LANDSCAPING

3.3.1 Permitted planting list

The plant palette for Ushukela has been carefully chosen and approved to include only indigenous and endemic plants as well as rare and red data species. The addition of any plants to this plant list will require approval by the MA and possibly also the eThekwini Environmental Department.

At least 10 % of the overall site should be landscaped. In order to achieve this roof gardens and planters on decks will probably be required. This excludes sidewalks and embankments which shall also be landscaped.

The additional use of planted vertical screens and pergolas covered in vines is encouraged.

All subsequent planting (after completion) must also adhere to this list.

A plant list must be included on the landscape plans to be submitted with the drawings submitted to the MA for approval for any site (density and size to be indicated on landscape plans).

PLANT LIST:

LANDSCAPED AREAS

Trees
Acacia natalitia
Acacia sieberiana var. woodii
Acacia tortilis
Albizia adianthifolia
Antidesma venosum
Brachylaena elliptica
Calodendrum capense
Cassipourea gummiflua
Celtis africana
Cussonia sphaerocephala
Drypetes natalensis
Ekebergia capensis
Erythrina lysistemon
Erythrina caffra
Ficus glumosa
Ficus ingens
Ficus lutea
Ficus natalensis
Ficus polita
Ficus trichopoda
Kraussia floribunda
Mimusops caffra
Nuxia floribunda
Pavetta inandensis
Pavetta lanceolata
Psychotria capensis
Pittosporum viridiflorum
Rauvolvia caffra
Rhothmannia globosa
Sclerocarya birrea
Sideroxylon inerme
Syzygium cordatum
Trema orientalis
Trichilia emetica

Shrubs
Agapanthus praecox
Aloe barberae
Aloe pluridens
Aloe thraskii
Anthericum saundersiae
Aptenia cordifolia
Aristea ecklonii
Aristida junciformis
Asparagus densiflorus
Carissa bispinosa
Chlorophytum krookianum
Clivia gardenii
Clivia miniata var. miniata
Crinum macowanii
Dietes grandiflora
Euphorbia tirucalli
Juncus kraussii
Kniphofia pauciflora
Loxostylis alata
Plumbago auriculata
Sansevieria cylindrica
Strelitzia reginae
Tecoma capensis
Watsonia densiflora

Lawn
Cynodon dactylon
Dactyloctenium australe (LM Berea)

COASTAL FOREST AREA

Trees
Acacia sieberiana
Albizia adianthifolia
Apodytes dimidiata
Bauhinia tomentosa
Caesaria gladiformis
Canthium inerme
Celtis africana
Chaetacme aristata
Chionathus peglerae
Clerodendrum glabrum
Combretum bracteosum
Combretum kraussii
Cussonia spicata
Croton sylvaticus
Cryptocarya woodii
Drypetes natalensis
Ekebergia capensis
Ficus natalensis
Ficus sur
Ficus thoningii

Grewia occidentalis
Halleria lucida
Harpephyllum caffrum
Heteropyxis natalensis
Hippobromus pauciflora
Ilex mitis
Millettia grandis
Mimusops caffra
Pittosporum viridiflorum
Rauvolvia caffra
Rapannia melanophloeos
Rhus chirindensis
Sideroxylon inerme
Schotia brachypetala
Syzygium cordatum
Syzygium guineense
Trichilia dregeana
Vepris lanceolata
Xylotheca kraussiana

Groundcovers, bulbs & shrubs
Bulbine spp.
Clivia gardenii
Clivia miniata
Crinum moorei
Euclea natalensis
Grewia occidentalis
Halleria lucida
Justicia capensis
Pavetta spp
Pavetta revoluta
Rhoicissus tomentosa (creeper)
Rothmania globosa
Strelitzia nicolai

WETLAND/RIPARIAN AREAS

Trees
Acacia robusta
Bridelia micrantha
Burchellia bubalina
Ekebergia capensis
Erythrina lysistemon
Ficus sur
Ficus trichopoda
Ficus capreifolia
Harpephyllum caffrum
Milettia grandis
Phoenix reclinata
Rauvolfia caffra
Syzygium cordatum
Voacanga thouarsii
Protorhus longifolia

Groundcovers, shrubs
Aspilia natalensis
Chlorophytum krookianum
Cotula nigellifolia
Crinum bulbispermum
Crinum macowanii
Cyanthea dregei
Cyperus articulatus
Cyperus dives
Cyperus latifolius
Cyperus prolifer
Cyperus sexangularis
Cyperus textilis
Dissotis canescens
Dissotis princeps
Eleocharis limosa
Eragrotis capensis
Fuirena hirsuta
Gunnera perpensa
Isolepis prolifer
Juncus kraussii
Juncus lomatophyllus
Kniphofia littoralis
Kniphofia pauciflora
Leersia hexandra
Mariscus solidus
Nymphaea nouchali
Nymphoides indica
Psoralea pinnata
Phoenix reclinata
Pycnostachys urticifolia
Pycnostachys reticulata
Ranunculus multifidus
Schoenoplectus littoralis
Schoenoplectus scirpoides
Tremeria grandifolia
Trichelia emetica
Trichelia dregeana
Zantedeschia aethiopica

GRASSLAND & WETLAND BUFFER AREAS

Trees
Acacia siberiana
Albizia adianthifolia
Apodytes dimidiata
Erythrina lysistemon
Ficus burkei
Harpephyllum caffrum
Mellettia grandis
Mimusops obovata
Phoenix reclinata
Pittosporum viridiforum
Sideroxylon inerme
Strelitzia Nicolai
Trema orientalis
Trichilia dregeana
Trichilia emetica
Ziziphus mucronata

Groundcovers
Anthericum saundersiae

Barleria obtusa
Chlorophytum cooperi
Gerbera ambigua
Themeda trianda
Vernonia capensis

Wetland buffer
Dissotis canescens
Dissotis princeps
Pseudarthria hookeri
Juncus kraussii
Pycnostachys urticifolia
Pycnostachys reticulata
Ranunculus multifidus
Zantedeschia aethiopica
Crinum bulbispermum
Aspilia natalensis
Cotula nigellifolia

Bulbs
Crinum macowanii
Crinum moorei
Hypoxis hemerocallidea
Orthonogalon longibracteatum
Scadoxus multiflorus subsp. katharinae
Scadoxus puniceous
Scilla natalensis

Grasses/grassland
Aloe cooperi
Aloe parviflora
Aloe maculata
Anthericum cooperi
Aristea woodii
Aristida junciformis
Asparagus africanus
Asparagus densiflorus
Asystasia gangetica
Boophone disticha
Chloris gayana
Convolvulus natalensis
Crinum macowanii
Cynodon dactylon
Dianthus zeyheri
Dispyros lycioides
Eragrostic teff
Eucomis autumnalis
Gloriosa superba
Hypoxis hemerocallidea
Imperata cylindrica
Kniphofia gracilis
Kniphofia pauciflora
Leersia hexandra
Leonotis leonorus
Panicum maximum
Rhus nebulosa
Setaria sphacelata
Sporobolus africanus
Sporobolus pyramidalis
Stachys aethiopica
Themeda triandra
Vernonia spp

Grasses/grassland

DRYLAND GRASS MIX

Bothriochloa insculpta
Melinis repens
Themeda triandra
Aristida junciformis
Eragrostis capensis
Melinis nerviglumis
Monocymbium ceresiiforme
Sporobolus africanus

Grasses/grassland

WETLAND GRASS MIX

Bothriochloa insculpta
Melinis repens
Themeda triandra
Aristida junciformis
Eragrostis capensis
Imperata cylindrica
Monocymbium ceresiiforme
Miscanthus capensis
Setaria sphacelata
Alloteropsis semialata
Brachiaria serrata
Tristachya leucothrix

Shrubs
Barleria obtuse
Justicia capensis
Plectranthus ciliatus
Polygala virgata

SWAMP FOREST

Trees
Barringtonia racemosa
Baphia racemosa
Birdelia micrantha
Bridelia micrantha
Ficus lutea
Ficus polita
Ficus sur
Hibiscus tilliaceus
Macaranga capensis
Phoenix reclinata
Rapanea melanophloeos
Syzygium cordatum
Tarrenna pavettoides
Tabernaemontana ventricosa
*Voacanga thouarsii (Wild Frangipani)

Groundcovers
Hibiscus pedunculatus
Plectranthus ciliatus
Scadoxus multiflorus subsp. katharinae

Shrubs
Asystasia gangetica
Cordia caffra

3.3.2 Planting expressly not permitted

Plant species that are not permitted include any species on the CARA list, or any other exotic species.

Because Ushukela is located within the King Shaka International Airport flight-path, it is advised not to use fruiting tree species that will attract birds.

3.4 HARD LANDSCAPING MATERIALS

Paving materials will be chosen from a list incorporated into the guidelines document.

It is intended that all hard landscaping such as retaining walls, paving, lights, bins, bollards and street furniture etc. adheres to an acceptable theme/palette to ensure overall harmony in materials.

Where possible street furniture should be continuous with the urban landscape fabric e.g. the use of seat walls is preferable to free standing benches. Bins, bollards and pergolas must be in keeping with the style of existing Ushukela street furniture. Bins should encourage the separation of waste for recycling. See 3.5 for approved street furniture. Other designs or proposals will be considered if in keeping with the overall style of street furniture within Ushukela.

3.5 EXTERNAL LIGHTING

Uplighters are discouraged as they are a source of light pollution, unless focused onto non-reflective, sufficiently large plants/trees only.

All pedestrian paths and steps must be well lit but lights should be shielded and directed only to where needed.

Floodlighting of buildings, neon signs or bright colourful signage is expressly discouraged.

Any lighting must be specifically approved.

3.6 ACCESSIBILITY FOR WHEELCHAIRS AND BICYCLES

Designs are to provide for ease of access by bicycle and wheelchair movement.

Cycle lanes have been included in the overall Ushukela plan and developers of individual erven are required to ensure that links to these lanes onto their sites are allowed for.

Dropped kerbs must be included on pedestrian routes for wheelchair / pram access.

Individual developers are to ensure that interlinking routes accommodate wheelchair access (ramps to be no steeper than 1:12) and landings / handrails should be provided as per NBR.

3.7 APPROVED HARD LANDSCAPE MATERIALS AND STYLE

These will be incorporated in the guidelines document to be drafted at detailed design stage.

Appendix 14: Agricultural Potential Assessment: The Farms Described as Inyaninga and Watson Highway

AGRICULTURAL POTENTIAL ASSESSMENT : THE FARMS DESCRIBED AS INYANINGA AND WATSON HIGHWAY : IN EXTENT 1160 ha.

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December 2009