Basins to limit scouring of the filter media; preserve the vegetation; and minimise the re-mobilisation of pollutants.

The media beds of the bio-retention systems are typically 600 mm deep with an average particle size of 0.5 mm and a hydraulic conductivity of 100 mm/hr with a minimum depth of storage above the media of 300 mm. A discharge control structure can be configured (during the Development Application process) to promote extended detention times if required.

Treatment is attained by detaining flows to promote sedimentation, direct filtration of particulate matter and nutrient stripping by bio-films which establish on the surface of the media bed and within the gravel layer. The organic sandy loam bed and plant system minimises evaporation losses and the raingarden will be constructed with an impermeable barrier to prevent seepage losses and to avoid groundwater salinity impacts.

The location and size of the proposed co-located raingarden systems are shown on the respective attached Preliminary Engineering Concept drawings for each Detention Basin. The general features and configuration of the proposed raingardens for the MPIP, as modelled in MUSIC, are detailed in Table 7.4.

Table 7.4

**MAJOR BIO-RETENTION SYSTEMS
GENERAL FEATURES AND CONFIGURATIONS**

Basin Name	A	O	B	P	E	K	G	I	J	M
Storage Properties										
Extended Detention Depth (m)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Surface Area (m^2)	1600	350	800	2500	7400	1000	6000	5000	3000	3000
Seepage Loss (mm/hr)	0	0	0	0	0	0	0	0	0	0
Infiltration Properties										
Filter Area (m^2)	1600	350	800	2500	7400	1000	6000	5000	3000	3000
Filter Depth (m)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Filter Media Particle Diameter (mm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Saturated Hydraulic Conductivity (mm/hr)	100	100	100	100	100	100	100	100	100	100
Outlet Properties										
Overflow Weir Width (m)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

The expected sediment and nutrient removal performance of the bio-retention systems was determined using the default equations and parameters provided in the MUSIC model (Ref. 15). The water quality reduction mechanisms in MUSIC are based on an exponential decay equation referred to as the k – C* curve (refer to Wong et al. – Ref. 19).

The performance parameters used in the MUSIC model are summarised in Table 7.5. The viability of the raingarden and the longevity of its pollutant removal efficiency is dependent on the capacity of the pre-treatment GPTs to intercept and remove light litter, detritus and coarse sediment.

Table 7.5

MUSIC – PERFORMANCE PARAMETERS

Pollutant	Bio-Retention k (m/yr)	Bio-Retention C* (mg/L)	Rainwater Tanks k (m/yr)	Rainwater Tanks C* (mg/L)
TSS	8000	20.000	400	12.000
TP	6000	0.130	300	0.130
TN	500	1.400	40	1.400

The surface area of the individual co-located bio-retention systems for the MPIP has been determined using the MUSIC water quality model. A summary of the estimated performance of each system is detailed in Section 7.5 of this report, and their configuration is indicated on the respective attached Preliminary Engineering Concept drawing for each Detention Basin. (Refer to Appendix D)

Once the catchments upstream of the co-located raingardens are stabilised, their maintenance would generally involve plant replacement, weed control, repair of localised erosion and minor structural damage, the removal of localised sediment build-up, and checking for any reduction in infiltration capacity and hydraulic conductivity of the media. This would be undertaken on a quarterly basis on average with media and vegetation replacement budgeted for on a decadal cycle.

7.5 Pollutant Load Estimates

Total annual pollutant load estimates were derived from the results of a MUSIC model based on a stochastic assessment of the developed site incorporating the proposed water quality treatment system. The estimated annual pollutant loads and reductions for TSS, TP, TN and Gross Pollutants (for each sub-catchment) are presented in Tables 7.6, 7.7, 7.8 and 7.9, respectively with a summary for the whole of the MPIP presented in Table 7.10.

Table 7.6

SUMMARY OF ESTIMATED MEAN ANNUAL POLLUTANT LOADS AND REDUCTIONS – TOTAL SUSPENDED SOLIDS

Location (node)	Total Development Source Loads (kg/yr)	Minimum Reduction Required (kg/yr)	Total Residual Load from Site (kg/yr)	Total Reduction Achieved (kg/yr)	Total Reduction Achieved (%)
Basins A & O	77,200	65,620	11,000	66,200	**85.8%**
Basin B	25,000	21,250	2,420	22,580	**90.3%**
W-1	102,200	86,870	13,420	88,780	**86.9%**
W-2	46,500	39,525	6,660	39,840	**85.7%**
Western	148,700	126,395	20,080	128,620	**86.5%**
N-1	155,000	131,750	21,600	133,400	**86.1%**
N-2	30,000	25,500	3,140	26,860	**89.5%**
N-S	185,000	157,250	24,740	160,260	**86.6%**
B-1	73,700	62,645	9,960	63,740	**86.5%**
B-2	8,680	7,378	2,800	5,880	**67.7%**
B-3	106,000	90,100	12,500	93,500	**88.2%**
B-4	91,800	78,030	10,300	81,500	**88.8%**
Bells	280,180	238,153	35,560	244,620	**87.3%**
Total Site	613,880	521,798	80,380	533,500	**86.9%**

Table 7.7

SUMMARY OF ESTIMATED MEAN ANNUAL POLLUTANT LOADS AND REDUCTIONS – TOTAL PHOSPHORUS

Location (node)	Total Development Source Loads (kg/yr)	Minimum Reduction Required (kg/yr)	Total Residual Load from Site (kg/yr)	Total Reduction Achieved (kg/yr)	Total Reduction Achieved (%)
Basins A & O	126	81.9	43.9	82.1	**65.2%**
Basin B	40.7	26.455	12.2	28.5	**70.0%**
W-1	166.7	108.355	56.1	110.6	**66.3%**
W-2	76.3	49.595	26.3	50	**65.5%**
Western	243	157.95	82.4	160.6	**66.1%**
N-1	253	164.45	82.7	170.3	**67.3%**
N-2	48.8	31.72	13.7	35.1	**71.9%**
N-S	301.8	196.17	96.4	205.4	**68.1%**
B-1	120	78	41.3	78.7	**65.6%**
B-2	14.4	9.36	10.50	3.9	**27.1%**
B-3	174	113.1	54.4	119.6	**68.7%**
B-4	151	98.15	46.2	104.8	**69.4%**
Bells	459.4	298.61	152.4	307	**66.8%**
Total Site	1004.2	652.73	331.2	673	**67.0%**

Table 7.8

SUMMARY OF ESTIMATED MEAN ANNUAL POLLUTANT LOADS AND REDUCTIONS – TOTAL NITROGEN

Location (node)	Total Development Source Loads (kg/yr)	Minimum Reduction Required (kg/yr)	Total Residual Load from Site (kg/yr)	Total Reduction Achieved (kg/yr)	Total Reduction Achieved (%)
Basins A & O	849	382.05	425	424	**49.9%**
Basin B	265	119.25	127	138	**52.1%**
W-1	1114	501.3	552	562	**50.4%**
W-2	506	227.7	278	228	**45.1%**
Western	1620	729	830	790	**48.8%**
N-1	1700	765	814	886	**52.1%**
N-2	311	139.95	143	168	**54.0%**
N-S	2011	904.95	957	1054	**52.4%**
B-1	811	364.95	365	446	**55.0%**
B-2	73.9	33.255	58.9	15	**20.3%**
B-3	1110	499.5	510	600	**54.1%**
B-4	927	417.15	412	515	**55.6%**
Bells	2921.9	1314.855	1345.9	1576	**53.9%**
Total Site	6552.9	2948.805	3132.9	3420	**52.2%**

Table 7.9

SUMMARY OF ESTIMATED MEAN ANNUAL POLLUTANT LOADS AND REDUCTIONS – GROSS POLLUTANTS

Location (node)	Total Development Source Loads (kg/yr)	Minimum Reduction Required (kg/yr)	Total Residual Load from Site (kg/yr)	Total Reduction Achieved (kg/yr)	Total Reduction Achieved (%)
Basins A & O	10,700	9,630	174	10,526	98.4%
Basin B	3,350	3,015	26.1	3,324	99.2%
W-1	14,050	12,645	200	13,850	98.6%
W-2	6,280	5,652	209.0	6,071	96.7%
Western	20,330	18,297	409	19,921	98.0%
N-1	21,100	18,990	489	20,611	97.7%
N-2	3,820	3,438	30.6	3,789	99.2%
N-S	24,920	22,428	520	24,400	97.9%
B-1	10,300	9,270	1,090	9,210	89.4%
B-2	864	778	133	731	84.6%
B-3	13,500	12,150	406	13,094	97.0%
B-4	11,300	10,170	195	11,105	98.3%
Bells	35,964	32,368	1,824	34,140	94.9%
Total Site	81,214	73,093	2,753	78,461	96.6%

Table 7.10

SUMMARY OF ESTIMATED MEAN ANNUAL POLLUTANT LOADS – WHOLE OF THE MPIP

Pollutant	Existing Conditions (kg/yr)	Developed (no controls) (kg/yr)	Developed (with Controls) (kg/yr)	Percent Reduction	Reduction Target
Gross Pollutants	0	81,210	2,750	95%	90%
TSS	21,200	613,880	80,380	87%	85%
TP	100	1,000	330	65%	65%
TN	850	6,550	3,130	50%	45%

Note: *Loads have been rounded to the nearest 10 kgs and Percent Reduction to the nearest 5%. They are intended for comparison purposes only.*

Existing Loads are indicative and have been calculated on the basis of the generic loading rates described in Ref.17.

Developed Loads have been determined using a stochastic MUSIC model.

7.6 Discussion of Modelling Results

Table 7.10 provides a summary of the total load of pollutants anticipated to emanate from the site both before and after the proposed development. The Existing Conditions estimates are based on information provided by the CRCCH (Ref.17). It assumes that the site is being used for agricultural activities and that these activities do not generate Gross Pollutants.

The performance of the proposed water quality management strategy for the MPIP, as determined through a stochastic MUSIC assessment, is summarised in Tables 7.6, 7.7, 7.8 and 7.9 and estimates that:

- Total Suspended Solids (TSS) will be reduced by approximately 521,050 kg/yr which equals the 85% load reduction target of 521,050 kg/yr;
- Total Phosphorus (TP) will be reduced by approximately 650 kg/yr which equals the 65% load reduction target of 650 kg/yr;
- Total Nitrogen (TN) will be reduced by approximately 3,270 kg/yr which exceeds the 45% load reduction target of 2,940 kg/yr;
- Gross Pollutants will be reduced by approximately 77,150 kg/yr which exceeds the 90% load reduction target of 73,090 kg/yr;

Consequently it has been demonstrated, through the use of a MUSIC based assessment, that the combination of rainwater tanks, gross pollutant traps and raingarden bio-retention systems will, when configured according to the "treatment train" proposed for the Marsden Park Industrial Precinct, reduce priority pollutant loads to the required minimum pollution control targets required by Blacktown City Council and the NSW Department of Planning.

8 TRUNK DRAINAGE CHANNEL ANALYSIS

The existing flowpaths through the MPIP, which are proposed to be converted to open channels, will be vegetated in accordance with the BCC landscaping requirements for a Category 3 Stream. The twelve (12) channels identified will have the capacity to convey flows up to the 100-year ARI storm event including a 0.5 m freeboard above the 100-year water level estimated for each channel. Concept sizes for these channels have been determined for the purposes of establishing drainage corridor widths and assisting the process of preparing the Section 94 Contribution Plan (see Appendix C)

All the channels, except channel TC8B, were assessed using Manning's Equation to determine 'normal depths' in trapezoidal channel cross-sections. The use of 'normal depth' calculations is applicable for the channels west of Richmond Road which are expected to exhibit uniform flow regime characteristics. East of Richmond Road there are three (3) channels that are within close proximity to Bells Creek and are likely to be influenced by the water levels in Bells Creek, and where this occurs the affected channels have been analysed more robustly using HEC-RAS.

Channel TC11 discharges into Basin M and is therefore not subject to the influence of Bells Creek. Likewise, an initial check downstream of Basin I identified that the Bells Creek 100-year flood level of 26.4 m AHD is much lower than the outlet invert level of channel TC13. Consequently, 'normal depth' calculations were assessed as being appropriate to assess the conveyance capacity of channels TC11 (upstream of Basin M) and TC13 (downstream of Basin I).

The lower reach of TC8, downstream of Richmond Road, has been designated as reach TC8B and is affected by tailwater from Bells Creek which makes it unsuited to a 'normal depth' assessment using Manning's Equation. Consequently an assessment of its conveyance capacity and associated channel profile has been undertaken using HEC-RAS. The output from the HEC-RAS analysis includes flood levels, flow velocities and Froude numbers and these are shown graphically in Appendix C.

8.1 Use of Manning's Equation to Size Channels

The key parameters adopted for sizing the channels using Manning's equation were:

- Channels to convey 100-year ARI flow
- Maximum flow depth of 1 m
- Minimum Freeboard above the 100-year ARI top water level of 0.5 m to finished ground level with a further 0.2 m to finished floor level (FFL)
- Embankment side slopes of 4H:1V (based on the use of vegetated low maintenance batters)
- Channels to be vegetated to replicate a Manning's roughness coefficient of 0.07
- Flow velocity not to exceed 1.63 m/s
- Minimum channel gradient of 0.5%

The channels will be vegetated and in the long term are assumed to have a Manning's roughness of 0.07, which replicates the style of landscaping required by the DECCW and BCC. Natural Channel Design Guidelines (Ref.21) recommends that the bankfull flow velocity within channels exhibiting these characteristics does not exceed 1.63 m/s. Velocities in excess of this allowable velocity may cause damage to the vegetation and possibly result in failure of the channel invert and embankments.

The 100-year flows used in the sizing of the channels were taken from the results detailed in Section 6 Hydrologic Assessment for the post-development scenario. A summary of the 100-yr Design Flows and the individual channel characteristics are provided in Appendix C.

The freeboard for channel TC12A was checked for post climate change 500-year ARI flows to ensure Richmond Road, being a flood evacuation route, would be flood free during a local 500-year flooding event. This check determined that a freeboard of 0.3 m remained from the 500-year top water level to the top of the channel embankment.

The depth of flow in all channels except TC12A and TC8B was restricted to 1 m. At this point in time it is likely that channel TC12A will be constructed as a box culvert. However, for the current intention of determining the potential land-take required for the flow path, the channel was assumed to be an open vegetated trapezoidal channel. Consequently the resulting width for a channel should result in a conservative estimate whereas the width required for a box culvert would be much narrower.

8.2 Modelling of Channel TC8B

Cross-sections for use in the HEC-RAS model were extracted from the existing terrain model, commencing from immediately downstream of Richmond Road down to a point approximately 50 m past the ILP boundary. Four sections, approximately 50 m apart, were determined for the hydraulic analysis.

A riparian corridor is indicated on the ILP for the entire reach of channel TC8. Except for some filling and localised reshaping work, the intention is to retain the meandering alignment, incised channel and invert levels of the existing TC8B channel. To contain flows in excess of about the 1-year ARI, filling outside of the existing channel will be necessary with batter slopes to be no steeper than 4H:1V. As with the other channels, the side slopes of TC8B will be vegetated and hence a Manning's roughness of 0.07 was used to describe this reach. The grade of channel TC8B varies between 0.1 % and 2% with an average gradient of about 1.2%. The steepest sections are located in the upstream and downstream reaches whilst the flattest section is along the lower middle reach.

Steady flow analysis in HEC-RAS was performed assuming normal depth occurring in the upstream reach of the channel and with the downstream end controlled by the 100-year flood level in Bells Creek, which was adopted as 29.65 m AHD (based on GHD Tuflow model for Bells Creek). A slope of 0.92% was adopted for the Energy Gradient at the upstream end of the channel, which is consistent with the general bed slope at this location. These criteria formed the downstream control for the HEC-RAS analysis.

Flood levels, flow velocities and shearing stresses for selected sections along the creeks were determined from this analysis. This information is required to assist in assessing the capacity of the creek to convey 100-year flows without adversely impacting on the riparian vegetation. By increasing the 100-year top water levels by an additional 0.5 m to allow for freeboard it was then possible to determine the appropriate fill levels for development outside the riparian areas. Channel widths, depths, grades and freeboard are provided in Appendix C and Indicative Design Contours for the surrounding area are shown on the Engineering Concept Plan for CTC8B at Appendix D – 8955/SK6 D

8.3 Maintenance Provisions

A 5 m wide access track and a 2.5 m alternative access track have been included in the determination of the width of the Trunk Drainage Reserve where the trunk drainage channel does not run parallel to an adjoining road. The 5m wide major access is for light truck maintenance access whilst the 2.5 m wide all weather access "along the alternate top of the channel (if not a road frontage)" is to provide emergency and rescue access.

BCC recommend that where channels do not run parallel to an adjoining road provision should be made, within the Drainage Reserve for an additional 7.5 m (5 m major and 2.5 m minor) in excess of the width required for conveyance capacity. Where an internal road runs to one side of the channel, an additional 2.5 m wide minor access track is also recommend along the opposite side. Suitable access provisions for each Trunk Channel will be determined prior to the lodgement of the Development Application for the respective Trunk Channel.

8.4 Discussion of Modelling Results

By fixing the depth of flow in the channel, the width required for hydraulic conveyance varies in proportion to the 100-year flow to be conveyed. Channels TC7A, TC7B, TC7C and TC11 have the narrowest width requirement of about 18 m (between top of banks) while channel TC8A, which conveys flows from an external catchment, requires the widest width of about 43 m to maintain conveyance capacity.

Results of the HEC-RAS analysis for channel TC8B show side channel velocities were generally less than 1.63 m/s. Channel TC1 which has a gradient of about 0.9% has the highest flow velocity of 1.14 m/s. Further, the depth of flow in the upper reaches of the channels was generally less than 1 m. However, in the downstream reaches, where the Bells Creek tailwater influence dominates, flow depths were generally greater than 1 m.

A summary of the channel characteristics, resulting from the 'normal depth' analyses and the required width of each channel is given in Appendix C. A tabulated summary of results for the HEC-RAS analysis of channel TC8B is presented graphically in Appendix C.

9 STREAM EROSION INDEX

9.1 Introduction

Both Blacktown City Council and the Department of Environment and Climate Change have recently released draft guidelines (Ref. 5 and 16) to address the risk of stream erosion from the urbanisation of catchments. Compliance with the guidelines is a method, acceptable to both DoP and BCC, for controlling the risks associated with discharges from developed catchments into informal watercourses and is generally referred to as a Stream Erosion Index (SEI) risk assessment.

The assessment procedure relies on calculating the increase in the relative frequency of flows from the site greater than the "stream forming flow" based on a continuous series of rainfall data over many years. Achieving a value at or below the recommended SEI value is considered to be an appropriate means of assessing and addressing the impacts that on a watercourse of the more frequent flows from the developed catchment.

The stream erosion index is defined by the Department of Environment and Climate Change *as the post-development duration of flows greater than the 'stream forming flow' divided by the natural duration of flows greater than the 'stream forming flow'*. The 'stream forming flow' is defined as 50% of the 2-year ARI flow rate estimated for the catchment under natural conditions. The DECC guidelines recommend a stream erosion index of between 3.5 and 5, while Council's Draft DCP (June 2009) proposes an SEI of between 3 and 5 for a 'stream forming flow' defined as 25% of the 2-year ARI.

9.2 SEI Simulation

GHD carried out an SEI assessment based on simulations for a natural and a developed (with mitigation) 35.34 ha sub-catchment. *"The simulations were undertaken with 6-minute data for the years 1988 to 1994, which includes an average year, and high and low rainfall years."*

Structural measures, in the form of a discharge control pit, were introduced into the calculations to replicate the mitigation afforded by the basin outlet structure. The simulations resulted in an SEI of 4.

9.3 Discussion of Modelling

The GHD simulation demonstrates that the use of raingardens, co-located within the Detention Basins, with a discharge control pit on the outlet from the basin, results in an SEI of 4, which complies with the *Draft Blacktown City Council Growth Centre Precincts Development Control Plan 2009* (Ref.7) and (Ref.16). .

Energy dissipation, discharge control pits and stream erosion protection is proposed on outlets from the Detention Basins and the formal drainage network. These structures, in combination with the dense vegetation proposed for the formal channels and riparian areas, have been determined by GHD as being capable of maintaining the Stream Erosion Index below the required maximum value of 5 (Ref.7 and Ref.16). It has been our experience with similar developments within Western Sydney that the inclusion of a co-located raingarden within the Detention Basin provides sufficient base flow attenuation to comply with the DEC recommended criteria for the Growth centres Commission (Ref.16).

10 COSTING OF DETENTION BASIN MAJOR WORKS

A Draft S94 has already been prepared for the TD comp of MPIP as part of the Draft ILP. Since the exhibition of the Draft ILP, and as reported herein, there have been significant changes to the size, location and number of Detention Basins. Consequently it has been necessary to revise the costs associated with the construction of the Detention Basins Major Works in order to inform an amended S94 Contribution Plan.

Details of the methodology, and parameters used, to achieve compliance with the relevant peak flow attenuation and stormwater quality criteria, are discussed in the preceding headings of this report. The stormwater management components determined from this process were used in the development of preliminary engineering concept designs for the relevant trunk drainage elements (Appendix D).

From these preliminary concepts it was possible to estimate the size of the Detention Basins and the associated bulk earthworks and vegetation requirements.

The above information resulted in the production of a Bill of Quantities, the individual items within which were multiplied by rates based on our experience from similar projects to provide a Construction Estimate fro the Trunk Drainage Major Works.

A summary of the Costs associated with the construction of the Basins and their associated vegetation are presented in a simplified form in Table 10.1 which addresses only those items of significant cost. A more detailed breakdown of the Bill of Quantities and the associated Construction Estimate for each Basin is provided in Appendix B.

Table 10.1

PRELIMINARY CONSTRUCTION COST ESTIMATE
MPIP DETENTION BASINS AND ASSOCIATED VEGETATION

NO.	ITEM	AMOUNT Exc GST$
1	BASIN A	$918,000.00
2	BASIN B	$1,517,000.00
3	BASIN P	$1,275,000.00
4	BASIN E	$2,959,000.00
5	BASIN K	$568,000.00
6	BASIN G	$2,151,000.00
7	BASIN I	$1,712,000.00
8	BASIN J	$881,000.00
9	BASIN M	$354,000.00
10	BASIN O (Optional)	$347,000.00
	BASINS TOTAL	$12,682,000.00

11 SUMMARY & CONCLUSION

The Water Cycle Management Strategy proposed for the Marsden Park Industrial Precinct has been prepared to support the finalisation of the corresponding Indicative Layout Plan and S94 Contributions Plan. The strategy has been prepared to conform with the requirements of the NSW Department of Planning and Blacktown City Council as well as deliver industry best practice for stormwater management within the MPIP.

The Water Cycle Management Strategy described herein, builds upon the Water Cycle Management Assessment prepared by GHD which was developed to inform the preparation of the Draft ILP, and was placed on exhibition in early 2010. It proposes a series of individual elements arranged in what may be described as a "treatment train" consisting of on-lot treatment, street level treatment and precinct based public domain infrastructure treatment measures. The structural elements proposed for the development consists of:

- Rainwater tanks on each allotment, installed during building construction;
- Proprietary GPT units upstream of each raingarden and on each stormwater discharge point to trunk drainage channels;
- On-lot water quality bio-retention/filtration raingardens for commercial/industrial catchments;
- Precinct based bio-retention/filtration raingarden systems co-located within the precinct scale Detention Basins;
- Conservation and enhancement of the existing and future riparian areas.

Provision of the proposed detention basins within the development will ensure that peak post development discharges are restricted to pre development levels.

Provision of the proposed water quality treatment strategy within the development will ensure that the quality of the post development stormwater discharges meet the requirements of the NSW Department of Planning and Blacktown City Council.

Climate Change Impacts have been assessed on the basis of increasing the flows in the trunk drainage network by 15% and reviewing the associated risks to adjoining infrastructure and fill levels. The increase in peak flows resulting from a 15% increase in rainfall intensity resulted in a reduction of approximately 100 mm in the freeboard allowed for the 100-yr flood levels. According to *Draft Flood Risk Management Guide: Incorporating sea level rise benchmarks in flood risk assessments, October 2009* Department of Environment, Climate Change and Water, the 0.5 m freeboard allowance in floodplains is capable of absorbing small increases in flood levels resulting from Climate Change impact assessments.

Stream Erosion Index assessment criteria has been based on the Environmental Flows ratio advice provided by the Department of Environment and Conservation (DEC) to the Growth Centres Commission (Ref.16), which referred to a *"stream erosion control ratio of between 3.5 and 5.0"*. GHD, 2009 (Ref.1) carried out an SEI assessment for the MPIP using 6-minute rainfall data over a 6-year period for a 35.34 ha sub-catchment. Their assessment returned a ratio of 4, which demonstrated compliance with the advice from DEC (Ref.16).

The proposed Water Cycle Management Strategy for the MPIP provides a basis for the detailed design and development of the Precinct to ensure that the objectives for stormwater management and water quality are achieved.

12 REFERENCES

1. GHD (2009) Water Cycle Management Assessment: Flooding Stormwater and Water Sensitive Urban Design

2. NSW Department of Environment and Climate Change (2008) NSW Climate Change Action Plan: Summary of Climate Change Impacts Sydney Region, (October 2008)

3. NSW Department of Environment and Climate Change (2007) Practical Consideration of Climate Change – Floodplain Risk Management Guideline, (October 2007)

4. CSIRO (2007) Climate Change in the Hawkesbury-Nepean Catchment

5. Australian Government Bureau of Meteorology (2007) Climate Change in Australia – Observed Changes and Projections (October 2007)

6. Blacktown City Council (2009). Draft Integrated Water Cycle Management DCP

7. NSW Department of Planning (2009) Draft Blacktown City Council Growth Centre Precincts Development Control Plan

8. Engineers Australia (2006). Australian Runoff Quality – A Guide To Water Sensitive Urban Design

9. WSROC (2003). Western Sydney Salinity Code of Practice

10. Landcom (2004). Managing Urban Stormwater – Soils and Construction – 4th Edition

11. WILLING & PARTNERS PTY. LTD. (1994). Runoff Analysis & Flow Training Simulation. Detailed Documentation and User Manual, Version 4.0

12. WILLING & PARTNERS PTY. LTD. (1996). Runoff Analysis & Flow Training Simulation. Addendum, Version 5.0

13. Blacktown City Council (2005). Engineering Guide for Development

14. Institution of Engineers, Australia (1987). Australian Rainfall and Runoff

15. CRC for Catchment Hydrology (2005). MUSIC Model for Urban Stormwater Improvement Conceptualisation – User Guide Version 3

16. Department of Environment and Climate Change. Technical Note – Interim Recommended Parameters for Stormwater Modelling – North-West and South-West Growth Centres

17. CRC For Catchment Hydrology (2004). Stormwater Flow and Quality, and the Effectiveness of Non-Proprietary Stormwater Treatment Measures – A Review and Gap Analysis. Technical Report 04/8

18. Coombes, P., Kuczera, G. (2001). Rainwater Tanks Design for Water Supply and Stormwater Management. SIA 2001 Regional Conference

19. Wong, T.H.F., Duncan, H.P., Fletcher, T.D & Jenkins G.A. (2001). A Unified Approach to Modelling Stormwater Treatment, - Proceedings of the 2nd South

Pacific Stormwater Conference, Auckland, New Zealand, 27-29 June 2001, pp 319-327

20. XP Software. XPSWMM Stormwater & Wastewater Management Model Training Workshop Manual

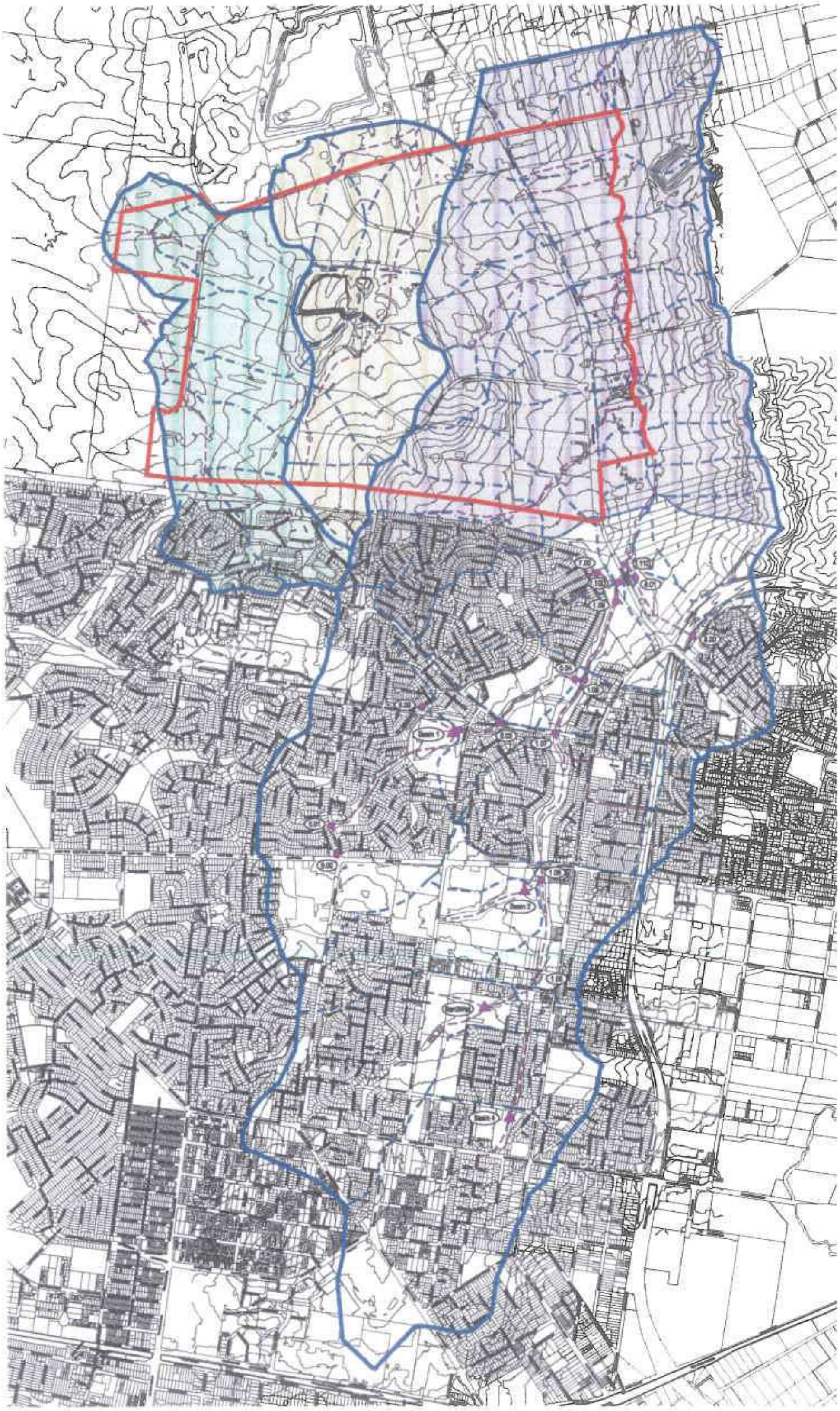
21. Brisbane City Council (2000) Natural Channel Design Guidelines (December 2000)

22. Department of Infrastructure Planning and Natural Resources (2002) Salinity Potential in Western Sydney (Map).

23. GHD (2009) Preliminary Report for Marsden Park Industrial Precinct – Geotechnical Assessment (Map 2009).

24. Bannerman, S.M. and Hazelton, P.A. (1990), Soil Landscapes of the Penrith 1:100 000 Sheet. Soil Conservation Service of NSW, Sydney.

FIGURES



REFER TO FIGURE 2 FOR THE SITE CATCHMENT LAYOUTS

LEGEND:

- SITE BOUNDARY
- SUB-CATCHMENT BOUNDARY
- XP-RAFTS NODE LABEL AND LOCATION
- DEVELOPMENT SITE CATCHMENT BOUNDARY BELLS CREEK CATCHMENT
- DEVELOPMENT SITE CATCHMENT BOUNDARY NORTH-SOUTH (CENTRAL) CREEK CATCHMENT
- DEVELOPMENT SITE CATCHMENT BOUNDARY WESTERN (LITTLE) CREEK CATCHMENT

1:25,000 — METRES

FIGURE 1

MARSDEN PARK INDUSTRIAL PRECINCT

INDICATIVE BELLS CREEK CATCHMENT LAYOUT & PRE-DEVELOPMENT MPIP CATCHMENT EXTENTS

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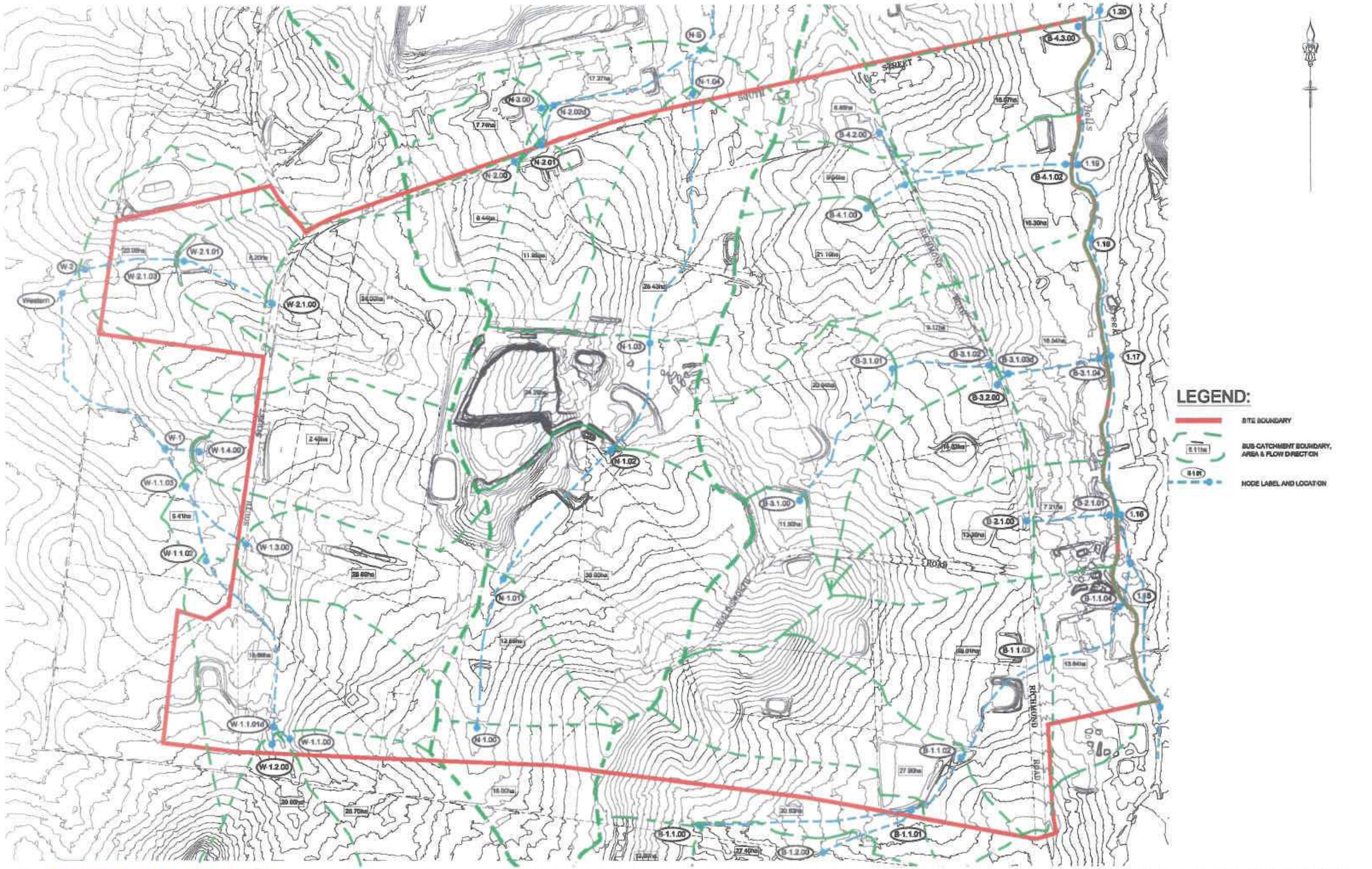
SHEET 1 OF 3



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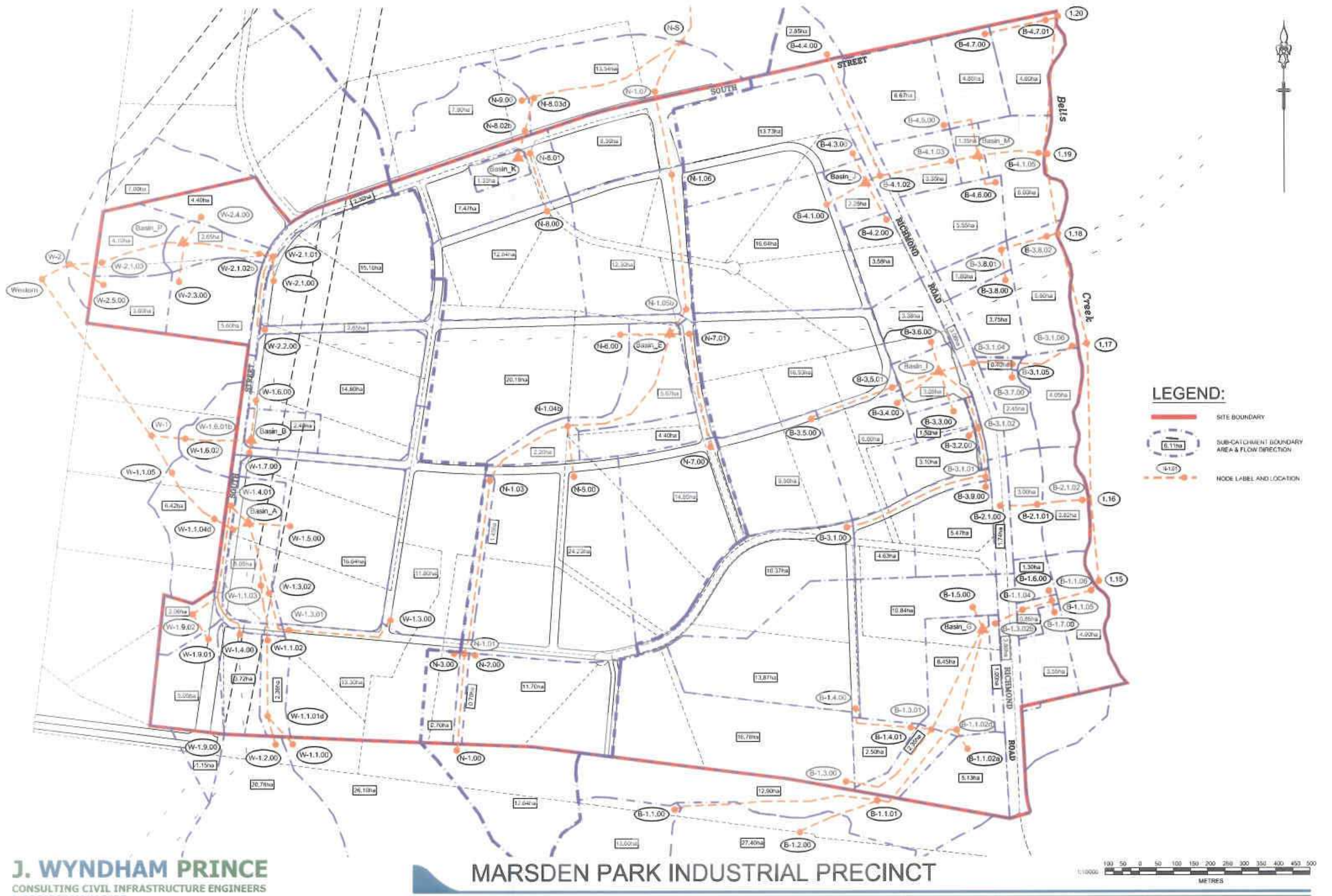
SHEET 2 OF 3

MARSDEN PARK INDUSTRIAL PRECINCT

CATCHMENT LAYOUT PLAN
PRE-DEVELOPMENT CONDITIONS

FIGURE 2



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SHEET 3 OF 3

MARSDEN PARK INDUSTRIAL PRECINCT

CATCHMENT LAYOUT PLAN
POST-DEVELOPMENT CONDITIONS

FIGURE 3

APPENDIX A

Marsden Park Industrial Precinct

Climate Change Assessment

Our Ref: 8955Rpt1G.doc.doc
GH:gh

24 March 2010

Marsden Park Development Pty Ltd
c/- APP Corporation Pty Ltd
PO Box 1573
NTH SYDNEY NSW 2059

Attn: **Michael Gray**

Subject: **Marsden Park Employment Precinct – Stage 1**
Climate Change Assessment

Dear Michael,

The following information is offered as an explanation of our investigations into the anticipated impacts of Climate Change on the performance of the Drainage System proposed for Stage 1 of the Marsden Park Employment Precinct.

The objective of this assessment is to provide information on the possible impacts of Climate Change, and make recommendations which can be readily transferred to the design of the drainage systems in other Stages of the Marsden Park Employment Precinct.

BACKGROUND TO CLIMATE CHANGE ASSESSMENTS

When undertaking a risk assessment into the impact of flooding on urban infrastructure, as a consequence of Climate Change predictions, it is necessary to quantify the possible changes in rainfall intensity and assess the impact that these changes may have on the catchment hydrology. In the absence of specific quantifiable guidelines from Blacktown City Council (BCC) the primary reference sources agreed to, for this assessment, are:

5. *NSW Climate Change Action Plan: Summary of Climate Change Impacts Sydney Region, October 2008*, prepared by the NSW Department of Environment and Climate Change;
6. *Practical Consideration of Climate Change – Floodplain Risk Management Guideline, October 2007*, prepared by the NSW Department of Environment and Climate Change;
7. *Climate Change in the Hawkesbury-Nepean Catchment, 2007*, prepared by the Commonwealth Scientific and Industrial Research Organisation, were adopted as the primary reference documents for this assessment; and
8. *Climate Change in Australia – Observed Changes and Projections, October 2007*, prepared by Australian Government Bureau of Meteorology.

Prior to assessing the estimated impacts of Climate Change on the Marsden Park Employment Precinct, it is necessary to compare the various recommended increases to Rainfall Intensities identified in these documents, determine the most appropriate Rainfall Intensity increase and apply it to the hydrologic assessment for Stage 1.

This process is consistent with the "Management Strategies For Future Development" outlined in Reference 2. Table 1 summarises the State and Federal Government approaches to accounting for changes to predicted rainfall intensities and storm volumes associated with Climate Change. All documents predict increases in peak rainfall intensity with an associated increase in storm runoff volume. However the overall Average Annual Rainfall for the region is anticipated to reduce, whilst summer rainfall is predicted to increase. Drawing a direct comparison between each of the predictions, and relating a conclusion to a predicted increase in rainfall intensity is not as straightforward as it may seem and it has been necessary to relate the stated volumetric predictions to a more tangible Average Recurrence Interval (see Reference 2).

TABLE 1 - Comparison of the Various Climate Change Strategies

Reference	Rainfall Intensity	Comment
1. Climate Change Impacts – Sydney Region, 2008 (DECC)	Summer runoff depths estimated to increase by 0% to 26% Summer rainfall volume projected to increase by 20% to 50%	Hydrologic change assessment based on seasonal variation estimates. The summer runoff depth increase is the largest.
2. Practical Consideration of Climate Change – Flood Risk Management, 2007 (DECC)	Sensitivity Analysis based on increases of: 10% peak rainfall & vol.; 20% peak rainfall & vol.; 30% peak rainfall & vol. Table of increases in Extreme Rainfall Intensities (40-yr, 24-hr) based on %age change in Intensity and Storm Volume.	This approach relies on a risk analysis based on the potential impacts of the various increases. The lowest value with an acceptable An Av Damage is then adopted. Consideration of the AAD where this value is exceeded must be included and a strategy to accommodate the additional risk identified.
3. Climate Change in the H-N Catchment, 2007 (CSIRO)	Projected max. Change in the 40-yr, 24-hr rainfall by: 2030 – 12%; 2070 – 10%.	Total annual rainfall is predicted to decline by about 80 mm with the possibility of seasonal increases in extreme rainfall events.
4. Climate Change in Australia, 2007 (BofM)	General increase in daily rainfall intensities in summer only.	Expected volumetric change is to be minimal but extreme daily rainfall is expected to increase.

A summary of the information contained in the above reference documents is outlined below.

- All references agree on a general increase in summer rainfall volume;
- Reference 1 determines the summer daily volumetric runoff depth to increase by 26%;
- Reference 2 refers to a sensitivity analysis of Climate Change based on the risks associated with an Annual Average Damage analysis to determine the appropriate Flood Planning Levels, which can then be related to an Average Recurrence Interval (ARI). This approach accommodates a 10%, 20% and 30% increase in the rainfall intensities to determine revised flow rates and runoff depths.
- Reference 3 is the only reference to provide a quantifiable relationship between Climate Change and rainfall intensity for a particular Average Recurrence Interval (ARI). It estimates that the maximum projected change in rainfall intensity for the larger scale storms (40-yr, 24-hr) is about 12%;

These four (4) references were prepared as background documents to assist with Floodplain Risk Management planning. They provide limited guidance with respect to assessing the possible impacts of Climate Change on new urban developments and the costs associated with the subsequent increase in the land required for local flood control.

NOTE: Based on the 12% increase predicted in Reference 3, the rainfall depth hyetographs in the existing XP-RAFTS hydrologic computer models, constructed to represent the Basin I catchment, were 'conservatively' increased by 15%. The resulting increase in runoff depth, for the 100-yr ARI critical storm, was determined as approximately 25%, which approximates the summer seasonal runoff depth increases of 26% predicted in Reference 1.

SIZING OF DETENTION BASINS IN CONSIDERATION OF CLIMATE CHANGE IMPACTS

There are no specific parameters available which provide guidance for determining rainfall intensity increases when considering Climate Change Impacts (CCI) on the infrastructure within Urban Release Areas. To better understand the consequence of these impacts on the drainage structures and the land required for the Trunk Drainage system an assessment of two (2) configurations for the outlet structure of Basin I have been considered.

1. Flexible Outlet Arrangement

This option involves the Basin I outlet structure designed as a flexible multi-stage outlet which achieves a match between the post and pre development discharge rates. In calculating these peak discharge rates, the stage/discharge relationships were adjusted in proportion to the various increases in rainfall intensities, which were also applied as percentage increases on the post development and pre development rainfall intensities, in consideration of Climate Change. The peak discharge rates, storage volumes and land requirements for this option, which aims to match the post and pre development peak flows **at the confluence with Bells Creek**, are tabulated in Table 2. The management of the peak discharge rates for this option involves:

- Increasing the pre and post development rainfall intensities by the same percentage increase in consideration of Climate Change;
- Modifying the Basin I stage/discharge relationship to match post development peak discharges to pre-development peak discharges;
- Interrogating the downstream channel profile to determine its waterway area and capacity to convey the additional flows attributable to an increase in the pre-development rainfall intensity.

A flexible outlet structure will need to be designed, as part of the Development Application process, which takes into account a decadal variation in rainfall intensities and discharge rates as predicted in the earlier reference material. The additional peak discharge rates, attributed to predicted increases in the rainfall intensities associated with Climate Change, are to be accommodated within the freeboard allowance of the channel cross section downstream of Basin I (i.e. TC13).

TABLE 2 Basin I – Climate Change Sensitivity Analysis Matching Post Development to Pre Development Peak Discharges

100 Year ARI	Pre-Development Catchment	Post-Development Catchment			
Rainfall Intensity Increase	Peak Discharge (m^3/s)	Peak Discharge (m^3/s)	Storage Volume (m^3)	Water Surface A. (m^2)	Basin Surface A. (m^2)
0% (Current)	14.45	12.69	28,000	23,300	36,600
10%	16.77	16.65	28,000	23,300	36,600
15%	17.95	17.44	28,000	23,300	36,600
20%	19.18	18.19	28,000	23,300	36,600
30%	21.71	21.13	28,610	23,800	36,600

NOTE: Basin Surface A has been scaled from the ILP after overlaying with Basin I layout Water Surface A. & batters

2. Conventional Outlet Arrangement

This option involves a conventional multi-staged outlet for Basin I, designed to match between the post development discharge (including and allowance for CCI) with the **existing** pre development discharge rates (i.e. the basin is designed to mitigate future CCI). In calculating these peak discharge rates the stage/discharge relationships were adjusted in proportion to the various increases in post development rainfall intensities only, in consideration of Climate Change. The peak discharge rates, storage volumes and land requirements for this option, which aims to maintain the existing peak flows **at the confluence with Bells Creek**, are tabulated in Table 3. The management of the peak discharge rates for this option involves:

- Determination of the existing peak discharge rate;
- Increasing the post development rainfall intensities by the respective percentages in consideration of Climate Change;
- Modifying the Basin I stage/discharge relationship to match post development peak discharges to the existing pre-development peak discharges;
- Interrogating the downstream channel profile to determine its waterway area and capacity to convey the existing flows regardless of any CCI.

A conventional multi-staged outlet structure for Basin I will need to be designed, as part of the Development Application process, which takes into account a decadal variation in rainfall intensities for the post developed catchment as predicted in the earlier reference material. The additional peak discharge rates, attributed to predicted increases in the rainfall intensities associated with Climate Change, are to be accommodated in the increased storage volume within Basin I. The dimensions of the channel cross section downstream of Basin I (i.e. TC13) will remain constant for all increases in rainfall intensities that may be attributable to CCI.

TABLE 3 Basin I – Climate Change Sensitivity Analysis Matching Post Development to Existing Pre Development Peak Discharges

100 Year ARI	Pre-Development Site Conditions	Post-Development Site Conditions			
Rainfall Intensity Increase	Peak Discharge (m^3/s)	Peak Discharge (m^3/s)	Storage Volume Adopted (m^3)	Water Surface A. (m^2)	Basin Surface A. (m^2)
0% (Current)	14.45	10.93	28,000	23,300	36,600
10%	14.45	12.75	30,000	25,000	38,300
15%	14.45	12.88	32,000	26,700	40,000
20%	14.45	13.10	34,000	28,300	41,600
30%	14.45	12.52	42,000	35,000	48,300

NOTE: Basin Surface A has been increased proportionally, over the areas shown in Table 2, based on the corresponding increase in Water Surface A

Discussion of the Land Required to Manage Peak Discharges

The above comparison identifies the basin size required to match the post to pre development peak flows for various scenarios with and without accounting for Climate Change. In considering the impact of Climate Change on the size of Basin I and the Trunk Channel TC13 (see Table 4). An increase in rainfall intensities of 15% has been adopted for comparison purposes as it compares favourably with the Risk Assessment approach referred to in references 1, 2 and 3 and approximates the values referred to in References 1 and 3.

Basin I

Based on a 15% increase in rainfall intensity the analysis identifies that; to achieve a match between the existing post and pre development discharges, a Storage Volume of approximately 28,000 m^3 is required which equates to a Basin Surface Area of approximately 36,600 m^2. Whereas matching the post development discharge (rainfall intensity increased by 15%) to the existing undeveloped discharge requires a Storage Volume of approximately 32,000 m^3 and a Basin Surface Area of approximately 40,000 m^2. *NOTE: The discrepancy between the peak discharges in Table 2 (12.69 m3/s) and Table 3 (10.93m3/s) has resulted from the discharges out of the multi-staged outlet in Option 1, being sized to match the pre-development 5-year ARI peak discharges increased to include CCI.*

Trunk Channel (TC13)

The downstream channel reach between Richmond Road and Bells Creek is known as TC13. Its dimensions, determined in the GHD Report dated July 2009, include a minimum slope of 0.5%, batter slopes of 1:6 and a base width of 2 m, with a 5 m access track along the western side, for a total width of 25 metres.

Table 9 (p.25) of the GHD Report identifies the peak flow downstream of Basin I as 7.9 m^3/s (Initial Loss of 25 mm), this compares favourably with our own assessment of existing peak flow rate at Richmond Road, of 8.68 m^3/s. However, the information in Appendix G 'Water Sensitive Urban Design Strategy' identifies the Q100 design flow for TC13 as 4.6 m^3/s, which appears to be the flow rate used by GHD in their design of TC13. Our review and assessment of the amended developed catchment, at the confluence of TC13 and Bells Creek, has identified the existing 100-year peak flow as 14.45 m^3/s (Initial Loss of 15 mm) and it is this flow rate that has been adopted to determine Drainage Reserve width between Richmond Road and Bells Creek.

Table 4 provides a comparison of Drainage Reserve widths for the TC13 channel reach based on a: maximum depth of flow of 1 m; 0.5 m freeboard; 1:4 batter slopes. A 1:4 batter slope has been adopted in accordance with the requirements of a Category 3 Vegetation Management Plan as agreed with BCC and consistent with the BCC agreed approach for the North West Transport Hub site at Riverstone.

TABLE 4 - Comparison of TC13 Drainage Reserve Widths for Various Peak Flows

100 yesr ARI	Q100-yr m^3/s	Base m	Depth m	Width m	Area m^2
Existing	14.45	11	1.5	23	2,300
2010	12.69	11	1.5	23	2,300
+10%	16.65	15	1.5	27	2,700
+15%	17.44	16	1.5	28	2,800
+20%	18.19	17	1.5	29	2,900
+30%	21.13	20	1.5	32	3,200

Existing refers to the TC13 profile required to convey the existing peak flow from the upstream undeveloped catchment.
Drainage Reserve Width includes an allowance for 0.5 Freeboard but no separate 5 m wide Access Track.
Batter Slopes 1:4 based on a Category 3 Vegetation Management Plan.
Depth is based on a "normal depth" calculation using a Manning's roughness coefficient of 0.07 plus 0.5 m Freeboard.
Area of the Drainage Reserve based on a length scaled from the ILP of 100 m
The depth of flow in TC13 with a 16 m base width, based on Option 1 with a 30% increase in rainfall intensity is 1.1 m.

<u>Summary</u>

- Option 1 requires a "Drainage Reserve" (combine Basin and Channel Reserve) allocation of approximately 39,400 m^2;
- Option 2 requires a "Drainage Reserve" allocation of approximately 42,300 m^2. (2,900 m^2 or 7.4% larger).

DISCUSSION

The Sensitivity Analyses outlined above provides information to assist in determining appropriate parameters to be used when considering the impact of an anticipated increase in rainfall intensities as a result of Climate Change predictions. A discussion of the results follows:

- The peak discharge generated by a 15% increase in rainfall intensity approximates a peak discharge rate midway between the existing peak discharge and that generated by a 30% increase in rainfall intensity. Reference 2 predicts a 12% rainfall intensity increase by 2030 with a reduction to a 10% increase by 2100, over present day rainfall intensities. Further, a 15% increase in rainfall intensity results in a 25% increase in the peak runoff depth for the Basin I catchment. This increase in peak runoff depth approximates the 26% increase anticipated in the seasonal summer runoff depth referred to in reference 1.

- Maintaining the existing peak flow rate in the downstream channel reach (TC13), whilst accounting for a 30% increase in post development rainfall intensities, requires a: 50% increase in the storage capacity of Basin I over a conventional design (see Table 3). Providing this level of protection is considered to exceed the requirements of the Sensitivity Analysis referred to in reference 2, especially when the freeboard allowance of 0.5 m for Basin I provides an potential extended detention storage capacity of 11,500 m^3, which equates to an additional 40% in storage capacity.

- In our opinion, adoption of a 15% increase in rainfall intensities provides a reasonable estimate of CCI.

- To achieve the objectives defined in Option 1, Basin I must have a minimum Storage Volume of 28,000 m^3, which can almost accommodate a 30% increase in rainfall intensities (see Table 2),.

- To achieve the objectives defined in Option 1 Trunk Channel TC13 must have a minimum Drainage Reserve width of 28 m, which can accommodate a 30% increase in rainfall intensities if the freeboard allowance is reduced to 0.3 m (see Table 4).

- The Drainage Reserve width for TC13 would reduce by about 1.5 m if the freeboard allowance were reduced from 0.5 m to 0.3 m. A freeboard allowance of 0.3 m is consistent with the minimum Typical Freeboard Requirements for Industrial/Commercial development identified on Figure 1.1 of Blacktown City Councils "Engineering Guide for Development – 2005".

RECOMMENDATION

Rainfall Intensity –increased by 15% for the 100-year critical storm in consideration of the possible impact of Climate Change. Table 5 compares land requirements for a Drainage Strategy that matches the existing peak flow rates and one which includes a 15% increase in rainfall intensity utilising both Options 1 and 2 to control peak discharges.

Basin Size – determined on the basis of attenuating the 100-year post-development peak flow to the 100-year pre-development peak flow rate, including an increase of 15% in rainfall intensity to account for Climate Change for both (per Option 1). (see Table 5 for a comparison of Water Surface Areas)

Trunk Channel Waterway Area – profile to be based on Option 1 with a 15% increase in rainfall intensity. A similar approach is to be taken for Trunk Channels draining the local catchments i.e. the capacity of the channel must contain the runoff generated by a 15% increase in the 100-year peak flow rate for the developed catchment.

Freeboard – adoption of 0.5 m clearance over and above the flow depth generated by the existing 100-year peak flow from the developed catchment. This freeboard allowance includes a maximum of 0.2 m to accommodate CCI (see discussion in Attachment).

TABLE 5 - Comparison of Land Requirements for Basin I and TC 13

Options	Estimated Drainage Reserve Area Basin I	Drainage Reserve Dimensions TC13	Total Drainage Reserve Area Required
Match Existing Post Dment to Existing Pre Dment Peak Discharge Rates	36,600 m^2	23 m c. 2,300 m^2 (scaled length of 100m)	38,900 m^2
Match Post Dment to Pre Dment Discharge with 15% increase in Rainfall Intensity for both. **Option 1**	36,600 m^2	28 m c. 2,800 m^2 (scaled length of 100m)	39,400 m^2 This can be reduced to 38,900 m^2 if CCI is allowed to encroach by 0.1 on the 0.5 m Freeboard (see Attachment)
Match Post Dment (with 15% increase in Rainfall Intensity) to existing Pre Dment Peak Discharge Rates **Option 2**	40,000 m^2 (pro-rata)	23 m c. 2,300 m^2 (scaled length of 100m)	42,300 m^2

Basin I – refers to the water surface area only (i.e. no allowance for batter slopes or freeboard) based on a mean depth of 1.5 m.
Drainage Reserve Width TC13 – includes 1:4 batter slopes, 0.5 m freeboard and a 5 m access track.

These analyses relate to the Basin I catchment only, and may be subject to change once the whole of the Marsden Park Precinct is analysed and its relationship to flooding in Bells Creek defined.

If you have any questions regarding this matter please do not hesitate to contact the undersigned.

Yours faithfully
J.WYNDHAM PRINCE

GEOFFREY HUNTER
Senior Environmental Engineer

APPENDIX B

Marsden Park Industrial Precinct

Trunk Drainage Components

Preliminary Construction Cost Estimate

PRELIMINARY COST ESTIMATE

PROJECT: Marsden Park Section 94 Basins
Bulk Earthworks & Vegetation Only

CLIENT: Department of Planning C/- APP

JWP Plan Number/Version: 8955SK1-SK14 **BASIN A**

NO.	ITEM	QTY.	UNIT	RATE Exc GST$	AMOUNT Exc GST$
1	**BASIN A**				
	Establishment	1	Item	$50,400.00	$50,400.00
	Clearing (Allowance Only)	1	Item	$50,000.00	$50,000.00
	Strip & stockpile topsoil	19,900	sq.m.	$1.50	$29,850.00
	Respread topsoil	18,300	sq.m.	$2.50	$45,750.00
	Earthworks - Cut to Fill On Site	6,400	cu.m.	$5.00	$32,000.00
	Earthworks - Import material	12,100	cu.m.	$30.00	$363,000.00
	Trim and Compact	19,900	sq.m.	$1.00	$19,900.00
	Core Riparian Planting Bush Regeneration (incl 2 yr maint)	12,800	sq.m.	$10.00	$128,000.00
	Planting (incl maintenance for 2 years)	18,300	sq.m.	$9.50	$173,850.00
	Soil & Water Management (Allowance Only)	1	item	$25,000.00	$25,000.00
				TOTAL	**$918,000.00**

PRELIMINARY COST ESTIMATE

PROJECT: Marsden Park Section 94 Basins
Bulk Earthworks & Vegetation Only

CLIENT: Department of Planning C/- APP

JWP Plan Number/Version: 8955SK1-SK14 **BASIN B**

NO.	ITEM	QTY.	UNIT	RATE Exc GST$	AMOUNT Exc GST$
1	**BASIN B**				
	Establishment	1	Item	$78,450.00	$78,450.00
	Clearing (Allowance Only)	1	Item	$10,000.00	$10,000.00
	Strip & stockpile topsoil	12,500	sq.m.	$1.50	$18,750.00
	Respread topsoil	11,700	sq.m.	$2.50	$29,250.00
	Earthworks - Excavate and Dispose of Unsound Material	5,400	cu.m.	$200.00	$1,080,000.00
	Earthworks - Import material	5,000	cu.m.	$30.00	$150,000.00
	Trim and Compact	12,500	sq.m.	$1.00	$12,500.00
	Planting (incl maintenance for 2 years)	11,600	sq.m.	$9.50	$110,200.00
	Reinforced Turfing on Weir and Spillway (incl 2 yr maint)	100	sq.m.	$25.00	$2,500.00
	Soil & Water Management (Allowance Only)	1	item	$25,000.00	$25,000.00
				TOTAL	**$1,517,000.00**

J. WYNDHAM PRINCE

CONSULTING CIVIL INFRASTRUCTURE ENGINEERS
& PROJECT MANAGERS

PRELIMINARY COST ESTIMATE

PROJECT: Marsden Park Section 94 Basins
Bulk Earthworks & Vegetation Only

CLIENT: Department of Planning C/- APP

JWP Plan Number/Version: 8955SK1-SK14 **BASIN P**

NO.	ITEM	QTY.	UNIT	RATE Exc GST$	AMOUNT Exc GST$
1	**BASIN P**				
	Establishment	1	Item	$66,700.00	$66,700.00
	Clearing (Allowance Only)	1	Item	$20,000.00	$20,000.00
	Strip & stockpile topsoil	16,850	sq.m.	$1.50	$25,275.00
	Respread topsoil	14,350	sq.m.	$2.50	$35,875.00
	Earthworks - Excavate and Dispose of Unsound Material	4,450	cu.m.	$200.00	$890,000.00
	Earthworks - Import material	1,850	cu.m.	$30.00	$55,500.00
	Trim and Compact	16,850	sq.m.	$1.00	$16,850.00
	Planting (incl maintenance for 2 years)	14,110	sq.m.	$9.50	$134,045.00
	Reinforced Turfing on Weir and Spillway (incl 2 yr maint)	240	sq.m.	$25.00	$6,000.00
	Soil & Water Management (Allowance Only)	1	item	$25,000.00	$25,000.00
				TOTAL	**$1,276,000.00**

J. WYNDHAM PRINCE

CONSULTING CIVIL INFRASTRUCTURE ENGINEERS
& PROJECT MANAGERS

PRELIMINARY COST ESTIMATE

PROJECT: Marsden Park Section 94 Basins
Bulk Earthworks & Vegetation Only

CLIENT: Department of Planning C/- APP

JWP Plan Number/Version: 8955SK1-SK14	BASIN E

NO.	ITEM	QTY.	UNIT	RATE Exc GST$	AMOUNT Exc GST$
1	**BASIN E**				
	Establishment	1	Item	$159,950.00	$159,950.00
	Clearing (Allowance Only)	1	Item	$10,000.00	$10,000.00
	Strip & stockpile topsoil	60,700	sq.m.	$1.50	$91,050.00
	Respread topsoil	53,300	sq.m.	$2.50	$133,250.00
	Earthworks - Excavate and Dispose of Unsound Material	1,650	cu.m.	$200.00	$330,000.00
	Earthworks - Cut to Fill On Site	4,150	cu.m.	$5.00	$20,750.00
	Earthworks - Import material	53,630	cu.m.	$30.00	$1,608,900.00
	Trim and Compact	60,700	sq.m.	$1.00	$60,700.00
	Planting (incl maintenance for 2 years)	52,500	sq.m.	$9.50	$498,750.00
	Reinforced Turfing on Weir and Spillway (incl 2 yr maint)	800	sq.m.	$25.00	$20,000.00
	Soil & Water Management (Allowance Only)	1	item	$25,000.00	$25,000.00
				TOTAL	**$2,959,000.00**