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*3/2 Moore Street
WEST GOSFORD*

September 28, 2007

Crighton Properties
Suite F, Level 1
2 Reliance Dr
TUGGERAH NSW 2259

Attention : Mr Peter Childs

**PRELIMINARY STORMWATER ASSESSMENT FOR PROPOSED COMMUNITY TITLE
RESIDENTIAL DEVELOPMENT AT KINGS AVE, TERRIGAL**

Dear Sir,

This letter report has been prepared at the request of Crighton Properties, the owner of the "Parkside" property at Kings Ave Terrigal. Crighton's propose to construct a 146 lot residential community title subdivision over the site. This preliminary stormwater report has been prepared to provide an introduction to the proposed water quantity and quality measures to be implemented as part of the development, specifically within the western catchment of the subject site. It is intended that this report will be used for discussion purposes with the various applicable approval authorities, prior to the preparation of a more comprehensive report over the whole site for submission with a rezoning application to Gosford City Council. Comments received as a result of these discussions will be incorporated in finalising the stormwater strategy for the development. This letter report is complimentary to the Preliminary Basin Details, 3 sheets only, which have been included as an attachment to this letter report.

Stormwater Quantity Management

The Parkside site is located within the Terrigal valley catchment, which drains into Terrigal Lagoon. We understand that a trunk drainage network has already been constructed downstream of the subject site to convey the runoff expected from the fully urbanised contributing catchment, including the subject site.

A Water Cycle Plan was previously prepared for the site in 2005 by Cardno Pty Ltd. As part of these works, a hydrological assessment was undertaken on the contributing western catchment for the 100-year Average Recurrence Interval (ARI) design storm event for both the pre-development and post-development scenarios. For the current assessment, a hydraulic analysis was undertaken using the DRAINS computer program, with the flowrates estimated by Cardno being adopted for the purpose of calibrating the model for other ARI events. It is intended that at a later stage, a separate hydrological analysis will be undertaken to confirm the adopted flows and catchment characteristics.

The site has an existing redundant semi-offline detention basin inside the northern boundary, adjacent to Kings Ave, which was constructed as a temporary measure prior to the implementation of downstream trunk drainage works. A DRAINS model was established over the catchment using works-as-executed survey information prepared on the basin to determine the existing behaviour and extent of inundation. Based on the pre-developed 100-year ARI flows adopted from the Cardno study, the existing basin was calculated to pond to a level of RL 17.1, with a corresponding depth of approximately 2.3m. The retarded runoff was also found to “back-up” the existing watercourse adjacent to the basin some 100m to a maximum depth in the order of 2.1m.

To ensure that the post-developed flows from the site are not exacerbated as a result of the development, for all events up to and including the 100-year ARI, it is proposed to formalise the existing detention basin and to construct two small supplementary offline basins upstream of the primary basin.

The previously established DRAINS model was modified to reflect the developed site with the proposed basin arrangement and the model then re-run to determine the impact of the basins on the runoff regime. **Table One** summarises the results of the DRAINS modelling undertaken on the western catchment.

Table One – Preliminary Results of DRAINS Assessment on Western Catchment

<i>ARI</i>	<i>Pre Development</i>	<i>Post-Development (no OSD)</i>	<i>Post-Development (with OSD)</i>
1	2.71m ³ /s	5.18 m ³ /s	2.52 m ³ /s
2	4.50 m ³ /s	6.80 m ³ /s	3.94 m ³ /s
5	6.72 m ³ /s	8.99 m ³ /s	6.96 m ³ /s
10	7.98 m ³ /s	10.30 m ³ /s	7.94 m ³ /s
20	9.54 m ³ /s	12.00 m ³ /s	9.33 m ³ /s
50	11.20 m ³ /s	13.60 m ³ /s	10.70 m ³ /s
100	12.70 m ³ /s	15.10 m ³ /s	12.00 m ³ /s

The 100-year ARI water level in the primary basin was estimated to be in the order of RL 17.50, which is 0.4m higher than would currently occur in the same event. The corresponding combined storage volume required within all three basins would be approximately 6,350m³. An overflow weir would also be constructed adjacent to Kings Ave on the northern face of the primary basin with an additional 1,900m³ volume being provided as freeboard storage.

For the critical 60-minute storm duration resulting in the peak 100-year ARI developed flow, the period of inundation within the basin and adjacent watercourse would be in the order of 1.5hrs, after which storm flows in the watercourse would return to low depth stream flows, with little or no retardance occurring.

The results indicate that the construction of the proposed detention basins will reduce the flows from the developed site to less than existing for all events up to the 100-year ARI, except for the 5-year ARI event, which was found to be slightly higher. The discharge control pit will be fine tuned at the detail stage to ensure no net increase for all ARI events. It should also be noted that no allowance has been made for any water re-use within the development, however it is intended that some of the developed runoff will be captured and re-used on-site, which would further reduce the flows into the downstream stormwater system.

Stormwater Quality Management

Recognizing the ever-increasing importance of water as a valuable asset to the community, the developer is proposing to adopt a comprehensive water cycle management plan to ensure that the impact of the development on the both the demand for and impact on water is minimised. The plan, which has been detailed in the aforementioned Cardno report, identifies strategies

such as wastewater effluent recycling, stormwater collection and re-use and the implementation of water quality measures to treat stormwater runoff generated from the developed site prior to discharge into the riparian corridor that traverses the western catchment of the site and ultimately into Terrigal Lagoon.

For the latter of these proposed measures, a preliminary assessment has been undertaken using the 'Model for Urban Stormwater Conceptualisation' (MUSIC). MUSIC has been developed by the CRC for Catchment Hydrology and can be used to simulate both the quality of runoff from a catchment and the effects of a wide range of treatment facilities on runoff water quality.

The stormwater management strategy for this development requires the integration of a range of current best management practices (BMP's), in a 'treatment train' approach, to achieve the objective of limiting pollutant export to pre-developed levels. It is intended that the range of measures will include gross pollutant traps, rainwater tanks, buffer strips, grass swales, bioretention trenches and a constructed wetland within the primary detention basin adjacent to Kings Ave.

The Gosford City Council publication "Water Cycle Management Guidelines", which is complimentary to Council's DCP 165 – Water Cycle Management specifies the following post-development pollutant treatment rates for sites draining into the coastal catchments, such as Terrigal lagoon :

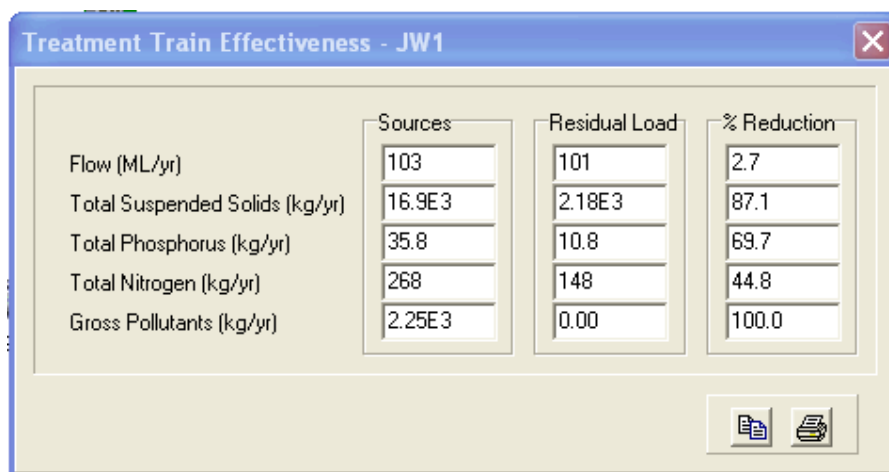
- Suspended Solids – 80% retention;
- Total Phosphorus – 45% retention;
- Total Nitrogen – 45% retention;
- Gross Pollutants – retention of litter greater than 40mm in size for flows up to 25% of the 1-year ARI peak flow;
- No Oil or Grease to be visible downstream of site for flows up to 25% of the 1-year ARI peak flow

Pollution retention relates to the percentage of the expected post-development pollutant load that would be expected from the site over the course of an average year if no water quality measures were implemented. This performance standard is based on the stormwater treatment objectives recommended by the Gosford City Council Urban Stormwater Management Plan (1999).

The MUSIC model for the developed site scenario with no measures was developed to provide a base-flow measurement of the mean annual loads for the pollutants described above. For the purpose of defining the catchment source nodes in the MUSIC model, the site was broken up into a combination of 'urban', 'forested' and 'rural residential' catchments, based on the anticipated land-use of the developed site.

Once the baseline annual loads had been determined, the model was updated to include a series of treatment measures, with indicative sizes being based on the availability of suitable areas after consideration of the site topography and the proposed development road and lot layout. **Table Two** includes an extract from MUSIC that summarises the results of the preliminary water quality modelling undertaken over the western catchment of the site.

Table Two – Preliminary Results of MUSIC Assessment on Western Catchment



	Sources	Residual Load	% Reduction
Flow (ML/yr)	103	101	2.7
Total Suspended Solids (kg/yr)	16.9E3	2.18E3	87.1
Total Phosphorus (kg/yr)	35.8	10.8	69.7
Total Nitrogen (kg/yr)	268	148	44.8
Gross Pollutants (kg/yr)	2.25E3	0.00	100.0

The results above demonstrate that the implementation of water quality measures on the developed site in a 'treatment train' approach can assist in reducing the post-developed pollutant loads into the downstream receiving waters to those required under Gosford City Council's Stormwater Management Plan.

Summary

This letter report has been prepared to outline the proposed water quantity and quality measures that are required to satisfy the relevant approval authorities requirements over the western catchment only for the proposed community title residential subdivision at "parkside", Kings Ave Terrigal. Details will also be prepared for the eastern catchment in due course, however it is anticipated that a similar methodology will be employed.

Our recommended schedule of works is outlined on the accompanying preliminary plans and includes;

1. The construction of three independent on-site detention basins within the community precincts of the site to limit post-developed flows to within pre-developed levels for all design storm events up to and including the 100-year ARI event;
2. The implementation of both lot and community based stormwater quality measures in a 'treatment train' approach to limit post-developed pollutant loads to allowable levels.

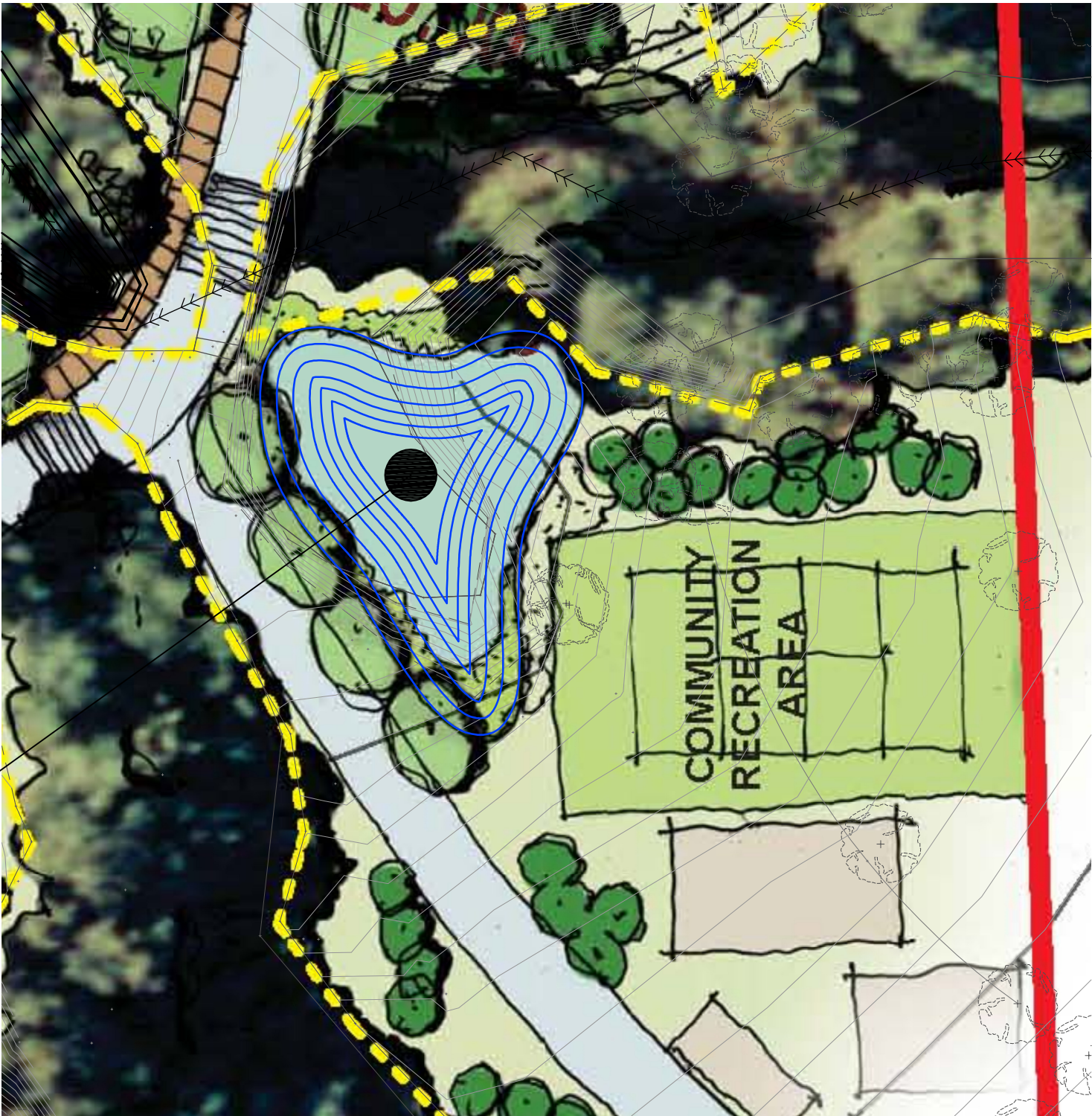
If you require any further clarification on this investigation and our subsequent recommendations, please do not hesitate to call us. Otherwise we would recommend that the proposals outlined above would be an acceptable and practical approach to providing stormwater quantity and quality control for the subject site.

Yours sincerely
Cahill & Cameron

Glen Cahill
enclosed

ATTACHMENT A -
PRELIMINARY BASIN DETAILS

CONSTRUCT OFFLINE WET BASIN TO
PROVIDE SUPPLEMENTARY OSD VOLUME
& FOR WATER QUALITY PRIOR TO RUNOFF
FROM COMMUNITY RECREATION AREA ENTERING
DOWNSTREAM WATERCOURSE



BASIN 2

WETLAND VOLUME PROVIDED =	75 m ³
OSD VOLUME PROVIDED =	24.0 m ³
FREEBOARD VOLUME PROVIDED =	100 m ³
TOTAL BASIN VOLUME =	415 m ³
PERMANENT WATER LEVEL =	RL 18.20
OSD TOP WATER LEVEL =	RL 19.40
TOP OF BANK LEVEL =	RL 19.70

BASIN 2

"WARNING"
BEFORE ANY EXCAVATION IS UNDERTAKEN,
TOTAL BEFORE YOU DIG MUST BE OBTAINED
FOR LOCATION OF UNDERGROUND SERVICES.

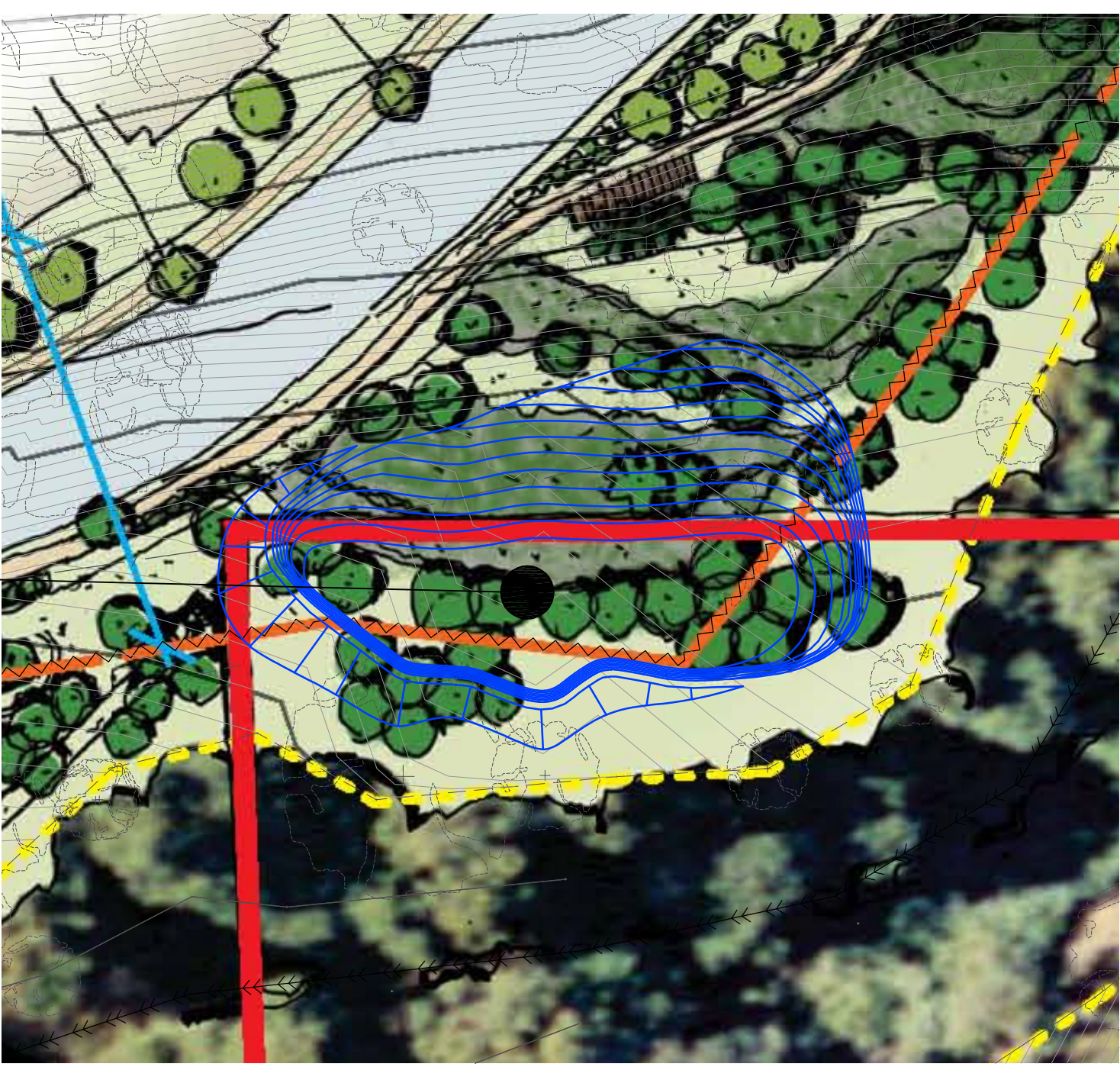


No	DATE	REVISION DETAILS	BY	SCALES



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CONSTRUCT OFFLINE DRY BASIN TO
PROVIDE SUPPLEMENTARY OSD VOLUME
& FOR WATER QUALITY PRIOR TO RUNOFF
FROM RESIDENTIAL LOTS & ROAD RESERVE
ENTERING DOWNSTREAM WATERCOURSE



BASIN 3

WETLAND VOLUME PROVIDED =	NIL
OSD VOLUME PROVIDED =	560 m ³
FREEBOARD VOLUME PROVIDED =	NIL
TOTAL BASIN VOLUME =	560 m ³
BASIN INVERT LEVEL =	RL 22.20
OSD TOP WATER LEVEL =	RL 23.40
SPILLWAY LEVEL =	RL 23.45

BASIN 3

PROJECT:	SURVEYED:	CAHILL & CAMERON	DATUM:	A.H.D.
	DESIGNED:	S.R.B	GRID:	ASSUMED
	DRAWN:	S.R.B	SURVEY REF	20003ALL
	CHECKED:		ISSUE DATE:	
DRAWING				

DRAWING No	REVISION
*	.
SHEET 2 OF 3	SHEETS
ISSUED FOR:	DISCUSSION PURPOSES

DRAWING SUPPLEMENTARY ON-SITE DETENTION BASINS LAYOUT PLAN

