Stormwater Management Strategy

Residential Subdivision, Catherine Hill Bay

December 2007

Coastal Hamlets Pty Ltd

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Executive Summary

The Catherine Hill Bay development involves the subdivision of 600 residential lots on a decommissioned coal mine, location shown in Figure 1. A study was undertaken to quantify existing and developed stormwater flow using the XP-SWMM computer modelling software package. The existing flows at the catchment outlets were calculated using the Probabilistic Rational Method (PRM) as described in Australian Rainfall and Runoff (1987), and used as a base line for comparison to ensure post development flows do not impact on the environment.

A stormwater management strategy has been composed to mitigate developed flows and recommend suitable water quality devices. Each precinct of the development is to include a centralised roof area stormwater harvesting system. This system will include the conveyance of harvested rainwater to strategically placed treatment reservoirs filled with a sand filter medium where a pump system will be used to pressurise the treated rainwater and reticulate it throughout the respective precinct. Runoff originating from the roads, pervious (vegetated) areas and surface hardstand areas of lots will be drained through a separate drainage system via swales located within the road alignments.

Water quality devices include the use of a landscaped swale drainage system, gross pollutant traps upstream of each reservoir and sand filter media in storage reservoirs. The proposed mitigation structures were included within the XP-SWMM model. The model predicted that the provision of these structures would be suitable to mitigate developed flows back to or below existing levels.

The site lies adjacent to a SEPP 14 wetland, which has been accurately surveyed by RPS Harper Somers O'Sullivan Ecological Consultants and 40m offsets have been mapped. The development encroaches on the 40 m riparian zone in a minor manor (5m) in one area. However, there will be no significant long term impact, as the works will be revegetated with appropriate endemic species.

Geotechnical reporting indicates minimal presence of ground water, and analysis indicates that the proposed water storage reservoirs will not penetrate into the ground water aquifers. No extraction of ground water is proposed. Analysis of the ground water indicates that the adjacent wetland is not likely to be affected by the development and the wider catchment to the wetland will sustain the current water regime of the wetland.

1. Introduction

1.1 General

Parsons Brinckerhoff Australia Pty Ltd (PB) was engaged by Coastal Hamlets Pty Ltd to prepare a stormwater management strategy for a proposed residential development located at Catherine Hill Bay.

The Catherine Hill Bay site was formerly an underground coal mine on the eastern shores of Lake Macquarie, approximately 6km south of Swansea. At this site, coal was transported from underground to the surface before being washed, graded and loaded on ships for export. The development site has since been decommissioned and undergone rehabilitation.

It is proposed to recover the site from its former coal production use and convert it to residential development. The location of the proposed development is shown in Figure 1. The development area is bounded by a SEPP-14 protected wetland to the south and future proposed conservation area dedication to the north.

1.2 Purpose

At the request of Coastal Hamlets Pty Ltd, PB has carried out stormwater modelling to assess the impact of a proposed residential subdivision in Catherine Hill Bay, on existing catchment hydrology. The modelling will be used as an important part of the stormwater strategy which will support the Concept Plan and Project Applications.

This study's objectives were to:

- Determine existing flow rates from the local drainage catchments,
- Estimate developed flow rates from the local developed drainage catchments following the construction of dwellings and roads on the development site,
- Estimate mitigated flow rates from the local drainage catchments following the inclusion of stormwater detention structures, and
- Recommend appropriate structures or devices for the treatment of runoff from the development.

1.3 Site Description

The study area lies on the boundary of the Lake Macquarie and Wyong local government areas, to the east of the Pacific Highway as indicated in Figure 1. The proposed development consists of approximately 600 residential allotments of standard density. The development has an assumed average lot size of 400m^2.

The site consists of a mix of flat (former stockpile) and sloping vegetated land. The current topography ranges between 5m AHD to 40m AHD and has been significantly disturbed throughout the operation of mining activities, hence extensive earthworks will be required to enable the site to be developed. Parsons Brinckerhoff Pty Ltd has also conducted civil engineering design for the site and produced proposed surface levels, which have been used in this analysis to determine sub catchment boundaries. There is an existing water storage pond in the southern corner of the site. It is proposed to utilise this pond as a final stormwater flow mitigation structure.

1.4 Available Data

Information used in the preparation of this stormwater strategy includes:

- Proposed development layout provided by Conybeare Morrison International Pty Ltd,
- Civil engineering surface design and catchment delineation,
- Contour map of the proposed development,
- Evapotranspiration rates, and
- Site specific rainfall information provided through Australian Rainfall and Runoff guide.

1.5 Consultation

A preliminary version of this strategy was reviewed by the Department of Water and Energy and comments were made in a letter to the Director of Strategic Assessments at the Department of Planning on 27 September, 2007, refer appendix C.

Principal issues raised by the Department were:

- Approval requirements under part 5 of the Water Act 1912 (if applicable).
- State Government groundwater policies.
- Potential impacts on groundwater dependent ecosystems
- Riparian protection.
- Harvestable rights.

These issues are addressed at section 5 of this report

2. Modelling Methodology

The methodology comprises quantitative analysis of available data to estimate exiting and future flow behaviour from the development site. The analysis involved examination of surface hydrology to assess runoff characteristics from the site and sizing of stormwater mitigation devices to control the impact of site development on existing flows.

2.1 Hydrology

Rainfall originating from the site will be conveyed through two separate drainage systems. As part of the proposed stormwater management strategy, runoff originating from the roads, pervious (vegetated) areas and surface hardstand areas of lots will be drained via swales within the road alignments. Swales will be used to convey peak flows from the system whereby water will infiltrate back into the natural water table, there it will be used by plantings within the swales via evapotranspiration.

A separate drainage network, also located within allotments, running parallel the sewer reticulation, will be used to convey up to 1 year ARI flows originating from the roof areas of lots to a series of reservoirs strategically located within the site as shown in Figure 3. The harvested rainwater will then be reticulated throughout the lots using separate pump systems to pressurise mains, which deliver water for gardens and other suitable non-potable uses. This centralised system has the logistical benefit of improved maintenance capabilities, with a group of owners able to share the responsibility as opposed to individual management of water tanks on each allotment. This stormwater management option enables a level of sustainability of the water supply due to significantly reducing the draw on the potable water source, and will partially satisfy the BASIX requirements for water efficiency of residential dwellings.

The catchments contributing to runoff within the study area have been identified from preliminary design information. The impervious area for each sub-catchment has been estimated from the proposed lot layout, assuming an average roof area of 200m^2 per lot. For the Hamlet 1 catchment, average lot configurations were extended to account for 50m^2 of surface hardstand and 150m^2 of garden area.

The SEPP14 wetland, located to the south of the development, will not be affected by flows originating from the development as they are directed through an existing channel to the ocean.

2.2 Hydraulics

The hydraulics mode of XP-SWMM was used to route estimated flows through proposed stormwater drainage and mitigation devices for the 1, 10 and 100 year ARI storm events.

3. Existing Hydrology

In order to determine the relative impact of site development on existing catchment hydrology, it is necessary to establish existing flow conditions. Provided below are estimates of existing flow rates from each catchment outlet

3.1 Parameters

A catchment plan of the site is shown in Figure 2. The catchments align with the 'precinct' or hamlet boundaries as nominated in the Concept Plan. However, the topography at Hamlet 1 (village centre) requires the delineation of two separate sub-catchments noted as 1A and 1B on Figure 2.

A summary of loss and roughness parameters for pervious land is provided in Table 3-1.

Table 3-1 – Adopted Loss and Roughness Parameters for Existing Conditions

Parameter	Pervious
Initial Loss (mm)	15
Continuing Loss Rate (mm/hr)	2.5
Roughness	0.07

3.2 Existing Flow Rates

A summary of existing flow rates at each catchment outlet is provided in Table 2 for the 1, 10 and 100 year ARI storm events. The probabilistic rational method (PRM) calculations for the 1, 10 and 100 year ARI storm events are provided in Appendix A.

Table 3-2 – Existing Probabilistic Rational Method (PRM) Peak Flow Rates at Catchment Outlets

Precinct (Catchment Area)	ARI	PRM Estimate Flow Rates (m^3/s)
1A (2.26ha)	1 Year	0.12
	10 Year	0.35
	100 Year	0.71
1B (2.21ha)	1 Year	0.12
	10 Year	0.34
	100 Year	0.69
2 (4.73ha)	1 Year	0.32
	10 Year	0.96
	100 Year	1.94
3 (7.57ha)	1 Year	0.34
	10 Year	1.00
	100 Year	2.03
4 (13.47ha)	1 Year	0.53
	10 Year	1.58
	100 Year	3.21
5 (8.19ha)	1 Year	0.32
	10 Year	0.95
	100 Year	1.93

4. Developed Hydrology

4.1 Stormwater Strategy

The stormwater management strategy for the proposed development is required to manage both water quality and quantity. A plan showing an indicative layout of proposed stormwater management structures is shown in Figure 3.

Water treatment reservoirs will be used as both a qualitative and quantitative mitigation structure for rainfall harvested from roof areas within each precinct.

4.2 Parameters

The catchment plan for the developed site is shown in Figure 2. Sub-catchment boundaries are defined by the lot and drainage layouts and separated into five separate precincts.

The percentage of impervious for each sub-catchment was calculated from the relative proportion of lot and road area. Additionally, a further roof area (200m^2) was used in a separate model to simulate the harvesting of rainfall for 1 year ARI storm event and sizing of the storage reservoirs. A water balance to analyse of the effectiveness of each reservoir was then undertaken using rainfall and estimated lot usages.

A summary of loss and roughness parameters for pervious and impervious land is provided in Table 4-1.

Table 4-1 – Adopted Loss and Roughness Parameters for Developed Conditions

Parameter	Pervious	Impervious
Initial Loss (mm)	15	1.5
Continuing Loss Rate (mm/hr)	2.5	0
Roughness	0.07	0.014

4.3 Developed Flow Rates

The developed peak flows expected from the outlet of each precinct (catchment) during a 1, 10 and 100 year ARI storm event is provided in Table4-2.

Table 4-2 – Developed Peak Flow Rates at Catchment Outlets

Precinct	ARI	Existing Flow Rates (m^3/s)	Developed [Mitigated] Flow Rates (m^3/s)	Change
1A	1 Year	0.12	0.08	- 33 %
	10 Year	0.35	0.25	- 28 %
	100 Year	0.71	0.39	- 45 %
1B	1 Year	0.12	0.12	0 %
	10 Year	0.34	0.33	- 3 %
	100 Year	0.69	0.57	- 17 %
2	1 Year	0.32	0.30	- 6 %
	10 Year	0.96	0.88	- 8 %
	100 Year	1.94	1.29	- 33 %
3	1 Year	0.34	0.29	- 14 %
	10 Year	1.00	0.65	- 35 %
	100 Year	2.03	1.01	- 50 %
Combined Precinct 4 and 5*	1 Year	0.64	0.83 [0.20]	+ 30 % [- 68 %]
	10 Year	1.92	2.28 [0.89]	+ 19 % [- 54 %]
	100 Year	3.89	3.62 [1.85]	- 7 % [- 52 %]

* Note that the peaks flows from precincts 4 and 5 occur at separate times, hence the resultant combined outflow is lower than the sum of the two respective peak flows. Values in brackets represent results obtained after the introduction of the mitigation works described below.

An existing pond of approximately 1,500m^3 capacity (located to the south of the site) has been modelled as a temporary storage for end of pipe peak flow mitigation for precincts 4 and 5. Rock lined swales will be provided for road drainage through precinct 1B to attenuate flows from the catchment.

4.4 Reservoir Sizing

Reservoirs for each precinct were sized using the XP-SWMM stormwater modelling package. The resulting reservoirs were then tested through a water balance model simulating rainfall, losses and general usage requirements of the harvested rainwater supplies. Garden watering was assumed to occur when daily rainfall < 5mm at a rate of 25 mm per week.

The effect of reusing harvested rainwater is a significant reduction in potable water usage a partial requirement of BASIX. During periods when reservoirs are dry, water will need to be supplemented from potable water mains, available as a backup when required.

Table 4-3 – Water Balance Modelling Of Each Precinct Reservoir

Precinct No. (lots contributing)	Reservoir Capacity (m^3)	Annual Average Days Where Reservoir Empty	Annual Average No. of Reservoir Overflows
1A (33)	1020	47.1	5.9
1B (34)	1140	43.5	5.0
2 (108)	3600	44.2	5.0
3 (85)	2850	44.7	5.0
4 (116)	3900	44.7	5.0
5 (79)	2650	43.5	5.0

4.5 Water Quality

The reservoirs for each precinct are to be filled with a sand filter medium to allow for sediment and nutrient removal. Gross pollutant traps will be placed at the inlet of each reservoir to improve the treatment capacity of the reservoirs.

Water quality modelling for each reservoir was undertaken using MUSIC modelling software. The modelling results, shown in Table 4-4, indicated that the developed reservoirs will mitigate stormwater quality in-excess of the current best practice, that is a percentage reduction in outflow concentrations of;

- Suspended solids – 80%
- Total Phosphorus – 40%
- Total Nitrogen – 40%

(Source – *Australian Runoff Quality*, Institute of Engineers Australia)

Table 4-4 – Pollutant Removal Efficiencies

Precinct	Capacity (m^3)	Suspended Solids removal (%)	Total Phosphorus removal (%)	Total Nitrogen removal (%)
1A	1020	98	93	90
1B	1140	97	92	89
2	3600	97	94	88
3	2850	85	78	65
4	3900	95	94	92
5	2650	80	74	62

5. Water management issues

5.1 General

In recognition of the general push towards Ecologically Sustainable Development, total water cycle management has become an important issue in new residential development. While the State Government's BASIX requirements for new housing require augmentation of the water supply to the Moonee Hamlets development, there are two broad options available.

1. Capture and reuse of excess stormwater
2. Importing of recycled sewer effluent

However, the relative remoteness of the development from the Belmont Waste Water Treatment Plant, and the absence of recycled water infrastructure leading away from the plant, means that the stormwater option is the only viable alternative.

Under this scheme, rainfall originating from the roofs and hard stand ground areas of lots will be transported in a dedicated stormwater system to 6 large sand filled reservoirs, to be distributed around the perimeter of the development as shown in Figure 3. The harvested rainwater will then be reticulated throughout the lots using separate pump systems to pressurise mains, which deliver water for gardens and other suitable non-potable uses. This centralised system has the logistical benefit of improved maintenance capabilities, with a group of owners able to share the responsibility as opposed to individual management of water tanks on each allotment.

As recognised by the Department of Water and Energy (refer appendix C), there are a number of potential issues with the capture and storage that need to be addressed.

5.2 Approval requirements under part 5 of the Water Act 1912

It is noted that the Water Act 1912 has been repealed by the Water Management Act 2000. The relevant provision is contained in Section 91 of the Water Management Act 2000. Approval is required for:

- Activity within 40m of the top of bank of a river, lake or estuary.
- Activity that is likely to penetrate into an aquifer.

Notwithstanding this, approval under the Water Management Act 2000 is not required following approval under part 3A of the Environmental Planning and Assessment Act, 1979.

The site lies adjacent to a coastal wetland captured by State Environmental Planning Policy 14. The wetland is drained via a water course that discharges to a pond that was constructed as part of the mines infrastructure prior to 1999. The primary purpose of the pond was to supply water to the former mining operation on the site. The pond drains through a natural creek to Moonee Beach, approximately 400m downstream.

Ecological Consultants, RPS Harper Somers O'Sullivan have surveyed the wetland to define its perimeter, refer Figure 4, which also shows an extension of 40m to determine the limit of land where separate approval is required from the Department of Water and Energy.

Figure 4 shows that there is only a minor encroachment of approximately into the 40m Riparian zone. However, the works are to be revegetated with local endemic species and will not present an ongoing threat to the riparian zone.

A geotechnical report has been prepared by Jeffery & Katauskas Pty Ltd, including the identification of groundwater, refer Appendix D. For the purposes of this assessment, the borehole locations have been plotted on the development site plans, refer Figure 6. Figure 6 also shows surface levels (SL), end levels (EL) and water levels (WL) where relevant.

Examination of Figure 6, cross referenced with the geotechnical report, reveals the following:

- Most of the Boreholes were dry, with no identification of ground water.
- Where boreholes did collect water, the water was always associated with the soil type identified as “Fill”. The water surface was generally at the interface of the fill layer and the natural ground surface.
- The geotechnical report identifies the fill as being generally poorly to moderately compacted.
- Ground water is generally located in areas where the surface profile is flat, allowing seepage from rainwater.

Due to the differing ground water levels encountered, it is considered that the most likely ground water movement is from the vicinity of BH 15, towards the beach as identified on Figure 6. This conclusion has two major impacts on the Project Applications:

1. It is unlikely that groundwater from the site is entering, or interacting with the adjacent wetland.
2. It is likely that ground water would be present at the site of the reservoir proposed for Hamlet 2 (east of BH 20 on Figure 6). However, having regard to the water level at BH15, and interpreting the likely permeability from apparent hydraulic grade lines, the water table would be lower than the invert of this reservoir (RL 8.0m). Therefore, it is unlikely that the ground water profile would be penetrated by the proposed reservoirs.

In addition, the water surface level of the upstream wetland is approximately 8.0m AHD, which is the minimum reduced level for the invert of any of the proposed reservoirs. Given that any ground water downstream of the wetland would have a hydraulic grade, it is further considered unlikely that the reservoirs would penetrate a ground water aquifer.

It is proposed to line the reservoirs with an impermeable liner, preventing leaking and also preventing ingress (and therefore interception) of ground water.

In conclusion, it is assessed that the development is not likely to intercept an aquifer, and it is not intended to extract ground water as a resource. It is therefore considered that licensing under S91 of the Water Management Act 2000 is not required.

5.3 State Government groundwater policies

NSW Groundwater Policy Framework: The framework sets the background for the management of Groundwater. It is supported by three implementation level policies, namely:

- Groundwater Quality Protection.

- Groundwater Quality Management.
- Groundwater Dependent Ecosystems.

However, as the development does not propose to interfere with, or extract any ground water resource, there is no further consideration of the State Government Groundwater Policy required. It is noted that there is no adopted or draft groundwater Management Plan in place for the Catherine Hill Bay locality.

5.4 Potential impacts on groundwater dependent ecosystems

The adjacent wetland hosts significant habitat for groundwater dependent ecosystems. This issue is therefore related to the likely quality and quantity of runoff. As demonstrated at section 5.2 of this report, any groundwater that is flowing from the site is likely to be emerging downstream of the wetland, and the proposed development is not therefore likely to impact at all on groundwater flows to the wetland. In addition, as there is likely to be no flow of water from the site to the existing wetland, the development of the site will have no impact on the hydrology of the wetland.

5.5 Riparian protection

As a result of its former use as a Coal Mine, the development site is heavily disturbed from its natural condition, and the topography detailed on even the current set of 1:25,000 scale maps is not representative of the creek lines on the site. Detailed survey of the site, together with the geotechnical report (Appendix D) shows that the pre existing gullies on the site have been filled in to provide level areas for coal stockpiling.

The redevelopment of the site to residential use provides an opportunity to shape the land appropriately and more in keeping with the pre existing topography, however, there are no existing riparian zones within the area of works, and disturbance of the riparian zone is not an issue. Refer to Figure 5 for a fully developed cut and fill diagram. Total earthworks on the site involves approximately 750,000 m3 of cut to fill, with no significant import or export of material from the site.

The proposed works plans incorporate sedimentation and erosion control, as detailed on plan number 41. It is intended to utilise the pond downstream of the wetland as the primary sediment control basin for the site works, having regard to the large area involved, it may be pertinent to include a number of smaller sediment basins throughout the construction phase to minimise the risk of the existing pond being filled beyond capacity. A significant feature of the sediment and erosion control plan is to ensure no disturbed area runoff enters the wetland during the construction phase of the development .

5.6 Harvestable Rights

The NSW Government allows for dams of a certain capacity to be built without a licence. The volume of the dam is determined by calculating the ‘maximum harvestable right’ (MHR) for the site in question. This volume is calculated by using the method set out on the Department of Water and Energy (DWE) website.

The total contiguous landholding for the site comprises approximately 60 Ha. Using the calculator provided on the DWE website, the MHR was determined to be 6.6ML (with a property multiplier of 0.11ML/ha).

The onsite storages for this area comprise approximately 15.2ML, which exceeds the MHR.

Notionally, the MHR applies to 10% of the runoff generated by the site, however, the proposed urbanisation of the site will significantly change the rainfall – runoff dynamic, and more careful assessment is required.

It is argued that licensing should not be required on the following basis:

- The MHR is a tool that applies to rural lands, and as such, the standard catchment on which the MHR is calculated would predominantly be rural or forested. However, in the case of the Moonee Hamlets development, the catchment is urbanised and accordingly, has the potential to generate significantly more runoff (up to five times the volume of runoff on an average annual basis) than the equivalent rural use. Accordingly, up to five times the MHR can be harvested without impacting significantly on the downstream catchment.
- The State Government's BASIX program requires the augmentation of mains supply water with appropriate quality recycled water, sourced from either recycled effluent, or rainwater. The corollary is that in an urban situation, the higher the rainwater capture, the more effective the solution for BASIX. For an average urban block, (600m2), the MHR using the DWE calculator would be around 6600 litres, which is less than an average 10,000 litre installation.
- It is noted that the harvestable use rights are not applied where the water is used for domestic purposes, which is the case at the Moonee Hamlets.
- We have modelled the runoff on an average annual basis and determined that the runoff from the development site would be no different than the site in its predeveloped (natural

In summary, the increase in runoff from the impervious areas is offset by the storage provided in the reservoirs, so that ultimately, the catchment hydrology remains essentially the same, refer Table 6.5. It is therefore considered that storages have no detrimental impact on the flow regime and licensing should not be required.

6. Wetland Runoff

6.1 General

In examining the likely impacts of the development on the wetland, including hydrology and likely water quality impacts, it is necessary to assess the wetland in the context of the wider catchment.

This section of the report contains:

- an outline of the assessment methodology
- a comparison of pre-development and post-development catchment conditions and pollutant loads.

This investigation has been undertaken using estimated catchments from a 1:25,000 topographic map of Swansea, refer figure 7.

6.2 Site Description

The proposed development incorporates a number of WSUD components to ensure that water quality and flow regimes are maintained at acceptable levels.

The following mitigation methods have been proposed for the site:

- A network of vegetated swales to convey flows from road reserves, lots (excluding roof areas) and open areas
- The use of an existing pond for the attenuation of flows and water quality treatment.
- A piped drainage network to convey harvested roof rainwater to strategically placed reservoirs for the storage and treatment of harvested rainwater. The reservoirs will be filled with a sand filter medium to allow for sediment and nutrient removal, and rainwater will be reused throughout the development for garden watering and other non-potable uses.
- Gross pollutant traps at the inlet to each reservoir.

Approximately one third of the site area drains to the wetland, giving a developed catchment of approximately 14ha. The entire wetland catchment area is approximately 270ha.

6.3 Discharge Quality

6.3.1 Modelling Methodology

The assessment was carried out using the computer program Model for Urban Stormwater Improvement Conceptualisation (MUSIC). Separate pre-development and post-development models were created simulating the conditions of the catchment contributing to the SEPP 14 wetland. The post-development model included all proposed mitigation measures. Contributing areas to the wetland were determined using topographic information.

Due to the absence of site specific water quality data, baseline pollutant loads for suspended solids, total nitrogen and total phosphorous were estimated and compared against published data for similar land uses.

The baseline estimates allowed a realistic assessment of the likely treatment performance of the proposed water quality management strategy. The performance of the proposed mitigation measures were assessed by comparison of pollutant loads produced by the pre-development and the post-development catchments. ANZECC based assessment criteria were considered, however, these were not considered appropriate as they did not include data specifically relating to coastal wetlands.

6.3.2 Pre-developed Catchment Conditions

The SEPP 14 Coastal Wetland catchment is bounded to the north by Montefiore St, to the west by the Pacific Highway and to the south by a ridge running east-west. Contributing catchment areas are shown in Table 6.5. Due to the undeveloped nature of the catchment, an impervious area of 0% has been assumed for each catchment. A catchment plan indicating both pre-development and post-development catchments is shown in Attachment A.

Table 6.5 Pre-developed Catchment Areas

Catchment	**Area (ha)**	**Impervious Area (%)^**
C1	78.1	0
C2	61.2	0
C3	84.2	0
C4	48.6	0
Total	272.1	0

Using the above catchment areas and published data for pollutant generation from forest land types, the annual pollutant loads shown in Table 6.6 were produced.

Table 6.6 Pre-developed Annual Pollutant Loads

Flow (ML/yr)	218.00
Total Suspended Solids (kg/yr)	10400.00
Total Phosphorus (kg/yr)	13.40
Total Nitrogen (kg/yr)	209.00
Gross Pollutants (kg/yr)	0.00

6.3.3 Post-development Catchment Conditions

The post-development catchment comprises the same areas for catchments C2, C3 and C4, with approximately 18 ha of catchment C1 replaced by the proposed development. The developed catchments within C1 have been divided into separate road, roof and lot areas. Individual lots have been assumed to have the pervious, impervious and roof areas shown in Table 6.7.

Table 6.7 Average Lot Areas

Roof Area	200m^2
Paved Area	50m^2
Pervious Area	150m^2
Total Area	400m^2

Catchment areas, as well as impervious percentage are shown in

Table 6.8.

Table 6.8 Post-development Catchment Areas

Catchment	Area (ha)	Impervious Area (%)
C1-4 Roof	2.86	100
C1-4 Road	3.25	45^
C1-4 Lots	2.86	25
C1-5 Roof	1.56	100
C1-5 Road	2.05	45^
C1-5 Lots	1.56	25
C1 Remainder	63.96	0
C2	61.2	0
C3	84.2	0
C4	48.6	0
C4	272.1	3

^ Road impervious percentages determined from road typical sections

Using the above catchment areas and published data for pollutant generation from each of the land types, the annual pollutant loads shown in Table 6.9 were produced. Table 6.9 also shows a comparison of the pre-developed and post-developed pollutant loads.

Table 6.9 Comparison of Pre-developed and Post-developed Pollutant Loads

	Pre-development	Post-development	Difference (%)
Flow (ML/yr)	218.00	218.00	+0.00
Total Suspended Solids (kg/yr)	10400.00	10700.00	+2.88
Total Phosphorus (kg/yr)	13.40	14.20	+5.97
Total Nitrogen (kg/yr)	209.00	209.00	+0.00
Gross Pollutants (kg/yr)	0.00	0.00	+0.00

7. Conclusions and Recommendations

The proposed stormwater management strategy for the development will comprise;

- A drainage network of vegetated roadside swales to convey flows from the roads, open areas and lots to existing watercourse to the south of the development,
- An existing pond structure located to the south of the development will allow for significant attenuation of flows from precincts 4 and 5,
- Rock-lined swales will be used to convey flows from the roads, open areas and lots through hamlet 1,
- A separate piped drainage system, located within the road reserve, to convey rainfall harvested from roof areas,
- Strategically placed reservoirs will be used to store and treat harvested rainwater,
- Pump stations to be used to pressurise the harvested rainwater throughout each precinct of the development,

This sustainable option of water re-use will significantly reduce the draw on potable water of the development as required under BASIX.

Mathematical modelling using XP-SWMM has demonstrated that the proposed storage structures will attenuate developed flows to, or below existing flows. Storage structures utilised across the site are to consist of;

- Several storage reservoirs filled with sand filter media,
- An existing pond located within the southern natural watercourse.

Harvested rainwater stored in the reservoirs should be used for garden watering and other suitable, non-potable uses. A first flush bypass device should be provided on each rainwater tank to intercept the first lot of roof runoff. Water captured in this device should drain to landscaped areas. Potable supplement will be required during extended dry periods where respective reservoir/tank is emptied. Gross pollutant traps will be placed at the inlet of each reservoir to improve the treatment capacity of the reservoirs.

The local swale drainage network in each precinct catchment will be required to capture and convey flows up to and including the 5 year ARI storm event, with enough capacity within the road reserve to convey the 100 year ARI storm event.

MUSIC modelling also indicates that the adjacent SEPP 14 wetland will not be impacted on by the development in terms of both quality and quantity.

Analysis of the ground water profile of the site indicates that there will be no impact on the wetland as a result of the development, nor will the development require ground water licensing.

The development involves a minor encroachment into the 40m riparian zone around the wetland, however, this will not have any long term impacts.

Sediment and erosion control will be employed in the development phase to ensure sediment does not enter the wetland.

Figures

Client: Rosecorp
Project: Stormwater Servicing Strategy
Location: Residential Subdivision
Catherine Hill Bay

PARSONS BRINCKERHOFF

0 500 1000 Metres

SCALE 1: 20,000

Locality Plan

Figure 1

Plot Date: 17/07/07 - 09:44 Cad File: \\auncif\ncidata\A502-NCL\PROJ\2122743A_Catherine_Hill\09_CADD\DRAWINGS\PR_0559\pr-0559-fig 1.dwg

Plot Date: 23/07/07 - 12:02 Cad File: J:\A502-NCL\PROJ\2122743A_Catherine_Hill\09_CADD\DRAWINGS\PR_0559\pr-0559-sw-fig 2.dwg

STORMWATER MANAGEMENT PLAN

Figure 3

Plot Date: 23/07/07 - 12:05 Cad File: J:\A502-NCL\PROJ\2127434_Catherine_Hill\09_CADD\DRAWINGS\PR_0559\pr-0559-sw-fig 3.dwg

Client: ROSECORP
Project: Stormwater Strategy - Catherine Hill Bay
Location: Catherine Hill Bay
NEW SOUTH WALES

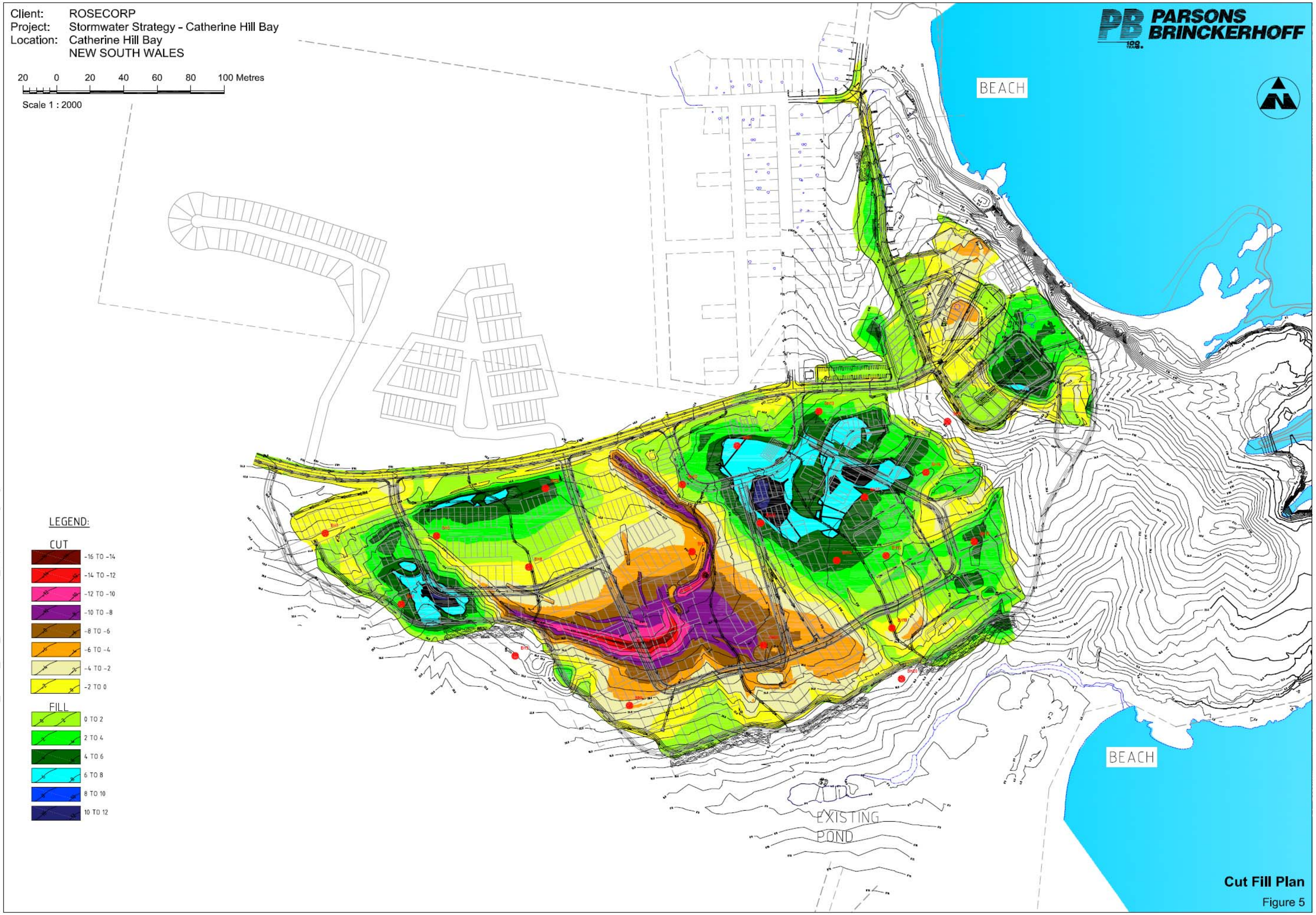
PARSONS BRINCKERHOFF

20 0 20 40 60 80 100 Metres
Scale 1 : 2000

SEPP Boundaries

Figure 4

Plot Date: 04/12/07 - 16:32 Cad File: J:\AS02-NCL\PROJ\2122743A_Catherine_Hill\09_CADD\DRAWINGS\PR_0559\pr-0559-sw-fig 4.dwg



Plot Date: 04/12/07 - 16:13 Cad File: J:\A502-NCL\PROJ\2122743A_Catherine_Hill\09_CADD\DRAWINGS\PR_0559\pr-0559-sw-fig 5.dwg

Client: ROSECORP
Project: Stormwater Strategy - Catherine Hill Bay
Location: Catherine Hill Bay
NEW SOUTH WALES

Reservoir Cut Fill Plan

Figure 6

Plot Date: 06/12/07 - 09:26 Cad File: J:\1A502-NCL\PROJ\2122743A_Catherine_Hill\09_CADD\DRAWINGS\PR_0559\pr-0559-sw-fig 6.dwg

Client: Rosecorp
Project: Stormwater Servicing Strategy
Location: Residential Subdivision
Catherine Hill Bay

PARSONS BRINCKERHOFF

0 500 1000 Metres

SCALE 1: 20,000

Catchment Plan

Figure 7

Plot Date: 06/12/07 - 09:39 Cad File: J:\AS02-NCL\PROJ\2122743A_Catherine_Hill\09_CADD\DRAWINGS\LT_0974\Figure 1.dwg

Appendix A

PRM Flow Estimates

Catherine Hill Bay

RATIONAL METHOD HYDROLOGICAL CALCULATIONS

ARI	**1**	$^{10}I_1$ =	52.5 mm/h
C10	**0.4**	Min Tc	**5**
Rainfall Data for:		**Catherine Hill Bay**	

Minimum tc	**5**
Method for tc	**1**

1 = Bransby Williams
2 = Regional tc=$0.76A^{0.38}$
3 = Kinematic Wave

Frequency Factors:

	ARI	1	2	5	10	20	50	100
Rural:	FFy	0.62	0.74	0.88	1	1.12	1.24	1.36
Urban:	FFy	0.8	0.85	0.95	1	1.05	1.15	1.2

Node	CATCHMENT DATA								SUBCAT. t_c				MAIN CHANNEL			TIME OF CONC.		RAINFALL INTENSITY	CA	**FLOW**
	Area	%Imperv.	FFy	C	CA	L	S	n	Bransby.W	Regional	Kinematic	tc	L	v	t	u/s	this			
	ha	%	-	-	ha	m	m/m	-	Min.	Min.	Min.		m	m/s	Min.	Min.	Min.	mm/hr	ha	m^3/s
1a	2.26	0.0%	0.62	0.248	0.56	200	0.08	0.07	7.05	10.8	14.5	7.1	180	1.5	2.0	0	7.1	75.6	0.56	0.12
1b	2.21	0.0%	0.62	0.248	0.55	200	0.08	0.07	7.07	10.7	14.5	7.1	170	1.5	1.9	0	7.1	75.5	0.55	0.12
2	7.57	0.0%	0.62	0.248	1.88	350	0.06	0.07	11.59	17.1	24.6	11.6	370	1.5	4.1	0	11.6	61.6	1.88	0.32
3	8.8	0.0%	0.62	0.248	2.18	450	0.06	0.07	14.67	18.1	29.7	14.7	380	1.5	4.2	0	14.7	55.4	2.18	0.34
4	13.47	0.0%	0.62	0.248	3.34	450	0.07	0.07	13.64	21.3	28.0	13.6	400	1.5	4.4	0	13.6	57.3	3.34	0.53
5	8.19	0.0%	0.62	0.248	2.03	440	0.07	0.07	14.01	17.6	27.3	14.0	420	1.5	4.7	0	14.0	56.6	2.03	0.32
Combined 4+5	21.66	0.0%	0.62	0.248	5.37	850	0.070	0.07	24.56	25.5	28.0	24.6	550	1.5	6.1	0	24.6	43.1	5.37	0.64
																	FINAL PEAK FLOW:			**1.42**

Catherine Hill Bay

RATIONAL METHOD HYDROLOGICAL CALCULATIONS

ARI	**10**	$^{10}I_1$ =	52.5 mm/h
C10	**0.4**	Min Tc	**5**
Rainfall Data for:		**Catherine Hill Bay**	

Minimum tc	**5**
Method for tc	**1**

1 = Bransby Williams

2 = Regional $tc=0.76A^{0.38}$

3 = Kinematic Wave

Frequency Factors:

	ARI	1	2	5	10	20	50	100
Rural:	FFy	0.62	0.74	0.88	1	1.12	1.24	1.36
Urban:	FFy	0.8	0.85	0.95	1	1.05	1.15	1.2

Node	CATCHMENT DATA								SUBCAT. t_c				MAIN CHANNEL			TIME OF CONC.		RAINFALL INTENSITY	CA	**FLOW**
	Area	%Imperv.	FFy	C	CA	L	S	n	Bransby.W	Regional	Kinematic	tc	L	v	t	u/s	this			
	ha	%	-	-	ha	m	m/m	-	Min.	Min.	Min.		m	m/s	Min.	Min.	Min.	mm/hr	ha	m^3/s
1a	2.26	0.0%	1	0.400	0.90	200	0.08	0.07	7.05	10.8	10.8	7.1	180	1.5	2.0	0	7.1	139.0	0.90	0.35
1b	2.21	0.0%	1	0.400	0.88	200	0.08	0.07	7.07	10.7	10.8	7.1	170	1.5	1.9	0	7.1	138.9	0.88	0.34
2	7.57	0.0%	1	0.400	3.03	350	0.06	0.07	11.59	17.1	18.1	11.6	370	1.5	4.1	0	11.6	113.6	3.03	0.96
3	8.8	0.0%	1	0.400	3.52	450	0.06	0.07	14.67	18.1	21.8	14.7	380	1.5	4.2	0	14.7	102.2	3.52	1.00
4	13.47	0.0%	1	0.400	5.39	450	0.07	0.07	13.64	21.3	20.6	13.6	400	1.5	4.4	0	13.6	105.7	5.39	1.58
5	8.19	0.0%	1	0.400	3.28	440	0.07	0.07	14.01	17.6	20.1	14.0	420	1.5	4.7	0	14.0	104.4	3.28	0.95
Combined 4+5	21.66	0.0%	1	0.400	8.66	850	0.070	0.07	24.56	25.5	20.6	24.6	550	1.5	6.1	0	24.6	79.7	8.66	1.92
																			FINAL PEAK FLOW:	**4.23**

Catherine Hill Bay

RATIONAL METHOD HYDROLOGICAL CALCULATIONS

ARI	**100**	$^{10}I_1$ =	52.5 mm/h
C10	**0.4**	Min Tc	**5**
Rainfall Data for:		**Catherine Hill Bay**	

Minimum tc	**5**
Method for tc	**1**

1 = Bransby Williams
2 = Regional tc=$0.76A^{0.38}$
3 = Kinematic Wave

Frequency Factors:

	ARI	1	2	5	10	20	50	100
Rural:	FFy	0.62	0.74	0.88	1	1.12	1.24	1.36
Urban:	FFy	0.8	0.85	0.95	1	1.05	1.15	1.2

Node	CATCHMENT DATA								SUBCAT. t_c				MAIN CHANNEL			TIME OF CONC.		RAINFALL INTENSITY	CA	**FLOW**
	Area	%Imperv	FFy	C	CA	L	S	n	Bransby.W	Regional	Kinematic	tc	L	v	t	u/s	this			
	ha	%	-	-	ha	m	m/m	-	Min.	Min.	Min.		m	m/s	Min.	Min.	Min.	mm/hr	ha	m^3/s
1a	2.26	0.0%	1.36	0.544	1.23	200	0.08	0.07	7.05	10.8	8.9	7.1	180	1.5	2.0	0	7.1	206.8	1.23	0.71
1b	2.21	0.0%	1.36	0.544	1.20	200	0.08	0.07	7.07	10.7	8.9	7.1	170	1.5	1.9	0	7.1	206.7	1.20	0.69
2	7.57	0.0%	1.36	0.544	4.12	350	0.06	0.07	11.59	17.1	14.9	11.6	370	1.5	4.1	0	11.6	169.2	4.12	1.94
3	8.8	0.0%	1.36	0.544	4.79	450	0.06	0.07	14.67	18.1	17.9	14.7	380	1.5	4.2	0	14.7	152.3	4.79	2.03
4	13.47	0.0%	1.36	0.544	7.33	450	0.07	0.07	13.64	21.3	16.9	13.6	400	1.5	4.4	0	13.6	157.5	7.33	3.21
5	8.19	0.0%	1.36	0.544	4.46	440	0.07	0.07	14.01	17.6	16.5	14.0	420	1.5	4.7	0	14.0	155.5	4.46	1.93
Combined 4+5	21.66	0.0%	1.36	0.544	11.78	850	0.070	0.07	24.56	25.5	16.9	24.6	550	1.5	6.1	0	24.6	119.0	11.78	3.90
																	FINAL PEAK FLOW:			**8.57**

Appendix B

Sub-catchment Data

The following sub-catchment data corresponds to XP-SWMM modelling undertaken whereby;

- Sub-catchment A – precinct 5
- Sub-catchment B – precinct 4
- Sub-catchment C – precinct 3
- Sub-catchment D – precinct 2
- Sub-catchment E – precinct 1A
- Sub-catchment F – precinct 1B

Node	Pervious (ha)	Slope (m/m)	Impervious (ha)	Slope (m/m)	Roof Area (ha)
A1			0.026	0.020	
A2	0.075	0.066	0.097	0.051	0.10
A3	0.090	0.069	0.108	0.046	0.12
A4					
A5	0.109	0.080			
A6					
A7					
A8					
A9			0.055	0.120	
A10					
A11	0.090	0.066	0.030	0.066	0.12
A12	0.105	0.066	0.035	0.066	0.14
A13	0.060	0.090	0.060	0.065	0.08
A14	0.075	0.087	0.107	0.062	0.10
A15	0.030	0.068	0.010	0.068	0.04
A16	0.045	0.068	0.015	0.068	0.06
A17	0.030	0.080	0.086	0.080	0.04
A18			0.047	0.080	
A19			0.071	0.076	
A20			0.031	0.070	
A21	0.120	0.045	0.092	0.035	
A22			0.100	0.059	
A23	0.060	0.058	0.084	0.029	0.08
A24	0.060	0.058	0.084	0.031	0.08
A25	0.208	0.064	0.059	0.015	
A26	0.075	0.075	0.075	0.063	0.10
A27	0.075	0.066	0.087	0.032	0.10
A28	0.060	0.066	0.091	0.033	0.08
A29	0.150	0.064			
A30	0.140	0.064			
A31	0.075	0.064	0.075	0.046	0.10
A32	0.075	0.064	0.095	0.050	0.10
A33	0.045	0.110	0.015	0.110	0.06
A34	0.045	0.100	0.015	0.100	0.06
A35	0.111	0.110			
A36					

Node	Pervious (ha)	Slope (m/m)	Impervious (ha)	Slope (m/m)	Roof Area (ha)
B1	0.060	0.058	0.180	0.015	0.08
B2	0.045	0.058	0.081	0.025	0.06
B3			0.089	0.075	
B4	0.095	0.070	0.073	0.070	
B5	0.076	0.071	0.056	0.068	
B6	0.068	0.066	0.048	0.066	
B7					
B8	0.040	0.041	0.049	0.030	
B9			0.139	0.030	
B10					
B11	0.060	0.091	0.090	0.053	0.08
B12					
B13					
B14	0.075	0.051	0.403	0.075	0.10
B15					
B16					
B17			0.030	0.070	
B18			0.026	0.055	
B19	0.060	0.068	0.062	0.043	0.08
B20	0.060	0.068	0.560	0.043	0.08
B21	0.060	0.075	0.061	0.044	0.08
B22	0.060	0.075	0.074	0.030	0.08
B23	0.060	0.075	0.093	0.048	0.08
B24					
B25	0.060	0.062	0.020	0.062	0.08
B26	0.350	0.040			
B27	0.230	0.040			
B28	0.168	0.055			
B29	0.227	0.064			
B30					
B31	0.075	0.045	0.080	0.039	0.10
B32	0.045	0.090	0.065	0.055	0.06
B33	0.060	0.060	0.020	0.060	0.08
B34	0.045	0.061	0.073	0.038	0.06
B35	0.030	0.090	0.010	0.090	0.04
B36					
B37	0.045	0.035	0.015	0.035	0.06
B38	0.030	0.058	0.048	0.033	0.04
B39	0.060	0.058	0.077	0.037	0.08
B40	0.060	0.058	0.077	0.045	0.08

Node	Pervious (ha)	Slope (m/m)	Impervious (ha)	Slope (m/m)	Roof Area (ha)
B41			0.055	0.062	
B42			0.049	0.075	
B43			0.059	0.075	
B44	0.075	0.062	0.080	0.046	0.10
B45	0.075	0.063	0.089	0.047	0.10
B46	0.090	0.040	0.030	0.040	0.12
B47	0.090	0.035	0.030	0.035	0.12
B48	0.045	0.067	0.057	0.054	0.06
B49	0.045	0.075	0.075	0.059	0.06
B50	0.045	0.075	0.015	0.075	0.06
B51	0.030	0.075	0.010	0.075	0.04
B52	0.045	0.043	0.053	0.034	0.06
B53	0.045	0.050	0.065	0.036	0.06
B54	0.015	0.080	0.005	0.080	0.02
B55	0.480	0.100			
B56	0.060	0.066	0.074	0.047	0.08
B57	0.150	0.066	0.187	0.046	0.20
B58	0.045	0.110	0.072	0.071	0.06
B59	0.060	0.110	0.099	0.073	0.08
B60	0.060	0.055	0.020	0.055	0.08
B61	0.060	0.055	0.020	0.055	0.08
B62					
B63	0.075	0.067	0.025	0.067	0.10
B64	0.075	0.062	0.025	0.062	0.10
B65	0.250	0.075			
B66	0.290	0.075			
B67					
B68	0.200	0.005			
B69					
B70	0.120	0.075	0.040	0.075	0.16
B71					

C1			0.038	0.050	
C2			0.020	0.055	
C3			0.090	0.055	
C4			0.028	0.050	
C5			0.050	0.050	
C6			0.030	0.046	
C7	0.210	0.050	0.120	0.051	
C8			0.035	0.046	
C9					

Node	Pervious (ha)	Slope (m/m)	Impervious (ha)	Slope (m/m)	Roof Area (ha)
C10					
C11			0.018	0.070	
C12	0.060	0.090	0.110	0.062	0.08
C13	0.060	0.100	0.079	0.064	0.08
C14					
C15	0.075	0.048	0.084	0.048	0.10
C16	0.030	0.055	0.030	0.048	0.04
C17	0.045	0.055	0.075	0.048	0.06
C18	0.030	0.050	0.010	0.050	0.04
C19	0.175	0.044	0.015	0.050	0.06
C20	0.030	0.055	0.035	0.055	0.04
C21	0.045	0.055	0.071	0.039	0.06
C22	0.045	0.035	0.015	0.035	0.06
C23	0.045	0.036	0.015	0.036	0.06
C24	0.045	0.053	0.043	0.030	0.06
C25	0.045	0.053	0.062	0.037	0.06
C26	0.045	0.037	0.101	0.032	0.06
C27	0.030	0.045	0.010	0.045	0.04
C28	0.045	0.045	0.103	0.043	0.06
C29	0.090	0.043	0.086	0.043	0.12
C30	0.045	0.050	0.015	0.050	0.06
C31	0.045	0.050	0.015	0.050	0.06
C32	0.075	0.055	0.115	0.033	0.10
C33	0.090	0.055	0.030	0.055	0.12
C34	0.090	0.066	0.097	0.052	0.12
C35			0.055	0.030	
C36	0.480	0.028	0.090	0.030	0.64
C37					
C38	0.170	0.075			
C39	0.220	0.050			
C40	0.170	0.050			
C41	0.024	0.053			
C42	0.350	0.045			
C43			0.079	0.020	
D1	0.045	0.050	0.040	0.043	0.06
D2	0.075	0.041	0.042	0.036	0.10
D3	0.045	0.015	0.041	0.030	0.06
D4	0.045	0.011	0.042	0.017	0.06
D5	0.075	0.055	0.025	0.055	0.10
D6	0.060	0.056	0.085	0.051	0.08

Node	Pervious (ha)	Slope (m/m)	Impervious (ha)	Slope (m/m)	Roof Area (ha)
D7			0.060	0.050	
D8					
D9			0.036	0.043	
D10			0.029	0.035	
D11	0.150	0.031	0.030	0.035	
D12					
D13			0.051	0.070	
D14	0.045	0.120	0.069	0.067	0.06
D15	0.060	0.116	0.093	0.062	0.08
D16					
D17	0.090	0.070	0.046	0.031	0.12
D18	0.120	0.075	0.040	0.075	0.16
D19	0.045	0.075	0.015	0.075	0.06
D20			0.050	0.051	
D21	0.060	0.055	0.050	0.053	
D22	0.108	0.055	0.078	0.052	
D23	0.045	0.059	0.063	0.043	0.06
D24	0.045	0.061	0.067	0.052	0.06
D25	0.045	0.050	0.015	0.050	0.06
D26	0.045	0.050	0.015	0.050	0.06
D27	0.045	0.060	0.053	0.048	0.06
D28	0.045	0.051	0.087	0.042	0.06
D29	0.045	0.050	0.058	0.040	0.06
D30	0.060	0.051	0.093	0.045	0.08
D31	0.045	0.056	0.015	0.056	0.06
D32	0.045	0.055	0.015	0.055	0.06
D33	0.045	0.055	0.054	0.055	0.06
D34	0.060	0.057	0.090	0.057	0.08
D35	0.045	0.049	0.074	0.041	0.06
D36	0.045	0.050	0.072	0.042	0.06
D37	0.060	0.055	0.020	0.055	0.08
D38	0.045	0.100	0.086	0.057	0.06
D39			0.260	0.090	
D40			0.027	0.030	
D41			0.056	0.045	
D42	0.045	0.071	0.044	0.053	0.06
D43	0.045	0.071	0.056	0.056	0.06
D44			0.073	0.051	
D45	0.045	0.051	0.015	0.051	0.06
D46	0.120	0.055	0.040	0.055	0.16

Node	Pervious (ha)	Slope (m/m)	Impervious (ha)	Slope (m/m)	Roof Area (ha)
E1	0.105	0.035	0.035	0.035	0.14
E2	0.120	0.037	0.040	0.037	0.16
E3	0.105	0.064	0.067	0.064	0.14
E4					
E5	0.075	0.075	0.107	0.025	0.10
E6	0.075	0.040	0.076	0.030	0.10
E7	0.075	0.031	0.081	0.031	0.10
E8	0.060	0.010	0.020	0.010	0.08
E9	0.030	0.075	0.010	0.075	0.04
F1			0.028	0.033	
F2			0.063	0.035	
F3			0.082	0.033	
F4			0.071	0.029	
F5			0.068	0.032	
F6	0.030	0.090	0.065	0.089	0.04
F7					
F8					
F9			0.063	0.035	
F10	0.060	0.091	0.088	0.028	0.08
F11	0.090	0.090	0.098	0.030	0.12
F12	0.045	0.102	0.084	0.031	0.06
F13			0.025	0.036	
F14	0.090	0.089	0.079	0.034	0.12
F15			0.063	0.034	
F16	0.120	0.087	0.040	0.087	0.16

Appendix C

DWE Assessment

NSW Government

DEPARTMENT OF WATER AND ENERGY

Your Ref: S06/00813
Our Ref: ER7171E

27 September 2007

Director
Strategic Assessments
Department of Planning
GPO Box 39
SYDNEY NSW 2001

Attention: Liz Peterson

Dear Madam

Revised Concept Plan (MP06_ 0330)
Project Applications (MP07_0107, MP07_0108, MP07_0109 & MP07_0110)
Catherine Hill Bay/ Moonee and Gwandalan

I refer to your letter of 31 August 2007 and accompanying information in these matters.

The department (former Department of Natural Resources) in letter of 26 February 2007 provided environmental assessment requirements for the project proposals for Catherine Hill Bay/ Moonee Colliery site and Gwandalan. These requirements remain valid and applicable for the revised Concept Plan and Project Applications. The information in the referral of 31 August 2007 discusses in general terms the assessment requirements of the department.

The principal issues for the Department of Water and Energy are approval requirements under Part 5 of the *Water Act 1912* (if applicable), consideration of State Government Groundwater Policies, groundwater, potential impacts on groundwater dependent ecosystems and riparian protection.

Should there be any further enquiry in this matter please contact Mark Mignanelli, Manager Major Projects, Assessments and Planning on telephone 4904 2549 at this office.

Yours sincerely

Peter Johns
Project Officer
Major Projects and Planning
Newcastle

NSW Government
DEPARTMENT OF NATURAL RESOURCES

26 February 2007

Your ref: File S06/00813
Our ref: ER7171

Director
Strategic Assessment
Department of Planning
GPO Box 39
SYDNEY NSW 2001

Received
28 FEB 2006
Strategic Assessment

Attention: Liz Peterson

Dear Madam

MP 06_0330 - State Significant Site Study & Concept Plan Environmental Assessment Project Proposals for Catherine Hill Bay/Moonee Colliery Site and Gwandalan

Further to your referral of 29 December 2006 for these proposals, the Department of Natural Resources (DNR) provides the following for your consideration:

Groundwater

The development of the proposed Catherine Hill Bay/Moonee Colliery site requires the provision of major service infrastructure. The environmental assessment (EA) does not address the issue of groundwater interception, potential impacts on groundwater (including groundwater dependent ecosystems) and approval requirements under water legislation. The EA should therefore detail if the proposed service infrastructure works (including existing and proposed stormwater storage reservoirs) involve excavations that intercept the groundwater during construction or require approval for bores or wells for dewatering purposes. Such development requires licensing under Part 5 of the *Water Act 1912.*

It is a DNR requirement that storage reservoir structures be lined to ensure that infiltration to groundwater does not occur. The EA must therefore provide details of these structures including the method of lining.

With groundwater interception the EA specifically needs to provide details of:

- Proposed works likely to intercept groundwater;
- Any proposed groundwater extraction, including purpose, location and construction details of all proposed bores;
- Proposed method of disposal of waste water and approval from the relevant authority;
- The existing groundwater users (including the natural environment) within the area of the proposed development and any potential impacts on these users;
- Measures to prevent groundwater pollution, so that future remediation is not required; and
- Protective measures for groundwater dependent ecosystems.

The EA should also consider the relevant NSW State Government Groundwater Policies when addressing these potential impacts. The policies include:

- NSW Groundwater Policy Framework Document - General
- NSW Groundwater Quantity Management Policy Advice
- NSW Groundwater Quality Protection Policy
- NSW Groundwater Dependent Ecosystems Policy

At the proposed Catherine Hill Bay/Moonee Colliery site, a long-term groundwater monitoring program is required to protect the State Environmental Planning Policy 14 - Coastal Wetland located to the south of the proposed development. This program should consist of a number of appropriately located sentinel bores with piezometers at suitable depths. Monitoring parameters should include contaminants associated with urban development including those emanating from road surfaces. The EA is required to provide details of this monitoring program.

For information on approval requirements under the water legislation or groundwater policies, please contact Hemantha De Silva, Senior Natural Resource Officer (Licensing North Branch) at this office on 4904 2525.

Riparian Protection
Both proposed development sites are traversed by a number of watercourses. The EA should address riparian protection issues and include:

- A detailed description of the proposed development including all proposed construction, clearing, draining, excavation and filling;
- An evaluation of the proposed methods of excavation, construction and material placement;
- A detailed description of all potential environmental impacts of the proposed development in terms of vegetation, fauna, sediment movement, water quality, and hydraulic regime;
- A description of the design features to be incorporated into the proposed development to guard against long term actual and potential environmental disturbances, particularly in respect of maintaining the natural hydrological regime and sediment movement patterns; and
- A description of the measures to be implemented to guard against actual and potential environmental disturbances during the construction of the proposal, particularly in respect of maintaining the natural hydrological regime and sediment movement patterns.

Requirements for the clearing of native vegetation should be directed to the Hunter-Central Rivers Catchment Management Authority, Private Bag 2010, Paterson NSW 2421.

If you require clarification of the matters raised, please contact me on 4904 2549.

Yours sincerely

M. Mignanelli

Mark Mignanelli
Manager, Major Projects & Assessments
Licensing & Policy Strategy Branch
Newcastle