2 October 2012

Director General
Department of Planning and
Infrastructure
23-33 Bridge Street
SYDNEY NSW 2000

Attention: Matthew Daniel

Dear Sir

MODIFICATION TO DA 4
SECTION 75W MODIFICATION LEWIS LAGOON
PENRITH LAKES SCHEME

I refer to the Section 75W modification lodged with the Department of Planning and Infrastructure (DP&I) for the continued use of Lewis Lagoon as a water quality control pond and Felicity Greenway's email of 16 March 2012 attaching the submissions from the Environment Protection Authority (EPA) and Penrith City Council (PCC). Attached is PLDC's response to the issues raised in those submissions for your consideration in determining the modification application.

The below information contains a summary of PLDC's responses to EPA and PCC, an outline of the role and context of Lewis Lagoon in relation to the 2012 Water Management Plan (WMP) (currently before the Department for its consideration and approval), a synopsis of the design brief to Browns Consulting in 2008, and a summary of the performance of ecosystem services against NSW State Government water quality criteria.

Environment Protection Authority (EPA)

The EPA in its letter dated 29 February 2012 concurs with the proposed modification and does not seek to impose any further conditions.

Penrith City Council (PCC)

Given the comments and issues raised by PCC, PLDC sought further advice from the designing engineers, Browns Consulting, on Lewis Lagoon as an effective water quality control pond. Browns Consulting concludes that Lewis Lagoon was designed and currently operates satisfactorily as a water quality control pond ensuring runoff from the eastern catchment is effectively managed prior to entry into the Wildlife Lake.

On the basis of this independent advice it is clear that Lewis Lagoon has, and will continue to have, a positive role in achieving water quality targets for the Wildlife Lake. A copy of the Browns Consulting Report dated 6 February 2012 is attached.

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The role and context of Lewis Lagoon in the management of water quality is further described in the draft Water Quality Strategy (WQS) submitted as part of the 2012 WMP as discussed below.

2012 Water Management Plan

Contained within Stage 1 of the 2012 WMP is the draft WQS and associated reports which will inform the upcoming water quality modelling and consultation process being undertaken by PLDC jointly with relevant Government agencies and stakeholders prior to submission of the Stage 2 WMP (dealing specifically with water quality).

This report provides an overview analysis of the information collected during development of the Scheme, along with the results of independent water quality experts engaged by PLDC. The WQS outlines the historical water quality data and ecological monitoring undertaken over the past few decades of operations. Section 4.1.3.1 of the WQS provides a detailed analysis of the water quality associated with Lewis Lagoon.

Design & Operational Strategy

The Lewis Lagoon Design Strategy and consultant brief centred on the use of the lagoon and contributory landscape as being able to provide additional pre-treatment of runoff from the extensive eastern catchment environs prior to entry into the Scheme.

Lewis Lagoon as a treatment pond receives water from the developed areas east of the Scheme and especially the North Scheme, Vincent Creek and Andersons Creek catchments. These catchments are undergoing increasing environmental strain due to ongoing development and land clearing. Land use in these areas includes residential, rural residential, light industrial, chemical waste management and commercial agricultural production. The runoff entering the Scheme and ultimately the Hawkesbury / Nepean River system from these catchments is typically high in gross pollutants, nutrients, noxious aquatic weeds from private dams and bacterial runoff from septic tanks and animal husbandry. PCC has for sometime been reviewing the land use, weed and stormwater management of the entire catchment to ultimately consider mitigating measures and implement a community awareness program. PLDC understands that PCC's consultant, AECOM, is still preparing its final report on Stormwater and Runoff management in this catchment.

Without controls in place on off-Scheme lands for managing pollutants, PLDC and its consultant designed the contributory landscape flowing into Lewis Lagoon to contain a number of minor ponds and vegetation buffers of suitable size to assist with the reduction of pollutants prior to entry into and residency within Lewis Lagoon treatment pond. This residency is the final stage prior to water overtopping into the Wildlife Lake and combining with waters from other successful treatment trains within the Scheme.

After installation of the Landscape and treatment ponds in 2008, PLDC has monitored the development and effectiveness of the Lewis Lagoon treatment train. In line with the relevant guidelines and criteria, monitoring results show that since this time Lewis Lagoon has progressed to successfully achieve:

- primary contact for bacterial pollution 99% of the time,
- primary contact for cyano bacterial blooms 90.7% of the time, and
- 69% median reduction in Total Phosphorus loading.

These results have primarily been achieved through the implementation of the original landscape and detention basin design and in particular the planting of submerged and emergent macrophytes around the lagoon. These vegetation buffers have successfully dominated the water body, and surrounding areas, polishing runoff and maintaining the high water quality received by the Wildlife Lake from Lewis Lagoon.

The major advantage of this treatment train is that pollutants are intercepted prior to entry into the Wildlife Lake and more importantly prior to entry into the Hawkesbury Nepean River system through the north of the Scheme and potentially playing an important role in protecting the natural resources of the river.

In summary, PLDC has undertaken extensive water quality studies and flood modelling to optimise the implementation of a whole-of-site Water Management Plan. The Scheme water management strategy is based largely on environmental outcomes to minimise, or ideally eliminate the intervention of either mechanical or chemical means to achieve water quality objectives. It respects the original characteristics established in a floodplain environment where practically possible while delivering a recreational and environmental outcome of high standard.

PLDC is strongly of the view that Lewis Lagoon currently provides and will continue to provide a vital role in achieving desirable water quality for the Wildlife Lake.

If you have any further queries, please do not hesitate to call Mr Joe Bevacqua on 4734 8141.

Yours Sincerely

Mick O'Brien
Project Director

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LEWIS LAGOON – SECTION 75W

USE OF LEWIS LAGOON AS A WATER QUALITY CONTROL POND

RESPONSES TO COMMENTS RECEIVED FROM PENRITH CITY COUNCIL AND ENVIRONMENT PROTECTION AUTHORITY

PENRITH CITY COUNCIL

ITEM	COMMENT	RESPONSE
1)	**A. POND DESIGN** **i. Water volume** The length of time water is retained in a pond is a key variable in determining how effective the pond will be in trapping certain pollutants. The greater the retention time the greater the opportunity for sedimentation of particulate material and the action of other purification mechanisms. In Browns Consulting expert advice (dated 6 February 2012) details of the hydraulic residence time are provided and appear satisfactory, although it is noted these are 'estimated' and not actual results for Lewis Lagoon. It is also not clear if a further 20% volume was added to allow for sedimentation in calculating the size (2.4 ha) of the pond.	A further volume capacity was added to the design to allow for the largest catchment (Southern Catchment via Vincent Creek) to have adequate residency time. This more than compensates for the localised catchment under normal operating conditions. As per Browns Consulting advice of 6 February 2012 which states that the hydraulic residence time is estimated at 33 days, whereas 13 days is typically the minimum desirable time for good treatment. This is more than sufficient for the adequate removal of suspended solids. Furthermore, Browns Consulting adds, that the permanent pool within the Lagoon will also minimise the opportunity for re-suspension of sediments and any attached pollutants.
2)	**ii. Pond configuration** It is desirable that inlet structures be located as far from outlet structures	In the design of Lewis Lagoon PLDC aimed to have minimum impact on the existing ecosystem and landforms. The design strategy called for the incorporation of natural drainage lines, creek lines and minor ponds. The inlet from the east was an existing natural

ITEM	COMMENT	RESPONSE
	as possible to maximise retention time and to ensure that the entire water body is utilised for pollution control. When the Wildlife Lake is fully constructed, it is important that the location of the outlet structure in Lewis Lagoon is considered relevant to the inlet locations (currently three inlets). The location of the current outlet (under Castlereagh Rd) is not likely to allow adequate retention times, particularly for flows entering from the east. It is also stated that high-flows currently bypass directly into the Wildlife lake. Consideration should be given to ensure that the potential for treatment bypass is greatly reduced, with details provided on a suitable criteria for the magnitude of high flow events that need to bypass dependant on flooding considerations.	drainage line from the escarpment catchment and its flow path was not altered in the construction of the lagoon. The lagoon accepts water from 15 ponds/dams of varying sizes along two creeks/drainage lines that merge at the three inlets into Lewis Lagoon. The locations of these inlets are also set by the topography of the area. In the MUSIC modelling undertake by Browns, the hydraulic residence time for Lewis Lagoon is estimated at 33 days, whereas 13 days is typically the minimum desirable time for good treatment under normal operating conditions. The design parameters sought to maximise the detention time of the largest catchment (southern) whilst being constrained by the Castlereagh Road alignment. Further consideration of the water quality under different flow regimes will be undertaken during the water quality modelling being undertaken by Sinclair Knights Merz.
3)	**iii. Macrophytes** Macrophytes (either emergent or submergent) enhance the pollutant removal potential of ponds by filtering finer particles and taking up nutrients. They can also help to prevent scouring of the sediments during high flows. The expert advice document states that macrophyte growth 'appears' to be evident, but it is not clear whether the configuration and design of the pond incorporates sufficient shallow areas to encourage the growth of beds of emergent and submergent aquatic macrophytes. A review of recent aerial photography indicates the pond is mainly open water. As a general guide, between 10 and 30 percent of the total surface area of a pond should be set aside for macrophyte growth, particularly in the upper reaches. I think the current ratio of open water to fringing	PLDC has undertaken extensive research to investigate the coloniser species needed to assist with the fabrication and reinstatement of the floodplain pre-contact history landscape and plant communities. The design strategy called for minimum intervention to the natural drainage lines and connections to fringes of natural vegetation. The lagoon itself was vegetated with coloniser and pioneer species of both submergent and emergent macrophytes. The biodiversity development was assisted by the connections to existing wetlands and natural drainage course. As part of the routine monitoring of ecosystem development, PLDC undertook a Macrophytes survey in September 2011 which demonstrated that Lewis Lagoon has surface coverage of

ITEM	COMMENT	RESPONSE
	macrophyte vegetation is likely to lead to poorer water quality outcomes and a risk of algal blooms in the long term. Best practice design incorporates benching or bands of shallow and deep water macrophytes perpendicular to the direction of flow so as to guarantee contact time with the vegetation, and the associated biological treatment. In its current design, the pond is relying heavily on physical treatment. Large open water ponds with minimal biological treatment are much more prone to algal blooms, low dissolved oxygen and associated issues such as temperature inversions.	Macrophyptes which exceeds the 10-30% guide suggested in Council's submission. In addition, as discussed in the draft Water Quality Strategy Lewis Lagoon has developed as a water quality control pond being able to: • Achieve Primary Contact for bacterial pollution 99% of the time and • Achieve Primary Contact for cyanobacterial blooms 90.7% of the time • Achieve a 69% median reduction in Total Phosphorus loading.
4)	**iv. Open Water zone** No details have been provided on the depth levels of the pond. To minimise the risk of temperature stratification, best practise suggests the maximum depth should not exceed 3m.	The lagoon has variable depth with it deepest point being approximately 5 metres based on an operating level of RL 15 and an average depth of 3.5 metres (Astute Surveying – Hydrographic Survey September 2012). Over 35% of the lagoon is within the optimum plant growing zone which creates a macrophyte dominant system rather than an algal dominated system which will assist in maintaining water quality. Stratification has not been an issue as evidenced by the water quality results referred to in point 3 above.
5)	**v. Edge Treatment**	Lewis Lagoon contains natural soft edges to encourage a variety of

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	The expert advice document states that vegetation along the batters provides nutrient uptake. In water treatment ponds natural soft edges should be used to encourage a variety of shoreline plants. The shoreline edge is also to be free draining to discourage isolated pockets of water (potential breading area for mosquitoes). The edge should be capable of withstanding wave action erosion. In the supporting documentation, no details were provided on the batter slopes. An edge side slope of 1 in 15 should be provided in areas where it is desirable to establish aquatic macrophytes to trap pollutants, provide bank stability, and provide habitat. This also provides for a gentle slope that doesn't pose a safety risk.	shoreline plants; it is also free draining to reduce the breeding areas for mosquitoes. The batter slopes underwater are generally 1V:6H which are consistent with the Penrith Lakes Land Rehabilitation Manual and Geotechnical advice for bank stability. No hard armour wave protection is required in Lewis Lagoon as the fetch lengths are insufficient to allow the generation of waves large enough to damage the shoreline. The Browns Consulting report dated 6 February 2012 clearly states that Lewis Lagoon was designed and currently operates as a water quality control pond. This is further supported by the monitoring undertaken by PLDC as discussed in point 3 above.
6)	**Recommendation:** The design of the pond should take consideration of the above, and further details should be provided to demonstrate that the pond will function appropriately in the long term as a water quality control measure.	Lewis Lagoon has been designed and constructed as a water quality control pond. The advice received from Browns Consulting together with monitoring results undertaken by PLDC indicate that the Lagoon is functioning well as a water quality control pond, therefore protecting the future receiving waters of the Wildlife Lake.
7)	**B. FLOODING CONSIDERATION** No details have been provided on how flooding considerations have been taken into account in the design of the pond. As the pond was initially designed and constructed for the Castlereagh Rd upgrade, any changes within the catchment that could have altered the drainage or flow paths subsequent to the road upgrade need to be taken into account in how the pond will function in the long term. Flood protection requirements for	The design of Lewis Lagoon considered local catchment inflows at the time of the Castlereagh Road upgrade and was constructed accordingly. Any subsequent changes to catchments and drainage or flow paths outside of the scheme would have had to show that they had no impact on downstream properties (including on Lewis Lagoon) prior to being approved by Council.

ITEM	COMMENT	RESPONSE
	other adjacent land uses should also be considered where appropriate.	
8)	**Recommendation**: To adequately review potential site flooding issues, further details should be provided and the proposal should be referred to Council's Engineering Stormwater Supervisor for further assessment.	The location of the Lakes Scheme on a floodplain requires the overall Scheme, including Lewis Lagoon to be designed to adequately cope with flooding from local catchments and the Nepean River system. Local catchment flooding is managed through the Farrell's Creek diversion works that have been approved and constructed. Extensive flood studies have been undertaken by Cardno over several years. These studies can be found in the Stage 1 2012 Water Management Plan. These studies have not revealed any adverse flooding impacts associated with Lewis Lagoon.
9)	**C. MAINTENANCE REQUIREMENTS** No details have been provided on the proposed maintenance and monitoring of the pond. Suitable access should be provided for maintenance machinery, and the pond design should incorporate an emergency drainage facility to enable the pond to be drained if required.	A suitable monitoring and maintenance plan will be developed and provided when this area is dedicated to Government. It is not practical to incorporate an emergency drainage facility in Lewis Lagoon as it is not a perched lagoon. If water needs to be removed from Lewis Lagoon a pump will need to be used, with water able to be transferred directly to the Wildlife Lake or Smith Creek.
10)	**Recommendation:** A suitable monitoring and maintenance plan is to be developed and implemented to ensure the continued water treatment functionality of the pond.	PLDC is developing Operational Management Plans for the completed landforms and landscapes to direct their ongoing management. These Plans will provide information to assist the development of future Management Plans and Maintenance Programs following dedication to Government. Technical Specifications have also been developed and outline how a particular task or operation should be carried out to ensure current industry standards and guidelines are met. They cover a range of activities including weed management (aquatic and terrestrial), land surface stabilisation, land

ITEM	COMMENT	RESPONSE
		rehabilitation and maintenance works (aquatic and terrestrial) amongst others. These Plans will be provided to Government upon dedication of the Scheme lands.

Environment Protection Authority Comments

ITEM	COMMENT	RESPONSE	REFERENCE
1	The EPA has reviewed the information provided and concurs with the proposed modification and will not be providing any conditions of approval as the modification will not trigger a change to PLDC's Environment Protection Licence.	Noted	
2	Given that there may be poorly maintained unsewered dwellings and grazing livestock in the sub–catchment of Lewis Lagoon PLDC should be mindful of the possibility of coliform contamination.	As the sub-catchment generally lies external from the Penrith Lakes Scheme boundary, PLDC is unable to control any coliform contamination from any unsewered dwellings or grazing stock in the sub-catchment entering the lagoon. However, Lewis Lagoon has been designed with adequate detention time to allow the coliform concentration to be reduced through natural die off of the bacteria.	

Our Ref: X05054

BROWN
Smart Consulting

Manager Planning and Infrastructure
Penrith Lakes Development Corporation
89 – 151 Old Castlereagh Road, Castlereagh
NSW 2749

6 February 2012

Attention: Joe Bevacqua

Dear Mr Bevacqua

Penrith Lakes North Scheme Drainage
Lewis Lagoon

The Penrith Lakes Scheme North Scheme Drainage Concept Design 2005 identified the use of Lewis Lagoon to provide additional pre-treatment for the North Scheme Drainage. The North Scheme Drainage concept and redesign of Lewis Lagoon was undertaken as part of the Castlereagh Road realignment project as Lewis Lagoon had to be moved away from the proposed road alignment. The Lewis Lagoon currently performs as a water quality control pond and treats the water from the upstream catchment prior to discharging into the Wildlife Lake, this letter provides clarification of the purpose of the Lagoon as part of the Penrith Lakes Scheme.

This addendum to the report provides a response to the Department of Planning & Infrastructure request for assessment of Lewis Lagoon as a functioning water quality treatment pond (dated 16/12/2011).

The scheme directs flows from North of Vincent Creek, Anderson Creek catchment and the North Catchment South of Smith Road to a water body identified as Lewis Lagoon, refer to Figure 1. Landuse throughout the catchment is generally rural and rural residential with sections of the Castlereagh Road Relocation also draining to the lagoon.

The flows pass through a number of minor ponds and vegetated buffer strips prior to entering Lewis Lagoon. And as a result the flows off the catchment experience a high level pre-treatment; resulting in reduced velocities, which allow sediments and other attached pollutant to settle and infiltrate the soils. Further treatment is also provided via filtration through the dense vegetation. Additional nutrient uptake associated with the dense vegetation would occur.

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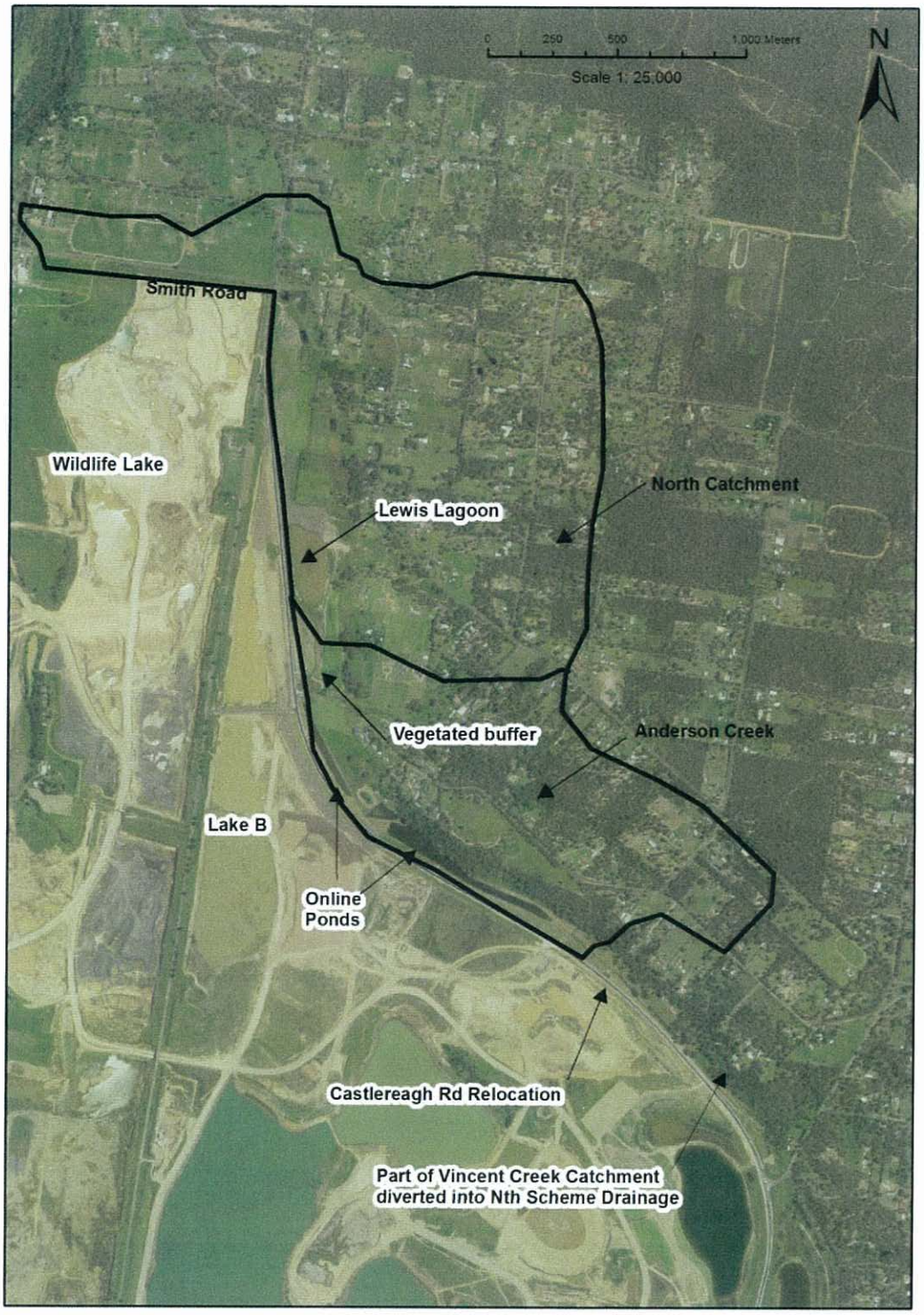


Figure 1: Aerial photo

Figure 2: Vegetated buffers upstream of Lewis Lagoon

The flow from the ponds and buffer strips enters Lewis Lagoon, flows from the East enter via a swale and flows along Anthony Creek and adjacent to Castlereagh Road are deflected into the pond via a constructed swale, high flows bypass are directed under Castlereagh Road into the Wildlife Lake. The pond achieves its pollutant removal primary through sedimentation; the low velocities allow for the settlement of sediment and attached pollutants. Evidence of macrophyte growth appears to be present in the pond, and further vegetation along the batters provides nutrient uptake.

Figure 3: Vegetated batters surround Lewis Lagoon

The treatable flows are detained in the Lewis Lagoon, until the water level builds above the outlet and discharge into the Wildlife Lake.

Based on sedimentation principles involving hydraulic efficiency, this pond is expected to remove 100% of sediment as fine as medium silt (32 μm).

The hydraulic residence time is estimated at 33 days (13 days is typically the minimum desirable time for good treatment), which accounts for the adequate removal of suspended solids. The estimated hydraulic loading rate of the pond is 25 m3/m2/y, which is recommended by the NSW EPA (1997) to achieve TN removal.

The MUSIC model was developed as part of the work undertaken in 2005. Lewis Lagoon was modelled as a pond and included the buffer strips. The modelling showed removal of total suspended solids, total phosphorus and total nitrogen. Following removal efficiencies were taken from the modelling results;

	Sources	Outflow from Pond	Removal Efficiency (%)
All of the North Drainage Scheme Treatment Train			
Total Suspended Solids (kg/yr)	97,400	14,400	85.2
Total Phosphorus (kg/yr)	216	84.5	60.9
Total Nitrogen (kg/yr)	1,630	913	44.1

Source: Penrith lakes Scheme North Scheme Drainage Concept Design (Brown 2005)

The results show effective removal of suspended solids and nutrients. The results are considered conservative as they only allow for sedimentation and do not include the removal associated with nutrient uptake or any ultra violet disinfection that may occur within the pond.

The stormwater discharge from the proposed 2.4 ha pond meets ANZECC guidelines for recreation water quality (only TSS is relevant). Faecal Coliforms is another criteria, although this cannot be modelled in MUSIC (although bacteria often attaches onto particulates so removal of TSS also has some positive removal of bacteria). Furthermore, ANZECC criteria are only applicable to the receiving water body, in this case the water quality in the Wildlife Lake.

No physical stressor trigger values are provided for wetlands, which would be more appropriate for Lewis lagoon. Wetlands would be expected to exhibit higher stressor values, such as Lewis Lagoon.

During the concept design an analysis was undertaken to size the lagoon to optimise the treatment performance while ensuring flow into the Wildlife Lake. The 2.4 ha pond, provides a improvements to the water quality and ensures low flows reach the Wildlife Lake.

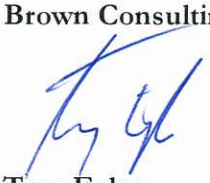
The permanent pool within the Lewis Lagoon also minimises the opportunity for re-suspension of sediments and any attached pollutants.

SUMMARY

Overall, the Lewis Lagoon meets 'best practice' sizing methods such as hydraulic residence and hydraulic loading rate assessments such as that recommended by the EPA. The estimated water quality performance in MUSIC achieves ANZECC guidelines for recreational water quality with regard to suspended solids (measure of turbidity).

The Lewis Lagoon was designed and currently operates as a water quality control pond.

Yours sincerely
Brown Consulting (NSW) Pty Ltd



Troy Eyles
Senior Engineer