

84, 96	That independent inspections are carried out by appropriately qualified Environment Protection Authority and National Parks and Wildlife staff with local representatives, due to the restricted access that applies to the area.	SCA would support any independent auditing of the borefield construction and operational practices
18, 28, 30	The so-called "peer review" is nothing more than the typical rubberstamping by a bunch of acolytes... which as you well know the bureaucracy cynically uses to substantiate the pre-ordained outcome.	Comment noted
133	I would point out that the major report conducted by SMEC on the Groundwater Dependent Ecosystems (GDEs) in the Kangaloon Aquifer has not been included in the Environment Assessment. "Baseline Groundwater Dependent Ecosystems Evaluation Study" (September 2006). Thus, the Dept of Planning has been denied the opportunity to review the thorough research conducted by those consultants, and the damning critique of the SCA's failures in regard to identifying the extent of the "dependence" of these precious habitats upon the groundwater, by Eamus et al. That is why I have referred to just a few of these comments, to at least alert you to the existence of such devastating critiques, by one of Australia's leading experts in the subject of GDEs.	The Eamus peer review attaches to the original SMEC baseline study from Spring 2006 prior to any of the later studies being concluded. Subsequent studies have indicated that there is no dependence associated with upland swamps, only minor connectivity with stream baseflows, and no known connectivity with terrestrial vegetation. Ecosystem monitoring will be part of the monitoring program if the borefield is constructed and operational.  There is sufficient certainty about groundwater dependence (or the lack thereof) to proceed with borefield development.
133	In regard to the overall Borefield proposal, we contend that the Peer Reviewers, especially Professor Derek Eamus et al (in the SMEC report), D.R. Woolley, and Dr Noel Merrick (in regard to the Coffey Report) all identify serious shortcomings in the scientific data on which the SCA's borefield proposal is based. These shortcomings are sufficiently serious as to warrant rejection of the SCA's Environment Assessment.	The peer reviews supported the methodology and work completed by SCA (at this time of the reviews) and identified additional work that would assist in confirming the resource occurrence, resource behaviour, ecosystem linkages and impacts, and the sustainability of development.  Most of this work has now been completed with subsequent studies, pumping trials, additional testing and numerical modelling studies now available (included in either the EA or reported in the preferred project report).
133	The EA does not address the numerous criticisms of poor methodology, limited analysis, and numerous calls for "further studies" which were made by numerous Peer Reviewers, employed by the SCA as consultants to review the numerous studies conducted by professional consultants, (engineering, technical and environmental).	The peer reviews supported the methodology and work completed by SCA (at this time of the reviews) and identified additional work that would assist in confirming the resource occurrence, resource behaviour, ecosystem linkages and impacts, and the sustainability of development.  Most of this work has now been completed with subsequent studies, pumping trials, additional testing and numerical modelling studies now available (included in either the EA or reported in the preferred project report).

133	<p>In the SMEC Report “Baseline Groundwater Dependent Ecosystems Evaluation Study” (September 2006) there is a Peer Review conducted by Professor Derek Eamus, Dr Hose and Assoc Prof Dangerfield, their concluding remarks are as follows:</p> <p>i) “There is much work to be done, however, before the following key question can be answered: what level of groundwater extraction is sustainable and what level does not pose an unacceptable threat to groundwater dependent ecosystems? This is the core question that must be addressed by the SCA prior to groundwater abstraction.” Peer Review: Eamus, Hose and Dangerfield. p14 of Appendix 9 of the SMEC report.</p> <p>b) That single most profound question by Eamus et al remains unanswered by the SCA to this date.</p>	<p>The Eamus peer review attaches to the original SMEC baseline study from Spring 2006 prior to any of the later studies being concluded. Subsequent studies have indicated that there is no dependence associated with upland swamps, only minor connectivity with stream baseflows, and no known connectivity with terrestrial vegetation. Ecosystem monitoring will be part of the monitoring program if the borefield is constructed and operational.</p> <p>There is sufficient certainty about groundwater dependence (or the lack thereof) to proceed with borefield development.</p>
<p>The following submissions also made comment on this issue - the content was similar to the selected issues above – 78, 140</p>		
<p><b>7.00.00 Miscellaneous (1 comments recorded)</b></p>		
130	<p>The current power easement across Crooked Creek has left the banks of the creek with severe erosion, We request that this be rectified.</p>	<p>Comment outside the scope of the Kangaloon borefield assessment process</p>
<p><b>7.00.01 Fire management (10 comments recorded)</b></p>		
3	<p>There is also the uncertain requirements for the Asset Protection Zones surrounding the infrastructure and power supply. Damage has already occurred during the recent bums that ignored the fire management protocols.</p>	<p>Infrastructure will be protected by ensuring that the correct Asset Protection Zones are included in the final designs</p>
18, 30, 35, 40, 41	<p>Another most recent example of the SCA’s incompetence to manage the catchment area occurred when they undertook a burn off in the catchment. From aerial photos we have studied an enormous area of forest was burnt to the ground, with no wild life corridors visible, leaving nowhere for the endangered wild life to flee. The intensity of the gigantic fires left no canopies on the old trees and also the vegetation was burnt to a cinder. This will result in the loss of listed endangered species such as the Geebung which will not survive in these areas. Many more will become extinct, as the fire was too hot for even seeds to survive, These aerial photos revealed not only the alarming devastation to the area, but a very large swathe of orange iron sludge making its way down the contours of the landscape towards a water course.</p>	<p>Comment outside the scope of the Kangaloon borefield assessment process</p>

28	From aerial photos we have studied an enormous area of forest was burnt to the ground, with no wild life corridors visible, leaving nowhere for the endangered wild life to flee. The intensity of the gigantic fires left no canopies on the old trees and	Comment outside the scope of the Kangaloon borefield assessment process
133	Is the Sydney Catchment Authority a responsible environmental manager? A case study of the burn-off along Tourist Road March 2008, and the damage which occurred to the 'best known community' of the <i>Persoonia glaucescens</i> (an EPBC Act listed threatened species), and to certain "Temperate Highland Peat Swamps on Sandstone" (Endangered Ecological Communities).	Comment outside the scope of the Kangaloon borefield assessment process
<b>7.00.02 Cycleway (7 comments recorded)</b>		
90	We would like to see the SCA working with the community and put a cycle track along Tourist Road for us all to use. We feel that to work with the community rather than against them would be better all round for the SCA and for us as a community too. People can then feel part of their environment rather than be pushed out of it. If the SCA are really planning to make this project environmentally attractive then a cycle track would be a wonderful thing for our community to feel part of our bush once more. For our families that live along Tourist Road, it would feel much safer to drive our children to school on this road if we weren't sharing the road with cyclists and runners as it is not a very safe road to drive on in the first place. Thank you for your consideration	A cycleway cannot be accommodated within the road reserve along Tourist Rd because the road is narrow and it would be dangerous to those who use it. A cycleway within the SCA land would create ownership, maintenance and liability issues for SCA and the presence of a cycleway is contrary to maintaining the visual amenity and the natural features of this area adjacent to Tourist Rd.
The following submissions also made comment on this issue - the content was similar to the selected issues above – 92, 93, 94, 95, 100, 123		
<b>7.00.03 SCA (48 comments recorded)</b>		
84, 96	The monitoring of the natural environment (groundwater, surface water and nearby ecosystems) has occurred only relatively recently and should be considered as preliminary findings. This reveals a lack of research in this area during decades of management of the Special Areas.	The EA describes the anticipated environmental impacts of the proposal. The extraction of groundwater will be within the sustainable yield of the aquifer and no significant impacts are expected to the natural environment. More intensive monitoring systems will be in place to monitor baseflows and key ecosystems when the borefield is operational.

101	<p>I have operated a beef grazing property of some 215 (initially 175) acres on land immediately adjoining the catchment area which was originally under the control of Sydney Water and more recently Sydney Catchment Authority ('SCA'), the present proponent. Farming and grazing have been conducted in the area since at least the 1880s, whereas the catchment land was not dedicated for this purpose until early in the twentieth century. Legislative controls over what can be done in 'special areas' (those adjoining the catchment) are increasing all the time. The SCA has a preferred position to its neighbours, despite the fact that it controls a vast area of land from Robertson to Picton which, until now, had been used solely for the passive collection of water from run-off and streams. The SCA is, for example, (unlike its predecessor) not subject to the provisions of the Dividing Fences Act, so that its neighbours must maintain all boundary fences at their sole expense.</p>	<p>Comment outside the scope of the Kangaloon borefield assessment process</p>
127	<p>The SCA appears to have drawn mainly from their research over the last few years, which still can be considered preliminary findings, and which reveals a lack of research in this area over the last 100 years or so.</p>	<p>The EA describes the anticipated environmental impacts of the proposal. The extraction of groundwater will be within the sustainable yield of the aquifer and no significant impacts are expected to the natural environment. More intensive monitoring systems will be in place to monitor baseflows and key ecosystems when the borefield is operational.</p>
119, 120	<p>Restriction of access to vast areas of Kangaloon bush land where access was once undisputed is an overkill.</p>	<p>Comment outside the scope of the Kangaloon borefield assessment process</p>
114	<p>In my own personal experience the managers of the SCA have not acted in an environmentally responsible way. In the area immediately behind my property they have felled willow trees in a creek and left them as an obstruction in that creek; they have clear felled pine trees and left them to rot for years on the ground as a fire hazard.</p>	<p>Comment outside the scope of the Kangaloon borefield assessment process</p>

114	The SCA have not acted as responsible landowners. Although they have felled and chipped massive pine trees for my neighbour which were dangerously close to his house, the fence of his that was dropped to do this was not replaced. This neighbour is elderly and of non-English speaking background. He is now also unemployed. No effort has been made by the SCA to help him replace the fence or assist him in obtaining quotes to do so. My own back fence is in a disgraceful state of repair because I was told the SCA would not pay for half of its replacement. I intend to take this issue up with the local Council when I am able to pay for half of its replacement. Also they have left vacant a perfectly good residence on Kirkland road for many years and not maintained it as a building. Such a property should have been let to a family in need of a home or used by an employee of the SCA	Comment outside the scope of the Kangaloon borefield assessment process
130	To assist with security of the project we request you relocate the Gate Barrier on Fire Road No. 3 westward to the true boundary of the Water Catchment Area.	Comment noted.
134	The proposed pipeline to Goulburn has serious implications for the Wingecarribee Shire area and its water supply and brings into question the enlarging of the Tallawa Dam.	Comment outside the scope of the Kangaloon borefield assessment process
The following submissions also made comment on this issue - the content was similar to the selected issues above – 46, 87, 89, 90, 92, 93, 94, 95, 99, 103, 104, 105, 107, 110, 111, 112, 113, 118, 125, 129, 131, 132, 133, 146		

## 5 Next steps

The Sydney Catchment Authority (SCA) has considered all submissions made to the Department of Planning in preparing this response. This submissions report forms part of the Preferred Project Report (PPR) that is resubmitted to the NSW Department of Planning and the Australian Department of Environment, Heritage and the Arts for their final consideration. The Department of Planning will consider the PPR including the submissions report and prepare a report for the Minister for Planning. The Minister (in consultation with the Australian Minister for Environment, Heritage and the Arts) will then determine whether to approve the project and the conditions of any approval.

The Department of Planning under the bilateral agreement that applies to Part 3A Major Projects under the EP&A Act will also submit to the Australian Minister for the Environment, Heritage and the Arts, a copy of the assessment report, the state level approval conditions, and any other information available to or used by the Department of Planning in their decision making process. The Australian Minister will then make his decision on the matters of national environmental significance.

Once the project has been determined, the SCA will write to all community members who made a submission during the investigation process and during the environmental assessment exhibition, advising them of the determination. The SCA will also write to all community members within two kilometres of the project and issue a media release advising the community of the project's determination. The Department of Planning will publish the determination documentation on their web site.

# **Appendices**

## **Appendix 1**

Groundwater Newsletter No. 4

## **Appendix 2**

Upper Nepean CRG Submission

# **Appendix 1**

---

Groundwater Newsletter No. 4





### Overview of the groundwater projects

The Sydney Catchment Authority (SCA) has progressed with its groundwater pilot testing programs at the three main sites across the Sydney Basin where there are potential groundwater sources for severe drought water supply.

The sites are at Kangaloon in the Upper Nepean Catchment in the Southern Highlands, and Leonay and Wallacia in western Sydney.

The Upper Nepean (Kangaloon) borefield is the most advanced with an environmental assessment currently on exhibition. The designs for the proposed borefield are also being progressed.

The Kangaloon site has been the subject of extensive scientific investigations in both drought and non-drought conditions. These studies have been independently peer reviewed, and confirm the expert conclusions that pumping the sandstone aquifers has not affected local ecosystems or private bores.

The final technical and environmental studies for the Leonay and Wallacia sites are nearing completion.

### What is the current status of the groundwater project in the Upper Nepean (Kangaloon)?

The SCA has finished its pumping trials along Tourist Road and at Stockyard Swamp. Temporary infrastructure for these projects has been removed. The results of the pumping trials are included in the appendices of the environmental assessment.

The development of a permanent borefield requires approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (NSW).

The SCA has lodged an environmental assessment for the borefield's construction with the Department of Planning as part of the approval for the building and operation of the proposed borefield in the Upper Nepean Catchment. The assessment addresses community concerns and outlines the ways to manage the possible development impacts that could occur from proposed borefield construction and operation.

The proposed borefield is located within 150 square kilometres of the catchment area between Mittagong in the north-west, Bowral in the west, and Robertson in the south. It would ultimately include up to 75 production bores, linked by underground pipelines along a corridor totalling approximately 40 to 50 kilometres in length. The spine of the borefield would be built along Tourist Road. A detailed map of the proposed location of the borefield is shown on page 3.

There is potential to build the borefield in stages, with areas east of Kirkland Road likely to be developed first.

It is proposed that 10 to 15 billion litres of water would be pumped from the borefield each year during severe drought periods. This water would be transferred to water treatment facilities before being pumped into the Nepean River system. This river flows into the Nepean Dam, which forms part of the water supply for Sydney and the Illawarra.

The water will be pumped from between 25 and 150 metres underground. The pump intake levels are expected to be no more than 90 metres below the surface.

The environmental assessment and its appendices are on public exhibition from 2 April to 5 May 2008. The Department of Planning welcomes submissions on the environmental assessment. Please refer to page 2 for details of the exhibition of the environmental assessment and how to make a submission.

## PUBLIC EXHIBITION OF THE ENVIRONMENTAL ASSESSMENT

The environmental assessment for the proposed permanent Upper Nepean (Kangaloon) borefield is on public exhibition from Wednesday 2 April until Monday 5 May 2008.

The environmental assessment can be viewed online at:

- the Department of Planning website [www.planning.nsw.gov.au](http://www.planning.nsw.gov.au)

Copies of the full environmental assessment documents can be viewed at the following locations:

- Department of Planning  
Information Centre  
23-33 Bridge Street, Sydney
- Nature Conservation Council of NSW  
Level 2, 301 Kent Street, Sydney
- Wingecarribee Shire Council  
Civic Centre  
Elizabeth Street, Moss Vale

The Department of Planning has placed advertisements and issued a media release to notify the general community that the environmental assessment is on public exhibition.

Submissions are welcome and should be clearly marked 'Upper Nepean (Kangaloon) Borefield', include reference number 06\_0331, and be sent to:

Major Infrastructure Assessments  
Department of Planning  
GPO Box 39, Sydney NSW 2001  
Fax: 02 9228 6366  
Email: [scott.jeffries@planning.nsw.gov.au](mailto:scott.jeffries@planning.nsw.gov.au)

For enquiries about the exhibition process please contact Scott Jeffries on 02 9228 6426.

For technical enquiries and copies of the environmental assessment please contact the SCA Community Relations Team on 1300 722 468 or [groundwaterinfo@sca.nsw.gov.au](mailto:groundwaterinfo@sca.nsw.gov.au)

## What happens after the exhibition of the environmental assessment?

At the end of the exhibition period for the environmental assessment, the SCA will address issues raised in any submissions and provide responses to the Department of Planning. The SCA may also revise the project design and statement of commitments. The statement of commitments in the assessment outlines the ways the environmental impacts that could occur from the building and operation of the borefield will be managed. The commitments include recommended measures to reduce and avoid identified impacts throughout the project.

The Department of Planning will consider the SCA's responses and prepare a report to the Minister for Planning. The Minister for Planning then determines whether to approve the project, and if approved, decides what the conditions of approval will be.

## Will the Australian Government also make a decision about the borefield project?

In July 2007, the former Australian Minister for the Environment and Water Resources decided the groundwater project is a 'controlled action'. This means it needs approval under the *Environment Protection and Biodiversity Conservation Act 1999*.

The Minister now responsible for this Act is the Minister for the Environment, Heritage and the Arts. The Department of Planning will submit the following to the federal Minister:

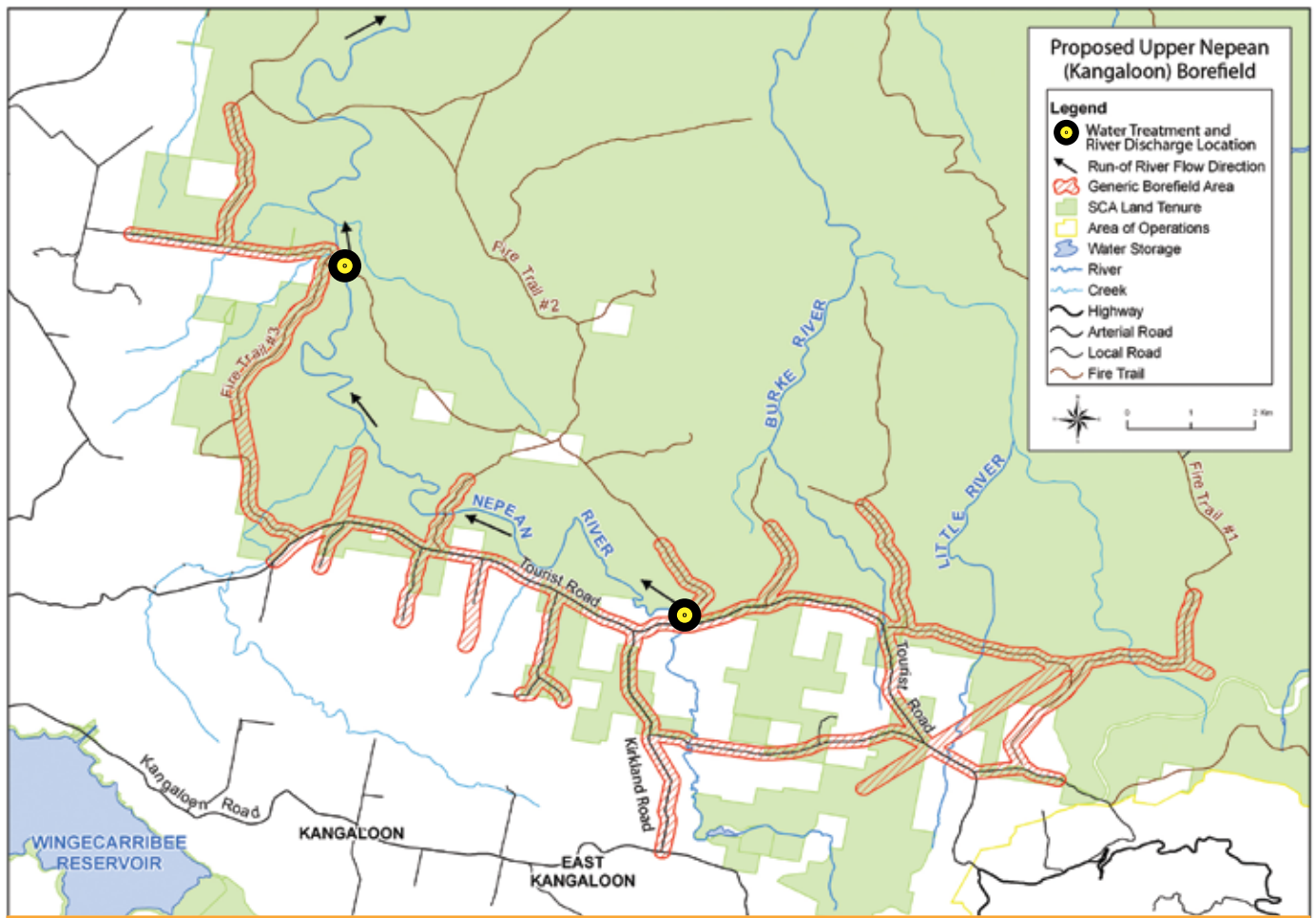
- the assessment report to NSW Department of Planning
- NSW Minister for Planning's approval conditions
- any other information available to, or used by the Department of Planning in its decision making process.

The Minister for the Environment, Heritage and the Arts will then decide on the specified matters of national environmental significance.

## What happens once the borefield project has been determined?

Once the NSW Minister for Planning and the federal Minister for the Environment, Heritage and the Arts determine the project, the SCA will write to all community members who made a submission during the groundwater investigation process and the exhibition of the environmental assessment to advise them of the decisions. The SCA will also write to all community members within two kilometres of the project, distribute a newsletter to the wider community, and issue a media release. Both ministers' decisions about the project will appear on their departmental websites (Department of the Environment, Water, Heritage and Arts - [www.environment.gov.au](http://www.environment.gov.au), and the Department of Planning - [www.planning.nsw.gov.au](http://www.planning.nsw.gov.au)), together with the conditions of approval. The Department of Planning will also publish an assessment report on its website.

The SCA will publish the determination and community information on our website at [www.sca.nsw.gov.au](http://www.sca.nsw.gov.au)



Location map of proposed Upper Nepean (Kangaloon) borefield site

## What research has been completed on the Kangaloon groundwater source?

The SCA has commissioned and completed substantial technical, scientific and environmental investigations (numbering more than 60 studies) on the groundwater source at Kangaloon and the local environment of the proposed borefield area. The investigation programs began in the Upper Nepean (Kangaloon) in March 2005 and monitoring programs have been under way for three years.

Two pumping trials have been completed to simulate borefield extraction over extended periods and monitor the condition of surrounding ecosystems.

The first pumping trial program near Butlers Swamp was carried out from early to mid 2007. There was no impact on the neighbouring swamps or the Nepean River during this trial, and more than 450 million litres of water was pumped to the Nepean Dam.

A second pumping trial at Stockyard Swamp is now finished. During the trial 170 million litres of water was pumped without impacting swamp water levels.

Several reports on the pumping trials are included in the appendices of the environmental assessment.

## GROUNDWATER SURVEY

From December 2006 to May 2007, the SCA invited property owners within two kilometres of the proposed permanent borefield site to take part in a groundwater survey.

The survey allowed the SCA to put together an inventory of springs, spring fed dams and creeks, wells and bores in use so any impacts from borefield pumping could be better assessed.

The SCA encourages private landholders to monitor water levels in their bores, and levels and flows from their different springs, to understand the natural differences in water levels and flows.

The NSW Government has made a commitment that existing users of private water supplies will not be disadvantaged by pumping from the proposed borefield. If there are identified impacts from the borefield operations, then options available to maintain supplies include lowering pumps and deepening bores. This will not be at the expense of the owner.



## QUESTIONS AND ANSWERS ABOUT THE PROPOSED KANGALOON BOREFIELD

### How much water will be pumped from the proposed borefield?

Around 10 to 15 billion litres of water would be pumped from the borefield per year during severe drought. Based on these figures, over a two to three year pumping cycle, around 30 to 45 billion litres, or approximately 10 percent of the total aquifer volume would be pumped.

### What is the groundwater quality?

The groundwater source contains a large amount of high quality, low salinity water that is suitable for drinking water supply.

### How long would the Kangaloon aquifer take to recover after pumping?

Groundwater levels in the aquifer will recover with both minor and major rainfall events. Full recovery depends on the length and number of heavy rainfall events. Results from the SCA's pumping trial after heavy rain in June 2007, suggest recovery times associated with large recharge events may take months rather than several years.

### How many bores are proposed?

The proposal includes installation of up to 75 production bores. There are four borefield areas and two water treatment facilities proposed. Borefield development may be staged with the two areas located east of Kirkland Road likely to be developed first.

The final number and location of production bores will depend on further test drilling programs and any staged development program.

There will also be a network of up to 90 monitoring bores (this includes around 50 bores already drilled during the investigation stages) and up to 10 stream gauging stations. These will provide data enabling the SCA to manage borefield performance and any related impacts.

### How long will the proposed borefield operate for?

Bores will operate 24 hours a day and for long pumping cycles of up to nine months. The period of operation will depend on the length of the drought and the number of significant rainfall events that recharge the aquifer.

### Will the pipeline and powerlines for the bores be underground?

An underground pipe work system will link the bores. The pipes will collect the water for transfer to water treatment facilities before it is pumped to the Nepean River system. There would be approximately 35 kilometres of underground pipelines on SCA land and up to 15 kilometres of pipelines across road reserves and private land for the full borefield development.

Mains power will be used to pump from individual production bores and to service the water treatment facilities. Where possible, existing powerlines will be upgraded to provide power to the borefield. Underground power will be installed in sensitive areas along Tourist Road with new overhead powerlines used in other areas.

The water treatment facilities will be built at two discharge locations, one on the Nepean River along Tourist Road, and one on Maguires Creek along Fire Trail Number Three (see the map on page 3). The treatment facilities will remove iron, increase the oxygen content of the groundwater, and ensure the water temperature matches the temperature in the river.

The Tourist Road treatment facility will include two storage ponds, a treatment plant, pipelines, and associated roads and services. Its total footprint will be approximately five hectares. The facility will be designed to fit into the agricultural and natural landscape. The facility located along Fire Trail Number Three will be smaller, at about 1.5 hectares.

### Does the SCA plan to buy property for the construction of the borefield?

The Upper Nepean (Kangaloon) borefield has been designed so the majority of bores and associated infrastructure are located within SCA land. However, the power and pipeline routes will cross some private properties and council road reserves.

The SCA has begun negotiations with affected property owners for easements, or in a limited number of cases, the purchase of their land, for production and monitoring bores, pipelines, and power.

The Upper Nepean Groundwater Community Reference Group was briefed on the extent of the proposed borefield layout and infrastructure, the pumping trials, and latest environmental studies at meetings in July, September and November 2007, and in March 2008.

The SCA briefed officers of Wingecarribee Shire Council in late November 2007 and in late March 2008 on the latest borefield developments and the likely effect on council roads. The SCA will continue to brief council and work with council officers.

## MORE INFORMATION

For further information contact:  
Community Relations – Groundwater  
Sydney Catchment Authority – 1 300 722 468  
or 02 4723 9246  
or email [groundwaterinfo@sca.nsw.gov.au](mailto:groundwaterinfo@sca.nsw.gov.au)  
or visit [www.sca.nsw.gov.au](http://www.sca.nsw.gov.au)

## **Appendix 2**

---

Upper Nepean Groundwater  
Community Reference Group  
submission

Major Infrastructure Assessments  
Department of Planning  
GPO Box 39  
SYDNEY NSW 2001

16 May 2008

Fax: 02 92286366  
Email: [scott.jeffries@planning.nsw.gov.au](mailto:scott.jeffries@planning.nsw.gov.au)

Dear Mr Jeffries

**Re: Upper Nepean (Kangaloon) Borefield (Application 06\_0331)**

The Upper Nepean Groundwater Community Reference Group (the group) has provided a submission to the NSW Department of Planning regarding the above development application.

The group acknowledges the extensive consultation that the Sydney Catchment Authority has provided over the past two years, with 18 formal meetings and a field trip to the affected area. The consultations and information were greatly appreciated by the group and the community at large. The group has provided a much-needed avenue for the public to express their concerns regarding this proposal.

There are many concerns that the group has about the proposal, and the recommendation is that the project is not approved, and that it does not proceed. If, contrary to this submission, the Minister for Planning approves the project, the group is of the view that it is essential that certain safeguards are included to ensure that the resource itself, the immediate and surrounding environment and local landholders are protected from losses of groundwater resources for extended periods.

Please forward confirmation of receipt of this document via email to the Chair of the group at [cavaray@hinet.net.au](mailto:cavaray@hinet.net.au)

A signed and printed copy of this submission will be forwarded to the Department of Planning by express mail.

Yours sincerely

Mr Rodney Cavalier

per the Upper Nepean Groundwater Community Reference Group

## **I. Summary**

The Upper Nepean (Kangaloon) Groundwater Community Reference Group (the group) unequivocally opposes the proposed development of a borefield at Kangaloon. The group (Appendix I) includes representatives of peak bodies, local landholders and the general community of the Southern Highlands. Group members have appreciated the opportunity to hear about the proposal and to provide comment on those issues that directly affect the environmental, social and economic interests of the community. Some excellent studies have been conducted in the area and worthwhile science into the groundwater system has been achieved, which will contribute to our understanding of these systems, so they can be better managed and protected into the future.

However, the group is opposed to the proposal for reasons outlined previously in a submission to the Sydney Catchment Authority dated September 2006 (Appendix II). On the basis of the precautionary principle of ecologically sustainable development, the borefield should not proceed until greater certainty exists regarding the impacts of groundwater extraction. This means that concept approval should not be granted when such components as water treatment and discharge to rivers have not been adequately addressed in the environmental assessment. Many problems Australia is now confronting in relation to its water resources result from taking water from one region to supply another, the primary example being the Murray-Darling system. This is not just an equity issue; it suggests that you do not, in light of that experience, embark on a new and untried scheme, without being absolutely certain that it will not have long-term consequences, and to the extent it does, that there is absolutely no alternative.

The group is concerned about many environmental issues that arise from this proposal. The environmental assessment appears to be premature and insufficient, and has been constrained by time, budget and a lack of access for the authors to the site. There is a lack of temporal data on effects of long-term drawdown on the important ecology of the area. There is a lack of certainty regarding vertical layering of old and new water. There are problematic iron levels in the bore water whereby extraction and treatment are likely to have pollution consequences.

If the NSW government does not go ahead with this proposal at Kangaloon the aquifer will maintain its integrity and high water level, supporting farms and important ecosystems. Groundwater will continue to flow into the Nepean Dam via baseflows in creeks and from other discharge locations. Risks to the Special Area including fire, degradation from vehicular access, and the introduction and proliferation of pests and diseases will be reduced. A secure water supply is more likely to be retained by farmers and landholders in Kangaloon if there is no development of the borefield.

Circumstances have changed since project inception, particularly in relation to the role of desalination in the event of severe drought, therefore a review of the

Metropolitan Water Plan (MWP) and particularly the role of the Upper Nepean borefield needs to occur.

## **2. Overview**

This submission highlights outstanding key issues that affect the community and environment of Kangaloon and more broadly the Southern Highlands. Importantly, this submission also makes recommendations on the key environmental and economic planning controls/safeguards that should be considered by the Department of Planning.

From its inaugural meeting on 3rd July 2006 to November, 2007 the group has met formally on 18 occasions. In addition, one technical workshop and a site inspection of the pilot borefield were held.

The group has received presentations on the Metropolitan Water Plan, the development of the groundwater project, technical studies conducted to date, the associated community consultation process and proposals for the next phases of investigation. Members have reviewed final reports from scientific studies.

## **3. Economic Impacts**

The proposed borefield at Kangaloon was conceived and designed to supplement the water supply for Sydney during prolonged drought, with pumping of water from the aquifer to the Nepean River, which flows into the Nepean Dam. The proposal was developed before the decision was taken by the NSW Government to construct a desalination plant for Sydney. It is understood that the desalination plant will cost in the vicinity of \$2 billion, will be operated continuously and will be capable of delivering 90 GL of water annually. By contrast the proposed borefield was intended as an interim measure pending a decision on the desalination plant or an improvement in storage levels. The borefield would be able to operate for a maximum continuous period of three years during which it would deliver a maximum of 15 GL of water a year, and would only operate in conditions of severe drought. The amount delivered would satisfy Sydney's demand for about one week during any year of operation. The lack of a cost/benefit analysis makes it difficult for the group to assess the economic merits of the proposal. Sydney water users benefit from a small amount of water at a significant cost estimated at \$60-\$80 million.

These considerations are relevant to environmental approval because this is not a proposal without environmental impact. To a large extent the long-term environmental impacts are unable to be characterised or quantified. Residents are concerned that construction work and the infrastructure once installed will have a long-term social, environmental and visual impact on the area. Disturbance of the pristine natural environment cannot be undertaken without permanent impacts. This will affect the appeal of the area to residents and tourists alike, particularly along Tourist Rd and Kirkland Rd. It is incumbent on the approving authority to weigh against these impacts, and the uncertainty surrounding them, the arguments advanced



in justification of such an extreme proposal, given the existence of alternatives, such as the desalination plant, which is now being constructed.

When assessing the detail of the arguments concerning the likely environmental impact, it is important that the approving authority bear in mind the vast area of land potentially affected, both in direct physical, as well as economic and social, terms by the proposal. Whereas the desalination plant has the potential to affect only the area of construction as well as any necessary additional pipeline corridor, the borefield proposal will affect, directly and indirectly, in a variety of ways, as outlined below, many hectares of both public and private land. The private land is productive and quite intensively developed and populated; the public land is largely in a pristine state and has been, for many decades until now, dedicated to the protection of the environment in the widest sense. Once this proposal is permitted to go ahead, even if it is never used for pumping, it will have had irreversible effects by virtue of the development of the infrastructure and the intrusion necessary for its ongoing maintenance and protection.

#### **4. The Local and Catchment Context**

Locally, this farming, tourist and catchment area will be depleted of a natural resource with the proposed sustained lowering of the regional water table. This will disconnect base flows to streams, (which already drain to the Nepean Reservoir) and will affect flows to some groundwater-associated landscapes north of the borefield.

For years farmers have been told to conserve the groundwater and to become involved with catchment management, which has led to improvements in water quality. This proposal negates the goodwill previously generated. The local and broader community is still opposed to this proposal. Major local concerns include the interference with local farming bores and the added cost of pumping from lower levels. When the groundwater is lowered in the vicinity of upstream creeks, the creek levels will be lower, particularly in drought when baseflows from groundwater make up a larger proportion of the total flow. This may also affect local springs, despite assurances that the water in the springs is disconnected from the aquifer being pumped. The introduction of powerlines and pumps in the catchment increases the risk of bushfires in the area. During construction (and destruction of trees) there is likely to be considerable soil and vegetation disturbance, and there is a greater risk of introduced weed species becoming established in the pristine environment from workers and vehicles. There will be considerable noise during construction and there will be decreased visual amenity of one of the most picturesque areas in the shire.

Of recent concern is the offer by the SCA to buy some of this highly productive farming land to create settling ponds. These will accumulate high level of minerals found in the extracted groundwater, effectively reducing land productivity and visual amenity as well as increasing truck movements for waste removal.

#### **5. Environmental Issues**

The Metropolitan Catchment Area, where most of the infrastructure is proposed, has remained in an almost pristine condition due to, restricted access, a high water table and previous management for conservation. The area has become a refuge for

significant numbers of endangered plants and animals and supports extensive tracts of intact Endangered Ecological Communities including Southern Highland Shale Woodland and Montane Peatlands and Swamps. The monitoring of the natural environment (groundwater, surface water and nearby ecosystems) has occurred only relatively recently and can be considered preliminary findings. This reveals a lack of research in this area during decades of management of the Special Areas. The flora and fauna surveys, carried out in spring and autumn have been very useful in highlighting the large number of endangered species and communities in this area. This is a rich ecological region and should be left undisturbed.

The regional groundwater level here is generally 5 to 20 metres below the surface although, at a few sites, the regional water table is close to the surface (EA p15). Vegetation could depend on this groundwater with canopy trees being the most obvious example, especially in times of drought when pumping is proposed.

The environmental assessment states that this is a new source of water and is part of a readiness strategy. This is not a new source of water. The documentation and research shows that this aquifer water drains slowly and naturally to the Nepean Reservoir. This happens as the naturally high level of the aquifer water feeds the lower creek levels. The Nepean River and other streams are 'gaining streams' due to the baseflows from groundwater and this flow is especially important in times of severe drought. The aquifer is intact (pre-pumping) and is not subject to evaporation or contamination.

This is not a strategic development of groundwater sources. If the proposed bores were situated below the catchment dams then this would have some strategic merit and may be new available water. The development of this groundwater will lead to more interference, degradation and potential pollution of the aquifers and the catchment area.

The potential deferral of an increase in capacity of the desalination plant seems an invalid argument, considering that the plant is now being constructed and it has a much greater capacity to deliver water than the groundwater option. With estimates of \$2 billion for the desalination plant, such capital expenditure should warrant maximum capacity. The desalination plant will feed water directly into Sydney Water pipes for consumption. It will also buy wind power and will promote this as an alternative energy. The Commonwealth Government gave an election promise to augment the state desalination plants if requested. The desalination plant should take the pressure off creeks, rivers and aquifers.

With regard to the borefield, this proposal uses ordinary mains power with new infrastructure to be installed. The extracted water must travel over 100 kilometres to Sydney via the Upper Canal to Prospect with losses from evaporation at the reservoirs and losses via the old open canal. The lower cost assumption needs to be properly determined with a cost/benefit analysis.

The potential degradation of the aquifers in this area from this project may reduce supply security and certainty in the Illawarra, which is potentially vulnerable in severe drought as Warragamba Dam does not supply this region. During severe drought and / or when overall dam storages drop to around 40% then large-scale and continuous pumping of the aquifer is proposed for 2 to 3 years. Then the aquifer system needs 5

years or more to recover. At this stage water that would normally flow naturally to the reservoir from the aquifer will not, due to the lower water table. Some upstream natural flows will go into the depleted aquifer, rather than into the reservoir (becoming a 'losing stream'). A percentage of rainfall will also go to the aquifer and not the reservoir.

Iron concentrations are sufficient to cause problems with production bores, pumps, and pipes. The water treatment facilities for iron removal are extensive, including aeration and sand filtration. Backwashing of the sand filter will be required every few days, and this backwash then needs treatment using Aluminium sulphate to settle the solids. The use of this chemical adjacent to the Nepean River (previously a class 'S' specially protected waterway) is of concern.

The projected iron concentrations in one borefield area of 20,250 kg/month are substantial and could lead to operational problems with this proposal. The iron and associated sludge water has the potential to pollute streams in its oxygenated form, with associated bacteria forming oily-looking scums in slow flowing rivers or pools.

## **6. The Investigations**

### **6.1 Ecological studies**

The findings of the *Autumn Baseline Ecosystem Study – Upper Nepean Groundwater Pilot Studies Final Report (2007)* provide adequate support for our position on the proposed borefield stated earlier. Five upland swamps are part of an endangered ecological community under NSW and Commonwealth legislation including Butlers and Stockyard Swamps containing peat soils that meet the substrate criteria for endangered communities. Threatened species were identified to exist in or around the upland swamps. The research showed some significant differences in aquatic habitat that were due to changes in flow levels and changes in in-stream habitat from the pumping trial discharge. An increase in physical deformities in Mountain Galaxias was noted in both frequency and number of sites. The Nepean River has significant platypus habitat, which was impacted by some earth bank erosion and the presence of iron flocculation. An increase in dense mats of iron was present at three study sites following the pumping trial.

The report confirms that the Metropolitan Special Areas show an amazing diversity and abundance of flora and fauna. As part of Sydney's drinking water catchment the Special Areas have been quarantined from development and have therefore remained pristine. Few similar areas remain which is a sufficient reason for the Metropolitan Special Areas remaining intact.

### **6.2 Pumping Trials**

The final reports from the pumping trial showed that there was no connectivity with the surficial aquifer and the regional aquifer at Butlers and Stockyard swamps. However, the pumping trial in 2007 was impacted by the rainfall event in February 2007, which allowed the aquifer to recharge and the impact of the pumping to be difficult to ascertain. The premature conclusion of the six-month pumping test at just less than 4 months is of concern. The operational borefield trial was compromised by

the un-seasonal break in the drought patterns, therefore the impacts of continuous pumping could not be established with any certainty.

It is possible that the groundwater is not mixing in a vertical plane, because the rock fractures are not as prevalent or as open as reported. If the fractures do not allow vertical mixing of water from the various aquifers, water could be extracted only from the lower or from other selected aquifers. That would be less likely to have consequences for existing users. There could be a separation of old, "iron-free" water in the lower aquifers from the younger, "iron-rich" water in the upper aquifers. However, the SCA have failed to prove the total variation of water quality or age within separate aquifers as the bores have taken mixed water, due to the design of the bores themselves. The assessment of water quality was based on cumulative water samples down the boreholes and iron content, for example, was determined only for the total cumulative sample from the completed bore.

Other risks to sustainable management of the resource have not been resolved, and therefore if, contrary to this submission, the proposal is permitted to proceed, further studies over a range of seasons should be conducted.

#### ***Butlers Swamp Trial***

There is a vast mixture of ages of water that came from three bores in the trial. A comparison of groundwater ages at the start of pumping with groundwater ages after recovery for three bores ranged from 320 years to 5754 years and ages varied before and after pumping. By comparing groundwater ages before and after pumping the report showed that the contribution of new recharge water (rainfall) was minor and that the water level recovery was primarily due to the inflow of water from aquifer zones unaffected by pumping into the zones affected by pumping. This is of concern for the group as we have been repeatedly told that recharge comes from direct rainfall on the sandstone area. It shows that the area of effect may be far greater than the anticipated drawdown area and that rainfall may have a minor influence on aquifer recovery. This may mean a lowering of groundwater levels over a greater distance than that predicted.

The URS Water Level and Drawdown Assessment contradicts these findings, "*These recovery rates ... are no doubt associated with the June rainfall recharge events. The speed of the recovery provides additional evidence that the aquifer system will recover quickly after substantial rainfall recharge events*" (URS 2007).

Water quality samples were collected after six weeks of groundwater recovery. The ANZECC (2000) guidelines and threshold criteria for pH, dissolved oxygen, iron, manganese and nitrogen and phosphorus nutrients were exceeded in groundwater, surface water and discharge water. Apart from iron and manganese there were no significant differences with the upstream water.

There is no shale layer at Butlers Swamp, so although the results suggest that the Swamp is protected from drawdown during pumping, the long-term effect is unknown, and the risks from these impacts may be substantial.

A third concern is the potential upstream drawdown on the Nepean River, which was

not monitored during the pumping test. Any drawdown upstream will impede water entering the reservoir and affect the ecology of the area.

### ***Stockyard Swamp Trial***

A pool downstream of Molly Morgans Crossing displayed a 10 cm drop in water level from the commencement of the pumping trial until approximately day 10. After this time drawdown was masked by significant local rainfall from early November until the end of the one month trial. Iron floc was also around this pool indicating a connection between the groundwater and Dudewaugh Creek.

This is of concern as pumping may affect this highly pristine creek, also, further down the creek there are two waterfalls with 7 and 11 metres drops (CMA map), which were not monitored but could be sites of groundwater discharge due to their lower elevation and may be affected due to pumping. This creek already drains to the Nepean Reservoir so if the creek is affected by pumping then less than the extracted water is gained.

The pumping trial produced large amounts of iron sludge, which spilled over the retention pond with the extracted water towards Dudewaugh Creek approximately 100 metres away. This aerated iron can cause pollution of the creek as associated bacteria breaks it down and forms an oily substance especially in pools and slow flowing streams.

This spill needed to be independently assessed and is an indication of a lack of safeguards with pumping and a general lack of independent monitoring.

## **7. Final Recommendations**

1. That the borefield be not approved and that the project is abandoned at this stage and that no further infrastructure is placed in the Tourist Road vicinity.
2. That the SCA abides by the REP and Plan of Management for the Special Areas, and the Department of Environment and Climate Change groundwater embargoes, to protect the groundwater resource.
3. That the Metropolitan Water Plan is updated to reflect the new role in water provision from the desalination plant, and that the flows from groundwater from the Upper Nepean be removed to reflect the new conditions.

If the Minister for Planning approves the development, the following safeguards are recommended.

4. That limits on annual extraction of 15 GL are retained and never exceeded to avoid over-exploitation of the resource.
5. That the duration of pumping cycles are clearly stated and effectively protected from alteration over time by shifting state policy directions and decisions.
6. That Stockyard Swamp and Butlers Swamp are protected.

7. That the SCA investigate the extraction of only the water within the basal aquifers of the Hawkesbury Sandstone. Our interpretation of their data is that it is the oldest and the most pure and may not require any treatment for iron.
8. That full recovery of the regional groundwater level is obtained and left for at least 6 months with no pumping before appropriately triggered subsequent pumping cycles commence.
9. That ongoing community consultation is undertaken by government agencies to allow ongoing impacts and other issues to be publicly debated. The proponent, if approval is gained, needs to inform the community of the Southern Highlands about ongoing construction and operation of the groundwater project. A peak body should be retained and informed at annual or biannual meetings to retain community input.
10. That public announcements of proposed pumping, duration of pumping, cease-to-pump, and additional studies and research are made through media outlets and peak representative groups.
11. That independent inspections are carried out by appropriately qualified Environment Protection Authority and National Parks and Wildlife staff with local representatives, due to the restricted access that applies to the area.
12. That the decommissioning requirements for the borefield are to be clearly stated in the approval to ensure that when the borefield is no longer operational, that there is minimal visual and environmental impact.

## 8. References

Parsons Brinckerhoff (2008) *Water Quality Monitoring During Pumping Trial Upper Nepean Trial Borefield - Final Report* February, 2008 Sydney Catchment Authority.

URS (2007) *Final Report. Kangaloon Borefield Trial. End of Trial Pumping Test - Water Level and Drawdown Assessment*, 13 July 2007 Sydney Catchment Authority.

## APPENDIX I

Participants (Representing a range of community perspectives)

Mr Rodney Cavalier	Chair
Councillor Larry Whipper	Representative, Wingecarribee Shire Council
Councillor Jim Mauger	Representative, Wingecarribee Shire Council
Ms Jenny Smith	Representative, Hawkesbury-Nepean Catchment Management Authority
Mr Jonathan Bell	Representative, NSW Farmers Association
Ms Mim Merrick	Community Representative, Burrawang
Mr Ian Tonking	Community Representative, Robertson
Mr Ray Nolan	Community Representative, Bowral
Dr Kerrie Eyding	Community Representative, Robertson
Mrs Beverly Clayton	Community Representative, Robertson
Mr Leon Hall	Community Representative, Kangaloon
Dr Barry O'Neill	Community Representative, Exeter
Dr Karen Guymer	Community Representative, Robertson

The qualifications and experience of these representatives can be found on the SCA website [www.sca.nsw.gov.au](http://www.sca.nsw.gov.au)

**APPENDIX II**

**Report to the Sydney Catchment Authority on the Proposed  
Borefield at Kangaloon NSW**

**Upper Nepean Groundwater Community Reference Group  
September 2006**



## Table of Contents

Acronyms.....	3
Summary.....	3
Background.....	4
1. Role of the Upper Nepean Community Groundwater Reference Group (CRG).....	4
2. Membership.....	4
3. Basis of Submission.....	5
Water Resources.....	5
4. Water Quantity.....	5
5. Water Quality and Age.....	6
6. Inefficient use of water.....	6
7. Pumping Tests.....	7
8. Drilling and Geophysical Logging.....	7
Geology.....	7
9. Geological Interpretation.....	7
Environment and Sustainability Issues.....	8
10. Interconnectedness of surface and groundwater.....	8
11. Effect of loss of groundwater baseflows in rivers and upland swamps.....	8
12. Ecological triggers.....	8
Groundwater Dependent Ecosystems.....	8
13. Upland Swamps.....	8
14. Terrestrial vegetation.....	8
Socioeconomic Issues.....	9
15. Unsustainable demand in Sydney.....	9
16. Effects on local water users and landholders.....	9
17. Scenic amenity.....	9
18. Cost/benefit assessment.....	10
Monitoring.....	10
Safeguards.....	10
Statutory/Legislative Issues.....	10
19. Water Management Act 2000.....	10
20. Threatened Species and Endangered Ecological Communities.....	10
21. Groundwater Dependent Ecosystems.....	11
Supporting Technical Documents.....	11
22. Groundwater Investigation Report.....	11
23. Technical Overview Report.....	11
24. Hydrological Modelling Report.....	11
25. Interim Ecosystem Evaluation Report.....	11
26. Bore Drilling Report.....	12

## **Acronyms**

SCA	Sydney Catchment Authority
DNR	Department of Natural Resources (NSW)
DEC	Department of Environment and Conservation (NSW)
CRG	Upper Nepean Groundwater Community Reference Group
REF	Review of Environmental Factors
EIS	Environment Impact Statement
HNCMA	Hawkesbury Nepean Catchment Management Authority
WSC	Wingecarribee Shire Council
LGA	Local Government Area

## **Summary**

The Southern Highlands regional community, as represented by the Upper Nepean Groundwater Community Reference Group (CRG), appointed by Minister Debus, is opposed to the proposal to develop a borefield at Kangaloon NSW.

The proposal to pump high quality drinking water from the Kangaloon Aquifer for general residential and industrial use in Sydney and the Illawarra is inequitable to present and future generations of this community and does not follow ecologically sustainable development principles.

Ongoing open communication and community consultation are recommended. The community feels that this project has been rushed, and the full implications of development cannot be ascertained in the short timeframe that investigations have occurred. A five-year moratorium on development would enable adequate data input, improved modelling outcomes and more detailed ecosystem studies.

The potential for the resource to be over-extracted or contaminated is very high. Given the continuing population growth and demand from urban centres and the farming community, the Southern Highlands community fears that the borefield will be regarded as supply augmentation and not a contingency drought supply only. Due to the relative low cost of additional bores, the CRG is concerned that greater quantities than the 15 GL quoted will be extracted if the drought worsens or demand continues to grow.

Sydney and the Illawarra are situated in high rainfall areas and need to become more self-sufficient in water resources management through reusing and harvesting water. Level 3 restrictions are not onerous in severe drought, and these restrictions should be maintained or increased if the drought continues. As outlined in the Metropolitan Water Plan 2006, there are other sustainable and achievable options and strategies that can provide for the future water needs of the metropolitan area. It is those options and strategies that should be urgently employed to adequately and properly provide for future metropolitan water requirements.

There is considerable risk and uncertainty in regard to the environmental sustainability of the proposed borefield for cyclical drought contingency supply. There is considerable uncertainty in regard to:

- sourcing 15 GL for 2-3 years and recovery of the system,
- consequent impacts on surface and groundwater resources,
- the transfer of groundwater via rivers to water storages and
- environmental impacts.

The proposed compensatory measures of deepening bores and lowering pumps of neighbouring groundwater users may not be a feasible or practical solution, however adequate compensation provisions will need to be incorporated into any approval for the project. It is imperative that the authorised use by existing users is maintained.

There is a very high risk that the proposal will adversely impact upon agricultural production and tourism in the region and land values may be degraded. These negative impacts on the local community are to be occasioned for "public good" outcomes in Sydney and the Illawarra in circumstances where there is no realistic proposal to properly compensate those who will suffer loss of income and reduction of asset values as a result.

The supporting technical documents do not satisfy issues of larger spatial and temporal scale, and the broader impacts of the proposal on rivers downstream of the borefield. The interconnectedness of surface and groundwater systems and the lag between cause and effect are not adequately addressed in the current suite of studies.

Before approval of a full-scale borefield can be contemplated, further extensive investigations and testing are essential (as recommended by Woolley and endorsed by McKibbin). The eight recommendations found in the *Peer Review of Technical Reports*, are endorsed by the CRG.

## **Background**

### **1. Role of the Upper Nepean Community Groundwater Reference Group (CRG)**

The CRG was appointed by the Minister for the Environment, the Hon. Bob Debus in June 2006. Its terms of reference are to provide a key communication channel between the NSW Government and the Southern Highlands community about the potential use of groundwater in the Upper Nepean catchment for drought contingency supply for Sydney and the Illawarra as well as an opportunity to discuss community matters regarding the full range of environmental, social and other issues which might arise from Borefield development and groundwater extraction.

The CRG recognises that its role requires two-way communication. Informally, CRG members have assisted with dissemination of information from the SCA to their various associations and community networks and have provided input to the SCA's ongoing investigations based on local knowledge of geological and environmental features, private use of surface water and groundwater, natural springs and other relevant matters.

### **2. Membership**

Mr Alex Walker	Chair
Councillor Larry Whipper	Representative, Wingecarribee Shire Council
Councillor Jim Mauger	Representative, Wingecarribee Shire Council
Ms Jenny Smith	Representative, Hawkesbury-Nepean Catchment Management Authority
Mr Jonathan Bell	Representative, NSW Farmers Association
Ms Mim Merrick	Community Representative, Burrawang
Mr Ian Tonking	Community Representative, Robertson
Mr Ray Nolan	Community Representative, Bowral
Dr Kerrie Eyding	Community Representative, Robertson

## *Upper Nepean Groundwater Community Reference Group*

Mrs Beverly Clayton	Community Representative, Robertson
Mr Leon Hall	Community Representative, Kangaloon
Dr Barry O'Neill	Community Representative, Exeter
Dr Karen Guymer	Community Representative, Robertson

The qualifications and experience of these representatives can be found on the SCA website [www.sca.nsw.gov.au](http://www.sca.nsw.gov.au)

### **3. Basis of Submission**

From its inaugural meeting on 3<sup>rd</sup> July to 18<sup>th</sup> September, 2006 the CRG has met formally on six occasions. In addition, one technical workshop and a site inspection of the pilot borefield were held with SCA representatives.

The CRG has received presentations from the SCA on the Metropolitan Water Plan, the development of the groundwater project, technical studies conducted to date by the SCA and its contractors, the associated community consultation process and proposals for the next phases of investigation. A senior DNR representative has also presented background information on water resource management and policy, including licensing of groundwater extraction. CRG members have appreciated the quality of the presentations and the opportunities for free and open questioning and exchange of views.

Although well informed on technical aspects of the groundwater project, CRG members do not generally have the scientific background to be confident about assessing many of the key aspects. Specialised and independent advice has been sought and the SCA has agreed to fund the appointment of an experienced hydrogeologist. To this end, Mr Dan McKibbin was appointed on 18<sup>th</sup> August to conduct a review of the technical reports and address key questions raised by CRG members. His independent advice is reflected in this submission.

## **Water Resources**

### **4. Water Quantity**

- There is a good drinking water quality supply with varying but relatively high yields in the area where the borefield is proposed. The water supply should not be considered only in terms of a water supply for Sydney, as it has substantial value for the environment and existing users.
- There is potential for the volume of water to be taken from the aquifer to increase from the estimated 10% of the total storage in the aquifer taken over 2-3 years, given that the SCA is sourcing the most productive fractured zones in the Hawkesbury Sandstone, and this means that the aquifer is vulnerable to over-exploitation.
- A full water resources audit should be undertaken in the borefield region to ascertain all water features, including all surface water supply features and works (springs, pumps on creeks and farm dams) and groundwater works (bores, wells and excavations). This will establish baseline conditions for all lands within the predicted pumping radius of influence of the proposed borefield.
- Considering the high connectivity of the ground- and surface-water systems in the borefield area and that both systems currently feed the water storages, the SCA needs to clearly demonstrate how it will avoid double accounting of the water gained from groundwater alone.

- The quantity of water in this aquifer supports the water supply dams, the special area natural environment and the local farming area. The aquifer water supplies the Nepean Dam through discharge near the dam (especially in times of drought) and creates gaining streams adding water for the dam. It supplies water to nearby wetlands, which filter the water and feed the beginnings of creeks to supply the dam. Water discharge via springs such as Dudewaugh Creek also feed water to the dam. This system works well and this special area has retained its pristine environment here due to its high regional water level, its inaccessibility and lack of disturbance.
- The sustainable yield of the aquifer needs to be determined so that clear limits on extraction rates and duration of pumping are articulated in the licence conditions developed by DNR.
- There is concern that precipitation data has not been collected at the site of the borefield, to provide a more accurate estimate of recharge.
- It seems likely that the SCA has not accurately assessed the quantity of water available, because the credibility of the data on transmissivities is questionable. (Refer to Pumping Tests below).

#### **5. Water Quality and Age**

- The studies by the SCA have revealed a high quality drinking water resource in this aquifer, which therefore must be protected from misuse and/or contamination. The precautionary principle must be applied, as the resource is servicing the environment and existing users now and in the future may be required as an emergency drinking water supply.
- There needs to be greater clarity regarding the age of water at various depths in the aquifer. The use of composite sampling is not accurate enough. There is concern that the water sourced from the aquifer may be very old at depth, which would indicate that the time required for recharge could be substantially underestimated.
- If older water is located within the deeper sandstone aquifers, to which recharge takes longer but from which water cannot seep to local gorges, use of that water is less likely to affect the nearby ecosystem.
- Iron and manganese accumulations may cause problems in pumps and pipes.

#### **6. Inefficient use of water**

- Loss of water supply in dams from evaporation is significant, and is one reason why sourcing water from an aquifer is advantageous; however this proposal lacks this advantage, due to the inefficient transport and storage of the water prior to end use.
- The action of streamflow depletion due to groundwater pumping either capturing baseflow or inducing stream leakage needs to be clearly identified in yield calculations.
- While inclusion of water losses through the stream bed in the hydrological model is commendable, it highlights the inefficiencies in the proposal, where a significant proportion of energy is expended recycling water.
- In a highly connected ground- surface-water system, the identification of new storages does not necessarily increase the net yield of that system. When surface water inputs are already calculated in the supply reliability calculations, the assumption that groundwater provides 'new' additional supplies (when a significant percentage may be made up of drawn down surface water) can lead to the same water being counted twice and false-economies.

## 7. Pumping Tests

- The results are questionable because the report on Pumping Test Interpretation and Data Logger Installation estimated a range of values up to 159m<sup>2</sup>/day, far greater than reported for local monitoring bores by McKibbin and Smith (In *Sandstone City*, Ed. G.H.McNally, B.J.Franklin), then quoted other values in their summary. Those values appear to have been ignored by Coffey, who quote other values on page 11, table 2 of the *Hydrological Modelling Report*.
- Following any 6-month trial pumping test, it would be appropriate to let the aquifer recharge to original levels to obtain accurate data on recharge rates and to limit damage to the environment. Best estimates of base line conditions and total recharge are needed for an EIS if the project continues.

## 8. Drilling and Geophysical Logging

- Insufficient use has been made of the geophysical logs, which would enhance the interpretation of what is foremost a sedimentary sequence with some faulting and, perhaps, fracturing. No direct evidence of the latter has been reported, other than orally from SCA representatives.
- Observations by the drillers and on-site geologists, on flows from aquifers, have either been changed or misquoted by later investigators, resulting in confusion as to the correct potential of the Hawkesbury Sandstone sequence.
- Information on individual aquifer flows, including flow rate, water quality and age would have provided real data for formulation of a satisfactory hydrogeological model.

## Geology

### 9. Geological Interpretation

- Installation of multilevel monitoring bores as reference points is recommended in the basalt land to the south of the borefield. The objective would be the confirmation of assumptions made of the geological setting and specifically of the shale layer beneath the basalt caps, that would prove or disprove the assumption in the hydrological model that the surface springs are not connected to the sandstone aquifer.
- The geological model is biased towards the known faulting and, largely inferred fracturing of the Hawkesbury Sandstone, within the proposed borefield. The inferred fracturing, reported only by SCA representatives (personal communication, as a result of views by a down-hole camera), has influenced all of the subsequent investigations and their assessments of what were assumed to be "leaking aquifers".
- An alternative model would include a series of semi-confined aquifers throughout the "upper" and "lower" sections of the Hawkesbury Sandstone, perhaps with those "upper" and "lower" sequences themselves being somewhat confined from each other. In other areas of this Shire, the "upper" sandstones are more iron-rich, are coloured accordingly and produce iron-tainted water, whereas the "lower" sandstones are mostly devoid of iron, are very porous, produce most of the water in any bore and it is usually free of iron and is very good quality. In this model, the more-than-average yields are due to the faulted, monoclinial feature raising the Hawkesbury Sandstone, so that it is not covered by the more impervious Wianamatta Shale and is accessible to high re-charge, possible from the high Robertson rainfall and the very suitable, flatter surface area south of Butlers Swamp and the Tourist Road.

- If the above model is realistic, loss of water from the “upper” aquifers will occur naturally with the gorges, not far north of the borefield but the “lower” and, perhaps, very old water, would have to reach features such as the Avon Dam or the escarpment before it could seep at the surface.

## **Environment and Sustainability Issues**

### **10. Interconnectedness of surface and groundwater**

- There has been little attention given to the impact of the groundwater pumping on an intermediate or catchment scale.
- A clearer understanding of the surface to groundwater connections is required, as the provision of environmental flows and the protection of baseflows and tributary flows are a fundamental part of river management in the Hawkesbury-Nepean catchment. The Nepean River is already hydrologically and ecologically stressed due to the damming of the rivers and the volume of surface water transferred out of the catchment. Any reduction in the baseflows currently provided by groundwater discharges during times of severe drought poses significant ecological risks to already stressed rivers. There needs to be a scientific justification for the assertions that there will be no (or negligible) impact on baseflows in streams beyond the area of drawdown.

### **11. Effect of loss of groundwater baseflows in rivers and upland swamps**

- The loss of baseflows in permanent streams including Doudles Folly Creek during pumping is a serious concern, given the likelihood for surface flows to also decrease during severe drought events, potentially placing these streams under hydrological stress.
- Streams and wetlands in this region provide many environmental and socioeconomic services, such as fresh flows into storages and habitat for platypus. These services need protection and enhancement, not degradation.

### **12. Ecological triggers**

- There needs to be a set of ecological triggers for cease-to-pump.

## **Groundwater Dependent Ecosystems**

### **13. Upland Swamps**

- Stockyard Swamp is a significant ecosystem that must be protected from degradation.
- The short pumping tests and monitoring may not have detected effects that have a significant time lag, for example drawdown impacts in slightly less fractured sandstone could take longer to detect and may be missed altogether by monitoring bores.
- Although reports state that Butlers Swamp (wetland of national significance) is not connected to the regional aquifer, further testing must be done to verify this, and the effects may not be immediate, as suggested in the prior point.

### **14. Terrestrial vegetation**

- Endangered plants are evident in the vicinity of the proposed borefield, and must be protected during testing and development phases of the project.
- There is a risk that larger trees are sourcing water during times of severe drought from the water table, and could be prone to stress and death while the water table is drawn down on average by 40 m across the immediate borefield area. This risk is difficult to test, however

some form of monitoring of tree vigour from aerial and ground surveys is strongly recommended, to provide baseline information.

## **Socioeconomic Issues**

### **15. Unsustainable demand in Sydney**

- Sydney's demand for water has not been adequately addressed, because there is no mention of limiting population growth in Sydney or of ensuring that all new housing developments are self-sufficient in terms of water supply. Unsustainable demand for water is created with new housing and increasing population. Water restrictions do not address these issues, and BASIX incompletely addresses water use efficiency. The minor uptake of the tank water rebate shows that water restrictions do not have much impact on changing behaviour. Rural people are expected to supply their own water as well as Sydney's, and this constrains rural industries in areas surrounding Sydney such as Kangaloon. The probability of the population of Sydney increasing and therefore demanding greater water is high, and so there is a high risk of the long-term over-extraction of the water resources at Kangaloon.
- The Southern Highlands community expects greater accountability and sustainability of water use in Sydney, and to that end, the assessment and trial of the use of groundwater from the Botany Sands Aquifer to supply Sydney is requested as a high priority for the SCA.

### **16. Effects on local water users and landholders**

- The potential for bores to fail temporarily or completely is a significant socioeconomic risk for the local landholders and water users, as in some cases it may be the only water source on the property, and in other cases, the groundwater supply is essential, not just for the success of the enterprise, but for the daily survival of livestock. Measures to address drawdown effects on private bores need to be proactive not reactive. The increased cost to the landholder of pumping water greater heights is also an equity issue.
- Local landholders will be impacted by more stringent land use controls that will inevitably form part of a land use management plan to protect the recharge areas, as already seen by the embargoes placed in the parishes that contain the proposed borefield. This is an equity issue between this semi-rural community and the Sydney and Illawarra urban population.
- The impact of the operation of the borefield has the potential to affect the productivity and profitability of rural industries in the local area, that are reliant on groundwater for irrigation or stock and domestic purposes. The region has some of the most fertile soil types in Australia. Ferrosols have a very limited distribution nationally, and are highly valued primarily due to fertility, good drainage and resilient pore structure. The protection of agriculture and the environmental services of this region, situated close to such a large market as Sydney must be seriously considered.

### **17. Scenic amenity**

- The scenic amenity impacts are significant, given that this is a popular tourist drive and is in relatively pristine condition. Power poles to supply electricity are particularly concerning, and will have an unacceptable impact on the woodland vegetation and the tourism and rural residential values of Tourist Road. Underground power would mitigate these impacts.



### **18. Cost/benefit assessment**

- The considerable development, operational and environmental cost of the project for a relative small quantity and value of delivered water (\$1.26 - \$1.63 per 1000 litres) is an undesirable feature of the project and the CRG will be surprised if a proper cost/benefit appraisal was shown to endorse the project. It is disappointing that this analysis will be Cabinet-in-confidence and therefore cannot be scrutinised by this committee or publicly.
- The risk of de-valuing the land adjoining the borefield is significant and fair compensation to affected landholders for such loss must be provided and included in the cost-benefit analysis of the scheme. There should also be an attempt to include the costs of losses of stream flows and other environmental degradation caused by the proposal.

### **Monitoring**

- The CRG, or similar representative group should have an ongoing role in monitoring and assessment, particularly during the further testing and monitoring phases; the environmental assessment process; and following that should the borefield become operational. The SCA has endeavoured to provide good community consultation to this point, and this will ensure a continuous dialogue with the community.
- Each individual production bore requires monitoring, as do the broader impacts of the project, during all test phases and during operation.

### **Safeguards**

- The limits on annual extraction and duration of pumping cycles must be clearly stated and effectively protected from alteration over time by shifting state policy directions and decisions.
- The time for aquifer recovery is estimated to be around 8 years, but it is essentially unknown and cannot be easily predicted and therefore it is important that full recovery of the aquifer is obtained before subsequent pumping cycles commence.

### **Statutory/Legislative Issues**

#### **19. Water Management Act 2000**

- While the CRG recognises that certain approvals have yet to be obtained, it understands environmental legislation has been amended to enable the project to be fast-tracked. This contrasts with the Government's own legislative stipulations which apply generally that "sharing of water from a water source must protect the water source and its dependent ecosystems and... must protect basis landholder rights". The Water Management Act 2000 also requires that water use be "consistent with the maintenance of productivity of land in the long term and should maximise the social and economic benefits to the community" and that "the impacts of water use on other water users should be avoided or minimised". (Water Management Act 2000, s. 5). The CRG expects that Government will strictly observe these principles in its future dealings.
- Under the controlled activities provisions of the Act, the SCA must ensure that during test pumping or operational phases no damage occurs to the bed or banks of rivers.

#### **20. Threatened Species and Endangered Ecological Communities**

- The NSW Threatened Species Conservation Act 1995, the Local Government Act 1993 and the federal Environment Protection and Biodiversity Conservation Act 1999, all emphasize our responsibilities to maintain, protect and enhance the environment for future generations. The Environmental Planning and Assessment Act 1979, requires that the

principles of ecologically sustainable development (ESD) be given due recognition in the development of environmental impact statements (EIS). It is therefore incumbent on all spheres of government to take this responsibility seriously. It is essential that this project proceed at a pace that allows full and unequivocal consideration of all the available science, irrespective of any extended timeframes, and where there are deficiencies to adopt the precautionary principle.

- More effort is needed to abide by NSW and Federal laws in regard to identification and management of threatened species and the large tracts of EECs in this special area.

### **21. Groundwater Dependent Ecosystems**

- The following statement in the Technical Overview Report "...there may be some groundwater dependence associated with each of the terrestrial, wetland, aquatic and aquifer ecosystems that have been surveyed". These areas surveyed are potentially within the area of predicted large drawdowns and include EEC's and endangered species. The long and continual pumping and the long recharge time may stop groundwater dependence for 10 or more years. This goes against the high level of protection given to this terrestrial landscape under state and federal laws.

## **Supporting Technical Documents**

### **22. Groundwater Investigation Report**

- A quote from page 25 "*The SEPP (Sydney Metropolitan Water Supply) 2004 permits the SCA to carry out groundwater investigations without obtaining a development consent. Therefore any groundwater investigations can be assessed and determined by the SCA pursuant to Part 5 of the EP&A Act, unless the proposal is one that is likely to have a significant environmental effect.*" There does appear that a significant environmental effect is likely with this proposal and even with investigations in this area, with 6 months trial pumping proposed and no assurance that the aquifer will totally recharge before any further testing. The extensive drawdown area during pumping will put terrestrial flora and fauna that depend on the high water table under stress.

### **23. Technical Overview Report**

- The comment by the independent peer review D R Woolley "*None of the reports seen to date has provided an estimate of the likely safe yields.*" P 69 is of concern, given that the target result of 15 GL per year is stated rather than working back from the sustainable or safe yield.

### **24. Hydrological Modelling Report**

- The wider impacts of the borefield are largely predicted by the hydrological model, and so there are significant environmental and socioeconomic risks if the model is not verified further using transient data.
- The boundary conditions must be measured to provide any credibility to the model, particularly elevations at the escarpment and in the permanent streams and wetlands.

### **25. Interim Ecosystem Evaluation Report**

- This interim report is a good introduction to the diverse and rare natural environment of this special area. The groundwater ecosystem report is not finalised and this would have been useful to us. It would be better to do a larger scale full area botanical and fauna study (over all seasons, even over years) before any trial pumping started. Analysis of such a proposed full study could be used for better management practices with pumping tests (and general management) and would supply more complete baseline data as well as helping

this committee assess the project proposal. It is recommended that a more detailed study be undertaken before any further test pumping.

- The report appears to be constrained by the assertion that there will be no impacts beyond the immediate local area.

## **26. Bore Drilling Report**

- Selection of the possible borefield was based on structural interpretation and that emphasis during drilling, geophysical logging and overall geological interpretation has been to the detriment of the sedimentological assessment of the many aquifers within the Hawkesbury Sandstone.
- Woolley stated, "*insufficient use seems to have been made of the geophysical logging*" and "*the geophysical logs ...have not been examined by an experienced person who might be able to define aquifer zones quite (more) accurately.*" When printed at the same vertical scale and with the same amplitude scales they are a valuable tool for sedimentological assessment of the total sandstone sequence across the borefield.
- The "*apparent correlation between the calliper log and some of the fracturing noted during drilling*" (Woolley, 2006) is not necessarily valid. The geologists based fracturing on "iron-filled" zones or fractures. The technical officer, who commented on the bore logs, assumed that all increases in bore diameter related to fractures. They just as logically could be "washouts" in the most porous zones of the sandstone aquifers as they usually correlate with increased water yields.
- There obviously is a monoclinial or horst structure present and the higher water yields are in boreholes along those structures. However, the effect of those structures could be only to raise the Hawkesbury Sandstone, and particularly its lower, more porous section (e.g. at Site 2) to the surface and into a very reactive re-charge zone. The northern boundary of the potential borefield could be where the nearby gorges commence, where up to 50 metres of the Sandstone is eroded, allowing the upper aquifers to "leak" into the rivers.

## **Appendix C**

---

Government Agency Issues and  
Responses

## Appendix C – Key NSW Government Agency Issues and Responses

Theme	Primary issue raised	Response	Changes made to borefield design or operation
<b>Department of Primary Industries</b>			
Coal seam gas	Protect coal seam gas reserves - introduce a depth restriction of 100 metres for water extraction so that deviated drilling can be carried out beneath the producing aquifer.	The borefield development needs to tap the whole of the Hawkesbury Sandstone aquifer to be viable - coal seam gas production would be below the sandstone in the much deeper Illawarra Coal Measures and SCA believes these land uses can co-exist without such a restriction - SCA's production bores would be to a maximum of 180 metres with maximum pump intake depths around 100 metres	No
Other water users	Sydney Catchment Authority should re-instate domestic stock supply to landholder bores that are impacted by drawdown for the project (e.g. by deepening bores or providing access to alternative supplies of comparable convenience)	An augmentation and alternative water supply package will be in place for bores and springs that are impacted by borefield pumping	No
Ecosystem impact	Monitoring plan (fisheries perspective) - ongoing monitoring of stream flow correlated with groundwater extraction and the ability to limit extractions to mitigate potential impacts, are recommended	Noted	Monitoring will be expanded - temperature and dissolved oxygen are included for locations on permanent streams
<b>Department of Environment and Climate Change</b>			
Ecosystem impact	Impact on surface water quality, quantity and aquatic ecosystem health and the necessity for appropriate monitoring and management arrangements to be included and addressed	SCA believe that some of the suggested water quality monitoring requirements are excessive based on the consistency of the water quality results obtained during the pumping trials - SCA believe this is a detailed matter that can be resolved in discussions with DECC on the Protection of the Environment Operations (PoEO) licence	SCA has committed to an expanded monitoring program but some of the issues raised by DECC may require further review- current commitments are in Section 4.4 of the PPR
Ecosystem impact	Impact on threatened species and habitat and the necessity for biannual surveys (construction, operation and post operational phases); Condition data to be included in ecosystem surveys; Several other threatened species to be included in future surveys; Targeted and seasonally relevant survey required for threatened species prior to final locations (bores and pipelines)	Survey frequency is noted and will be changed to biannual in the ecosystem monitoring program. Ecosystem surveys during the recovery/recharge period will generally be restricted to fully recovery/12 month periods (unless there is very slow recovery, connectivity has been established, and a longer survey of ecosystems is considered necessary) Threatened species requirements are noted and will be referenced.	Included in the monitoring framework and will be included in detail in the respective monitoring plans when written and required.
Groundwater Dependent Ecosystem	Possible impacts on GDEs from extraction. Department of Environment and Climate Change (DECC) specifically recommended: • both ecological and perched water-level monitoring continue:	In relation to each of the issues raised: * a key sites network will operate for the non operational periods, then be expanded substantially during the construction and subsequent operational periods - will include both water level	Most of these aspects are included in the monitoring framework and will be included in detail in the respective monitoring plans when

Theme	Primary issue raised	Response	Changes made to borefield design or operation
(GDE) impact	<p>prior to groundwater extraction; while production bores are in operation; and post operation;</p> <ul style="list-style-type: none"> <li>• further investigations, under a range of climatic conditions, should be undertaken to determine whether upland swamps and riparian woodlands in the area are dependent on groundwater;</li> <li>• appropriate measures be taken to limit impacts on upland swamp habitats during construction of bores and the pipeline; and</li> <li>• care be taken to avoid introducing <i>Phytophthora cinnamomi</i> and weeds during the construction and operation of the borefield.</li> </ul>	<p>and ecological monitoring</p> <ul style="list-style-type: none"> <li>* swamps are disconnected so no further studies are considered warranted - basic perched water table monitoring is under way for terrestrial vegetation and further advice will be taken in regard to assessing any groundwater dependence</li> <li>* protection measures for swamps and along the pipeline route will be in place during construction (CEMPs etc)</li> <li>* advice noted on <i>Phytophthora cinnamomi</i></li> </ul>	written and required.
Aboriginal heritage	<p>Impacts on Aboriginal cultural heritage values - DECC did not support the recommendation for archaeological monitoring during the implementation of the borefields (Navin Officer, 2007). The necessary investigations and/or salvage of archaeological sites and/or areas of sensitivity should be developed and undertaken prior to any construction works.</p> <p>The proponent should ensure that an Aboriginal Heritage Information Management System (AHIMS) site card be produced for all sites and/or potential archaeological deposits (PADs) identified within the project area prior to any archaeological investigation or development. These site cards should be revised following any investigations of the sites and/or PADs to ensure a detailed archaeological record of the sites discovered in the area are lodged with DECC.</p>	<p>Given the long, linear nature of the infrastructure (with power and pipelines potentially over a 50km length), it is not possible to investigate the whole of the trenched area in advance of construction - known areas of artefacts and significance will be protected and avoided (no salvage of sites will be required). Some preliminary augering of soils in high sensitive sites will be undertaken in advance of construction to confirm whether there are any substantial issues to address. Current investigations are complete and site cards will be updated and produced for all sites in advance of any further investigations or construction.</p>	No
PoEO licence	<p>PoEO licence for proposed treatment, discharge and conveyance of extracted groundwater</p>	<p>SCA will apply for licence after planning approval and in advance of borefield development. It is SCA's understanding that any licence issued would be compatible with the Part 3A consent but that the specific licence and monitoring conditions and requirements would be included in the PoEO licence</p>	No

### Department of Water and Energy

Hydrogeological assessment and resource impacts	<p>Comments related to:</p> <ul style="list-style-type: none"> <li>* geological and hydrogeological setting - need to improve the geological and structural interpretation, conceptual model, some data interpretations, and how the aquifer is conceptualised and in the revised numerical model</li> <li>* regional drawdown - model review, construction and transient modelling is required to more accurately represent the aquifer and to predict drawdowns</li> <li>* groundwater storage volumes - basis of the estimates requires more explanation, together with more information on hydraulic</li> </ul>	<p>SCA has been in discussion with DWE staff regarding many of the technical issues raised particularly the aquifer conceptualisation and the groundwater modelling. In relation to each of the issues raised:</p> <ul style="list-style-type: none"> <li>* the new numerical model is based on best interpretations as at June/July 2008 - model review is proposed at 5 year intervals so additional improvements can be made at this time</li> <li>* the new numerical model divides the Hawkesbury Sandstone into three layers and better represents the regional aquifer recharge and flow - transient model also includes a better</li> </ul>	<p>No substantial changes - The numerical modelling will inform the final key monitoring locations and inform the operational requirements and any mitigation requirements for the borefield</p>
---	---	---	--

Theme	Primary issue raised	Response	Changes made to borefield design or operation
	<p>boundaries and the most recent pumping trial results</p> <ul style="list-style-type: none"> <li>* operational Vs recovery monitoring - specific requirements need to be detailed about proposed monitoring, particularly in the post operational period in the recovery/recharge phase</li> <li>* Contouring control - need to take structural features into account when generating water level contour plans</li> </ul>	<p>representation of the aquifer and the expected drawdowns during severe drought</p> <ul style="list-style-type: none"> <li>* again the new numerical modelling better represents the storage characteristics of the aquifer - early data provided in the EA was presented to indicate the size of the resource, not the sustainability of the resource</li> <li>* expanded monitoring is proposed in the PPR that effectively addresses the issues raised in regard to operational monitoring versus recovery/recharge monitoring</li> <li>* the known structural features (apart from the Mt Butler intrusion) do not appear to have substantial influence on the water level contours at the scale at which SCA is assessing the resource</li> </ul>	
<p>Infrastructure works</p>	<p>Comments related to:</p> <ul style="list-style-type: none"> <li>* Bore design - likely constraints to apply in upcoming WSP regarding bores located close to GDEs (upper cemented casings to protect water tables and distance rules)</li> <li>* Inactive works - proper maintenance required during non operational periods</li> </ul>	<p>In relation to each of the issues raised:</p> <ul style="list-style-type: none"> <li>* there are no linkages with upland swamps and uncertain (but probably poor) linkages with terrestrial vegetation – slightly higher risks may occur in riparian areas - the proposed SCA production bore specification is considered appropriate to protect perched water bearing zones and to tap the main sandstone aquifers</li> <li>* proper maintenance arrangements will be in place during non-operational periods</li> </ul>	<p>No</p>
<p>Ecosystem and environmental impact</p>	<p>Comments related to:</p> <ul style="list-style-type: none"> <li>* GDEs - close assessment of upland swamps still required and further assessment of terrestrial vegetation is required. Spring and regional sandstone groundwater linkages to be further assessed and better conceptualised and mention needs to be made of the existence or non-existence of cave ecosystems</li> <li>* Stream level impacts - mention of ephemeral streams and linkages required; protection of hyporheic zones and water temperatures and flows; and appropriate monitoring to measure flows upstream and downstream of the borefield area</li> <li>* Fauna - concerns about platypus and frog populations related to flow volumes, river heights and protection of riffle zones</li> <li>* Scientific studies - need to consider use of control locations but recognises that drought and climatic changes may mask the effects of pumping; important to establish baseline data sets</li> <li>* there were specific technical queries relating to the PB water quality monitoring programs during the pumping trials and impacts on surface water, and on the SMEC baseline GDE evaluation studies</li> </ul>	<p>In relation to each of the issues raised:</p> <ul style="list-style-type: none"> <li>* there are no linkages with upland swamps and uncertain (but probably poor) linkages with terrestrial vegetation – slightly higher risks may occur in riparian areas; there are no cave ecosystems - latest studies in 2008 are all quite definitive in their conclusions on what is possibly groundwater dependent and what is not</li> <li>* the ephemeral streams are not linked to the regional aquifer - pumping will not impact the flow in these streams; increased water quality and in-stream monitoring should assure the protection of aquatic ecosystems</li> <li>* as above</li> <li>* control locations now included</li> <li>* specific study queries discussed in meetings with DWE staff</li> </ul>	<p>Most of these aspects are included in the monitoring framework and will be included in detail in the respective monitoring plans when written and required.</p>

Theme	Primary issue raised	Response	Changes made to borefield design or operation
<b>Hawkesbury-Nepean Catchment Management Authority</b>			
Ecosystem protection	The Hawkesbury Nepean Catchment Action Plan (CAP), which was prepared in consultation with key NSW Government agencies and stakeholders, recognises a number of groundwater dependent ecosystems in the project area. In planning the implementation phase the HNCMA recommends that the precautionary principle be applied to ensure that all appropriate measures are taken to protect these ecosystems, and related environmental investment, from any damage that could be attributed to either the operation of the borefield or to construction and management activities.	The extensive studies that SCA has completed are the most detailed of any known in the Nepean catchment on the possible groundwater dependence of ecosystems that exist in this area. While perched groundwater systems are important, the linkages of the deeper regional aquifer with surficial ecosystems is less than expected and fewer impacts are expected - an adaptive management approach is proposed for borefield construction and operation.	SCA has committed to an expanded monitoring plan for monitoring the resource behaviour and the local environment. Most of these aspects are included in the revised monitoring framework and will be included in detail in the respective monitoring plans when written and required.
<b>Wingecarribee Shire Council</b>			
Government policy	1. Flawed Policy — the proposal to 'drought proof' Sydney, whilst significant is problematic when deep aquifer water storages are accessed as a resource before other far more sustainable options are identified, developed and exhausted. Council agrees that there are significant opportunities to better manage water demand and supply such as adaptive re use, stormwater harvesting, recycling, reduced demand management, leakage detection and mitigation and non potable quality industrial use but considers these options should be better resourced, actioned and exhausted before alternatives such as borefield extractions are adopted and commissioned.	Noted	No
Government policy	2. Government policy in securing a sustainable water supply fails the 'improved valuing and pricing' principal of Sustainability/Ecologically Sustainable Development. Whilst ever there is reluctance to re value and re price water, options to identify sustainable alternatives and identify other sources to augment the water supply will be sub optimal and/or compromised.	Noted	No
Sustainability	3. The proposal fails the Precautionary Principle test. It is difficult to reconcile claims that there is a sustainable supply of good quality potable water in the deep aquifers and that harvesting these storages is sustainable based on current information/data, given the extremely short timeframe of investigations and test pumping. Recent extreme fluctuations in climatic conditions of prolonged drought and short term intense rainfall events means the investigation period has been during a period of great climatic variation. It is erroneous for the SCA to claim that their	There has been numerous comprehensive studies of the groundwater resource and local ecosystems as part of the Kangaloon borefield investigations. The pumping trials completed to date are the best study to assess sustainability - the next stage (to about pumping response data on an even larger scale) would be to construct all or part of the borefield and to operate it for an extended period of time. The numerical modelling (under a variety of rainfall scenarios) suggests that there will be local depletion of groundwater in the	SCA has committed to an expanded monitoring program



Theme	Primary issue raised	Response	Changes made to borefield design or operation
	testing and trials have been exhaustive. This is simply not true. An exhaustive trial period would be for a much longer period when average conditions and seasonal variability are more likely to be achieved and therefore assessed. The Precautionary Principle therefore should be applied more rigorously and trial periods conducted over a longer timeframe.	sandstone aquifers during pumping but this recharges with a return to normal rainfall patterns No further testing is considered warranted and with appropriate monitoring systems in place, groundwater and ecosystem trends can be identified early and resolved.	
Government policy	4. The NSW State Plan (which draws on the Metropolitan Water Plan) identifies the priority of securing a sustainable water supply for all users, and identifies particular targets to achieve this. The identified targets are considered incongruous with exploring aquifer/borefield options. For example the increased recycling target should be sufficiently broad that future demand can be achieved through this and other means without the need to introduce options such as the borefield (where outcomes from the proposal are unknown and difficult if not impossible to quantify). Similarly a target that restores water extracted from rivers to sustainable levels directly contradicts geomorphic and hydro geological processes of aquifer's i.e. one of the principal characteristics of an aquifer is that, in time, water is released from the aquifer to rivers and streams thus in part sustaining these systems	Noted	No
Hydrogeological assessment and impacts	5. There is a significant lack of knowledge relating to aquifer recharge areas. Aquifer recharge areas have not been identified and/or mapped. There has been some anecdotal references to the recharge areas being to the south of the proposed borefield however this has not been substantiated. Whilst the documentation addresses to some extent recharge volumes it does not identify where recharge areas exist in the landscape therefore references to volumes and rates are considered tentative at best. A project of this magnitude should not be allowed to proceed until the recharge areas are defined. There may be significant land use/land management issues relating to the location of the recharge areas hence its critical their extent and characteristics are fully understood prior to the borefield project progressing	Recharge to the sandstone aquifer system occurs everywhere where the Hawkesbury Sandstone is exposed at surface - some areas display fast recharge and large rises in water levels, other areas display time lags before maximum recharge occurs, while others only show small increases in water levels. Recharge rates and volumes are variable but it occurs everywhere in the landscape. Chemistry and water level studies support this process and have identified the primary recharge areas - it is simplistic to assume there are recharge and non recharge areas that can be mapped on a localised scale	No
Hydrogeological assessment and impacts	6. There is a paucity of information relating to the geological/hydro geological processes occurring to the south of the borefield. The directional flow of ground water south of the borefield, the relationship between the shallow aquifers and the deep aquifers in this area appear not to be known, The extent to which groundwater extraction may impact on the Wingecarribee Reservoir and the vegetation and ecosystems that support the Wingecarribee Swamp does not appear to have been	There is substantial information on groundwater elevations and flow directions, including sufficient from south of the main borefield for the project to proceed. The expected drawdowns are all within the local area of the borefield. Water is sourced from local aquifer storage and groundwater is recharged locally in the Upper Nepean catchment - the pumping trial and modelling studies indicate there is no impact at distance including the Wingecarribee Reservoir area	No

Theme	Primary issue raised	Response	Changes made to borefield design or operation
Technical studies	<p>investigated. Given, amongst other things, the Shoalhaven transfers are stored in the Reservoir and released to the Upper Nepean or the Wingecarribee Rivers for Sydney dam supplies this is a highly significant issue.</p> <p>7. With regards to the EA document and the process more generally, there is still (this is acknowledged in the documentation) considerable work to be done with regards to quantifying the environmental impacts. It is difficult to assess the documentation and establish likely impacts given the paucity of site specific information e.g. vegetation impacts resulting from WTP construction, impacts on threatened species/endangered communities, roadside vegetation, road surface conditions, impacts on culverts and drains etc</p>	<p>There is substantial discussion in the specialist assessment reports in the Appendix volume of the EA. Ecosystem monitoring will be part of the monitoring program if the borefield is constructed and becomes operational.</p>	No
Technical studies	<p>The EA documentation is littered with nebulous phrases such as 'un likely', 'considered', 'anticipated', and comments such as 'difficulty in accurately detecting' and 'the shape of the final drawdown pattern is difficult to accurately predict because of the complexity of fractured rock aquifers and three dimensional underground flow'. The effect of such phrases and comments is that a proper and detailed review is difficult and hence real or potential impacts may not be appropriately mitigated or resolved.</p>	<p>There is sufficient certainty for the project to proceed - linkages between groundwater systems and the environment are not always clear and precise, and where there is some uncertainty or studies are proceeding, less definitive terminology has been used.</p>	<p>Ongoing monitoring now at key sites plus additional monitoring through the construction and operational periods</p>
Operational triggers	<p>8. Another area of concern is the matters of thresholds and triggers and importantly the security of the cap or limit of pumping. The current 'trigger' for operating the borefield is when dam storage levels fall below 40%. There are no guarantees to ensure that if the proposal proceeds the Government will comply with the 40% benchmark,</p>	<p>Staging and operational strategies will depend on the demand requirements at the time. The construction of the borefield has been deferred and the current trigger is to utilise groundwater when dam supply levels reach 40% - the 40% mark is set in the Metropolitan Water Plan.</p>	No
Operational triggers and monitoring	<p>9. The SCA need to better articulate the response hierarchy in the event information/data suggests there are anomalies in the aquifer response once pumping has occurred (see Chapter 12 of EA). At the present this is not clear, It has been suggested that real time (water quality/quantity) and annual (biological/bio geographical) monitoring will occur however by the SCA's admission there will be a time lag between biological responses as a result of pumping anomalies. If anomalies occur it's proposed to increase the monitoring (to twice a year). Again, for such a critical project and considering the significance in surface ecosystems from a water catchment perspective alone, the Precautionary Principle should be applied more rigorously to explore immediate reasons for anomalies and the nexus to groundwater extraction, Climatic variation will occur over a significant period. Variations in floristic composition and structure for example as a result of borefield activities will be</p>	<p>More details regarding the proposed monitoring activities and operational responses to water level, water quality and ecosystem changes are provided in the PPR (Section 4.4)</p>	<p>Ongoing monitoring now at key sites plus additional monitoring through the construction and operational periods</p>

Theme	Primary issue raised	Response	Changes made to borefield design or operation
	rapid, therefore the SCA should be responding more cautiously than simply increasing the monitoring.		
Operational triggers and monitoring	Chapter 12 does not fully respond to concerns relating to a 'STOP' mechanism when anomalies are identified or when further monitoring makes it clear significant adverse impacts are occurring. This section of the EA should also identify a 'chain of command' relating to notifications (including the community) of a) when anomalies are identified h) when significant adverse impacts are identified.	More details regarding the proposed monitoring activities and operational responses to water level, water quality and ecosystem changes are provided in the PPR (Section 4.4)	Ongoing monitoring now at key sites plus additional monitoring through the construction and operational periods
Hydrogeological assessment and impacts	10. What is the potential effect on the structural integrity of the fractured sandstone if large volumes of water are extracted! especially if the cap of 10-15 GL is exceeded. Could mass failure of these geological sequences occur as a result of extraction of high volumes of water? The recent Inquiry into the Southern Coalfields received a significant number of submissions relating to subsidence as a result of longwall mining. What evidence exists to suggest that longwall mining will impact on the integrity of the aquifers and hence this groundwater resource? Has the SCA undertaken any inter departmental inquiries to establish the risk of longwall mining on the structural integrity of the aquifers?	There are no impacts to the integrity of the sandstone from pumping groundwater - the sandstone rock mass is too competent to be affected - partial water extraction is quite different to the processes that operate when a coal seam is longwall mined SCA commissioned a report into the subsidence effects of pumping groundwater from these sandstone aquifers which found that the impacts were nil. No studies have been undertaken on the impact of longwall mining on the area as there are no proposals to mine under the borefield at this time. Also this is work that the Mining company would have to complete to obtain their mining approval.	No
Iron waste	11. The waste management of iron residue extracted the water is a matter that requires further clarification particularly the matter of how the waste product is managed.	Iron sludge generated from the water treatment process will be discharged into two collection ponds at each WTP site (one filling and the other drying). Ponds will be banded so that sludge accumulates, dries and is then removed at a minimum every 6 months. There is no potential for material to be lost except in the event of a very large flood event (1:20 or higher) when there substantial dilution processes operating.	Design changes at the WTP to wholly contain sludge in collection ponds, plus future recycling opportunities will be explored
Water transfers	12. How much water will actually end up with consumers and if the identified volume is transferred, for how long will this sustain Sydney and the Illawarra? Clearly the water transferred will sustain demand for no more than a few days. Therefore from a cost benefit perspective the project does appears unsustainable. Council would appreciate a definitive response to this question.	The borefield proposal is to supply up to 50 ML per day during periods of severe drought - this is equivalent to about 4% of the constrained demand for the Sydney supply systems during the most recent drought (equivalent to about 10-12 days supply pa). No transmission losses were observed during the pumping trial and instream transmission and evaporation losses to the Nepean dam (8-10km from the discharge sites) are expected to be minimal. Water from this supply system would (most likely) help to secure the Illawarra and will not be lost from the Upper Canal system. Additional groundwater (currently up to 150 ML per day) may be available from other sources. The ACIL Tasman economic appraisal that reviewed the 2004 Metropolitan Water Plan in	No

Theme	Primary issue raised	Response	Changes made to borefield design or operation
Approvals	<p>13.The following relates specifically to the Draft Statement of Commitments:</p> <p>&gt;Action #4 refers to the Construction Environmental Management Plan (CEMP) which details the practises and procedures to be implemented to mitigate environmental impacts. Whilst the CEMP is supported, site specific issues have not yet been identified. In relation specifically to flora and fauna issues the presence/absence of significant habitat trees, threatened species, endangered communities have yet to be established. Council is concerned with the sequencing of the project in terms of releasing the EA and then if approved developing a CEMP. There appears no provision in the process to manage or assess the significance of isolated features e.g. a threatened plant, a remnant EEC</p> <p>&gt;Action #6 the biophysical monitoring needs to be more frequent. Changes to the hydrology of the swamps and the landscape more broadly as a result of groundwater extraction (during extended dry periods) will be rapid. A monitoring regime of twice per annum and then more frequent of anomalies are detected would be a more appropriate regime than that proposed.</p> <p>&gt;Action #25 as stated above if triggered, ecological monitoring should be more rigorous than that set out in Chapter 12 of the EA. The monitoring should be more frequent than that proposed, as alterations to the biota and landscape will be rapid (during periods of extended drought) if adverse outcomes arising from groundwater extraction arise.</p> <p>&gt;Action #34 raises a significant issue and relates to one of the broader concerns regarding the entire project. The commitment that should private landowners experience reductions in their bore's then some form, of compensatory measure will be offered including for example alternative water supplies or modification's to existing bores (lowering) is inadequate. Loss of or a reduction in bore volumes could potentially have huge socio economic</p>	<p>April 2006 critically evaluated groundwater in the context of other potable water supplies for drought supply and supported the development of groundwater sources.</p> <p>Significant survey has been completed within the corridor - flora, fauna, and aboriginal and cultural; heritage issues have been identified. All sensitive areas and known threatened species will be protected - if special trenching and construction methods are required near sensitive areas, then these will be identified and included in the CEMP requirements</p> <p>The baseline data sets that SCA has completed to date have been 6-monthly across two seasons (autumn and spring in 2006 and 2007) and there has been little correlation between each event - the biodiversity and the variability is high (even between upland swamps in the same area), so more frequent biophysical monitoring may not be useful. SCA's preference for ecosystem monitoring is more detailed 5-yearly to start with (non operational periods) and then to adopt 6-monthly or shorter periods as required during construction and operational periods. The baseline data sets that SCA has completed to date have been 6-monthly across two seasons (autumn and spring in 2006 and 2007) and there has been little correlation between each event - the biodiversity and the variability is high (even between upland swamps in the same area), so more frequent biophysical monitoring may not be useful. SCA's preference for ecosystem monitoring is more detailed 5-yearly to start with (non operational periods) and then to adopt 6-monthly or shorter periods as required during construction and operational periods. There is minimal groundwater use from bores in the catchment because of the numerous other water sources (rainwater tanks, springs, permanent creeks etc) and hence the socio-economic impacts (if any) are limited. When the borefield is operational, there will be a substantial network of observation bores between the borefield and existing bores and springs on agricultural lands. Impacts on springs (if any) are expected to be negligible.</p>	<p>More survey will be completed in advance of construction programs</p> <p>More survey will be completed in advance of construction programs and biannual monitoring has been adopted for construction and operational periods</p> <p>More survey will be completed in advance of construction programs and biannual monitoring has been adopted for construction and operational periods</p> <p>No</p>

Theme	Primary issue raised	Response	Changes made to borefield design or operation
	<p>impacts such that livelihoods and a community are jeopardised. To lower a bore would appear to be an unsustainable alternative to an already sustainable practice as would sourcing water from an alternative location. The potential social and economic implications are far more significant than perhaps they are being considered.</p> <p>This point is a principal cause of much of the concern with the entire project and has not been adequately considered by the SCA or the Government more broadly.</p>	<p>Groundwater level variations beyond the normal range of fluctuations are only expected to occur within two to 2.5 kilometres of operational production bores. If impacts are evident and are attributable to borefield pumping then SCA will have a range of remedial measures in place to re-establish, augment or replace existing supplies. Financial compensation measures are not required if there is no loss of supply.</p>	
	<p>&gt;Action #36 The road bridge and culvert dilapidation study must be prepared in consultation with WSC Roads and traffic staff to remove any potential ambiguities.</p>	Noted and agreed	NA
	<p>&gt;Action #38 it needs to be stated that NO works are to occur on a Sunday OR public holiday.</p>	Noted and agreed	NA
Design	<p>14. Council would prefer all pipeline infrastructure and works to be located within SCA property as a first option. Where this is not possible Council would like to be involved in the justification process for using the road reserve. Short term project savings could lead long term maintenance costs for road infrastructure.</p>	<p>This is SCA's preferred approach, and road crossings and use of road reserves will be minimised where possible.</p>	<p>Changes have been made in the eastern area to move away from Tourist Road onto recently acquired SCA land to avoid a 2-3 kilometre length of road</p>
Design	<p>15. Within the road reserve all pipelines should be located within the shoulder of the road and not within the pavement. The effect these works will have on table drains and natural vegetation are to be minimised and the table drains are to be left in a working condition after the installation and excavation.</p>	<p>This is SCA's preferred approach, and road crossings and use of road reserves will be minimised where possible.</p>	<p>The main pipeline route along Kirkland Road will now all be within the shoulder of the road</p>
Design	<p>16. Council's road opening conditions and the IPWEA specification for road restorations 306U are to be used where road crossing excavations are unavoidable. Road crossings are to be minimised and Council would like to inspect the backfilling of these works.</p>	Noted and agreed	NA
Design	<p>17. All creek crossings need to be assessed individually by Councils Asset Engineer. Some of our bridge and culvert assets are new where as others are due for replacement. Attaching SCA assets to our bridges and culverts will not be ruled out however in some instances this may not be accommodated.</p>	<p>Noted - this aspect to be discussed further with Wingecarribee Shire Council when final tender designs are prepared.</p>	<p>May have future design implications</p>
Traffic control	<p>18. Traffic control plans for the construction works will need to be approved by Council's Traffic Engineer. In some instances full road closures may be required and these will need to be addressed through the Local Traffic Committee. SCA are advised that this is process does take some time as the minutes need to be referred to full Council for endorsement.</p>	Noted and agreed	NA

Theme	Primary issue raised	Response	Changes made to borefield design or operation
Design	19. Within Moresby Hill Road trenching along the southern alignment would have a lesser impact on established trees than the northern side.	The northern side is proposed so as to minimise road crossings - minimal impact on trees is expected if the trenching is on the boundary of the road reserve and the SCA lands.	No
Other	The following issues some of which have been raised above have been identified by representatives of Councils Environment Committee and are included for DoP and SCA consideration:		
	- Purchase of green power to offset power consumption of project.	The borefield power consumption is low at only 1 to 2 MW per day if all components of the borefield were fully functional and there was some cycling of pumping. Green power options to run the borefield will be explored again when/if it is constructed and becomes operational, however its occasional use does not lend its operation as a green power scheme.	No
	- Relationship to Shoalhaven transfer project.	The proposed Shoalhaven Transfers project is another (separate) aspect of the MWP.	NA
	- Possible impact on supply of emergency water to Goulburn.	There is no link or impact on the separate pipeline proposal from Wingecarribee Dam to Goulburn.	NA
	- Impact of any change of quantity of groundwater extracted.	Impacts are addressed in the new transient modelling study	No
	- Insignificant contribution to current water consumption, 2-3% of Sydney's consumption would be available from Kangaloon aquifer.	The borefield proposal is to supply up to 50 ML per day during periods of severe drought - this is equivalent to about 4% of the constrained demand for the Sydney supply system during the most recent drought (equivalent to about 10-12 days supply pa). With additional groundwater sources from other areas, the contribution from groundwater during drought could be around 10%.	NA
	- Impact of construction of new power supply lines on roadside vegetation.	Minimal vegetation clearance is proposed, and the bulk of the infrastructure will be underground, or screened from public roads and private lands.	No
	- Preference to maximise undergrounding of power supply — Integral reluctance when this was proposed.	Underground power is proposed in publicly visible areas where there are no existing power lines. Upgrading of overhead power is proposed in the agricultural landscape where there is existing overhead power. The current routes will not change with the only extensions being from existing poles to new poles beside each production bore.	No

Theme	Primary issue raised	Response	Changes made to borefield design or operation
	- Aesthetic impact on high tourist areas e.g. Tourist Road.	Minimal vegetation clearance is proposed, and the bulk of the infrastructure will be underground, or screened from public roads and private lands. The water treatment facilities along Tourist Road and Fire Trail No.3 will be located, designed and landscaped to minimise visual impact, Disturbed areas will be rehabilitated quickly with native local species, and for this reason there will be minimal visual impact and changes to the landscape.	No
	- Impact on perched water dependent endangered swamps.	Nil - upland swamps are disconnected from the regional sandstone aquifer	Ongoing monitoring now at key sites plus additional monitoring through the construction and operational periods
	- Impact on streams from discharged water.	Water qualities will be compatible after treatment and temperature and DO adjustment	Ongoing monitoring now at key sites plus additional monitoring through the construction and operational periods
	- Loss of base flows into creeks when groundwater level lowered from pumping.	R&D studies, pumping trial and transient modelling studies suggest that stream connectivity is low and losses are around 5-20% across the area. The volumes lost from streams are very low in comparison to actual stream flow and the volumes of groundwater that are expected to be pumped.	Ongoing monitoring now at key sites plus additional monitoring through the construction and operational periods
	- Concern regarding iron content in extracted groundwater and disposal of iron sludge from treatment plants.	Iron sludge will be dried before being trucked to landfill - no sludges will be released to the Nepean River and hence there is no pollution potential	No
	- Impact on endangered species in area	Threatened species will be surveyed again and protected	Extra surveys

## **Appendix D**

---

Architectural Drawings from the  
Preferred Design Report



## Background

Due to the visible nature of the location of the water treatment plant for areas 1, 2 and 3, architectural input was sought to ensure the Tourist Road Water Treatment Plant and its associated structures would have minimal visual impact on the surrounds.

The proposed site the WTP for Areas 1, 2 and 3 is located to the north of Tourist Road at the junction of Kirkland and Tourist Road. The site is the only cleared area north of Tourist Road and is surrounded on three sides by densely vegetated forest.

The Nepean River demarcates the site boundary to the north east and west with a bridge, crossing over Tourist Road just East of the site. A large portion of the site acts as a flood plain for the Nepean River.

The requirements for the site include the location of a WTP, which includes four buildings and associated water treatment ponds, a pumping station and a balance tank.

## Precedent Review

As part of the design development a precedent study was undertaken to inform the design process. Existing dams and farm sheds in the area were analysed to inform scale, form and selection of materials for both the dams and structures associated with the Borefield Project.

Other precedent studies for dams and wetlands included an evaluation of wetlands at Sydney Olympic Park and Sydney Park, NSW. Precedent studies for built form included the McCormick Centre in South Australia (Figure 21) and the Work Barn in Victoria.

At Sydney Olympic Park and Sydney Park, constructed symmetrical ponds and more organic 'natural' ponds were evaluated as well as revegetation and natural water filtration systems.

It was evident from the precedent studies that typical farm sheds are generally grouped together and positioned in an informal arrangement defining a hard stand or yard. In larger shed arrangements there is generally a varied use of materials to break up and articulate building facades.







## Design Principles

A series of design principles to inform the masterplan were developed that responded to the site analysis and precedent studies. These design principles included:

- The design should respond to the natural setting;
- Revegetation of the site to facilitate long term screening of the WTP;
- Buildings should emulate typical groupings of rural sheds;
- Views from Tourist Road towards the WTP should be protected where possible; and
- Visual impact on neighbouring properties should be minimised where possible.

# Site Analysis

## Legend

-  **Rural residential and farm lots**  
Gently undulating and mostly cleared rural residential land.  
Average lot size is approximately 20ha with small single storey dwellings, dams and farm sheds.  
Dams are typically 7500m<sup>2</sup>.  
Generally farm sheds are 9 x 6m or 54m<sup>2</sup>.
-  **Tourist Road**  
Tourist Road branches off from Kangaloon Road. It provides a pleasant drive with views of open farm land to the South and densely vegetated forest to the North.
-  **Metro Special Area**  
The Metro Special Area consists of densely vegetated forest.
-  **Existing Vegetation**
-  **Nepean River**  
The Nepean River runs from South to North, crossing over Tourist Road just East of the site.
-  **Site boundary**



Nepean River



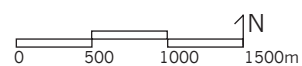
Tourist Road



Typical rural shed








Typical rural shed





# Site Analysis

## Legend

-  **Site**  
Gently undulating land which falls towards the Nepean River.
-  **Views**  
Views from Tourist Drive and adjacent properties are pleasant rural views with a densely vegetated backdrop.
-  **Flood level**  
\*Information to be provided
-  **Flood plain**  
Indicative flood plain
-  **Existing vegetation**



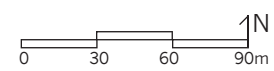
1 Outlook from adjacent properties



2 Views from Tourist Drive Nepean River bridge crossing



3 Views from Tourist Drive towards residential properties to the South





## Precedents - Ponds

Two precedents have been considered, Sydney Olympic Park and Sydney Park.

These precedents examine constructed, symmetrical ponds and more organic 'natural' ponds.

### Sydney Olympic Park

The water reclamation and management system includes:

- a water reclamation plant that removes water from sewage
- water storage reservoirs
- a water treatment plant to filter and disinfect water from the water reclamation plant and storage
- a separate, dedicated supply system to pipe water from the treatment plant through Sydney Olympic Park and Newington.



Sydney Olympic Park

0 344 688m



Approximately 22,000m<sup>2</sup> in area



Reclamation plant

### Sydney Park

Sydney Park includes:

- an organic shaped system of wetlands supporting native flora and fauna
- native gardens
- lakes



Sydney Park

0 344 688m



Approximately 27,000m<sup>2</sup> in area (North pond)



Pond edge treatment



View looking north



# Precedents - Structures

## Standard farm and industrial sheds

Corrugated iron farm sheds are typical of the area. Groupings of sheds (generally 9 X 6m) are usually positioned in a formal arrangement defining a yard.



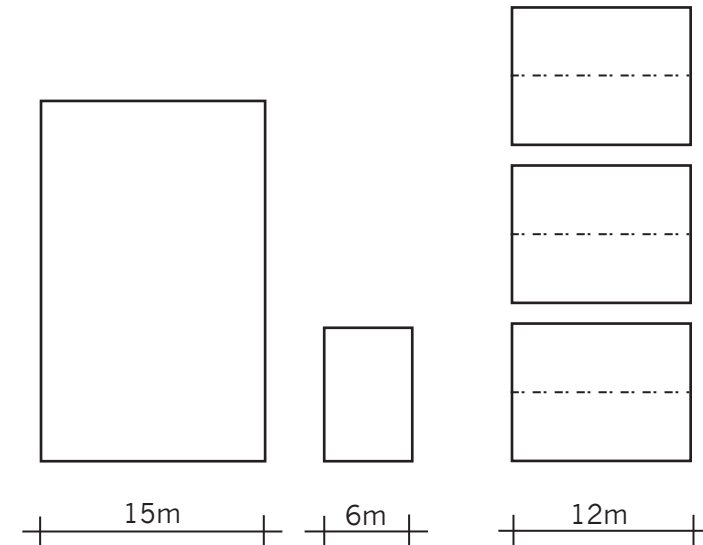
Typical sheds of the area



Farm sheds



Industrial shed



1:200 @ A3

**Standard industrial shed**

24 x 15m  
8m high

**Standard farm shed**

9 x 6m  
6m high

**Infinity system required plant footprint**

12 x 27m  
6m high

or / 3no. 12 x 9m  
or / 6no. 12 x 4.5m

## McCormick Centre, South Australia

The Centre for Environment in Renmark in the Riverland of South Australia explores regional to contemporary rural architecture. That of an expanded shed designed around ecological principles.



## Box Hill Tafe 'Work Barn'

This simple shed has a basic portal frame with roof cladding faceted down the south wall to make the building look as if it has a tubular form. A polycarbonate roof sheeting window allows a clear view to the trade facilities.

This building has no visible security so the interior is stripped of any material excess that could be venerable to vandalism.

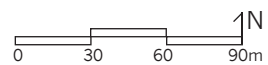
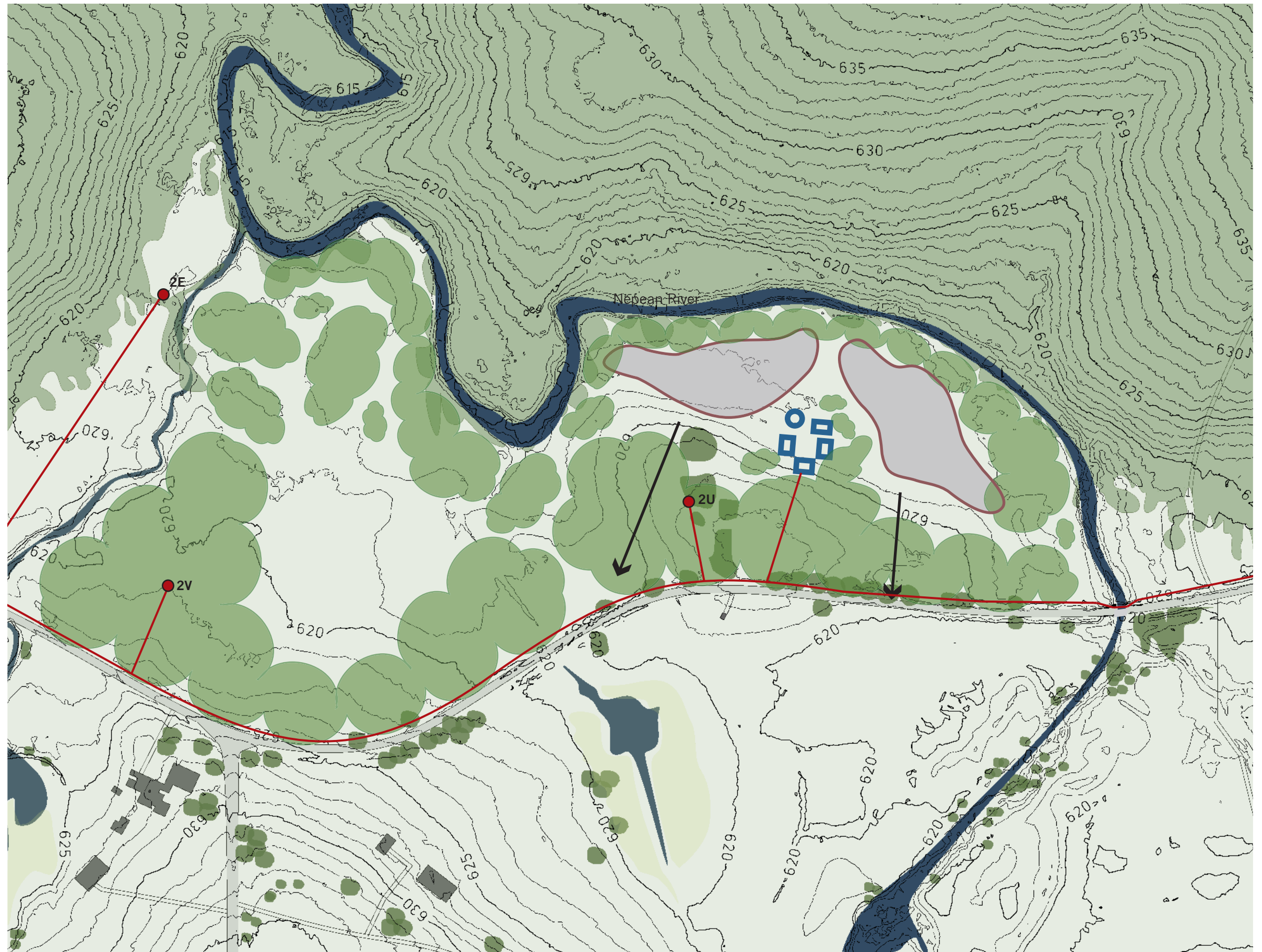




## Design Principles








A series of design principles have been developed which respond to the site analysis and precedent studies.

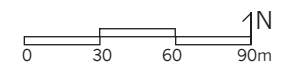
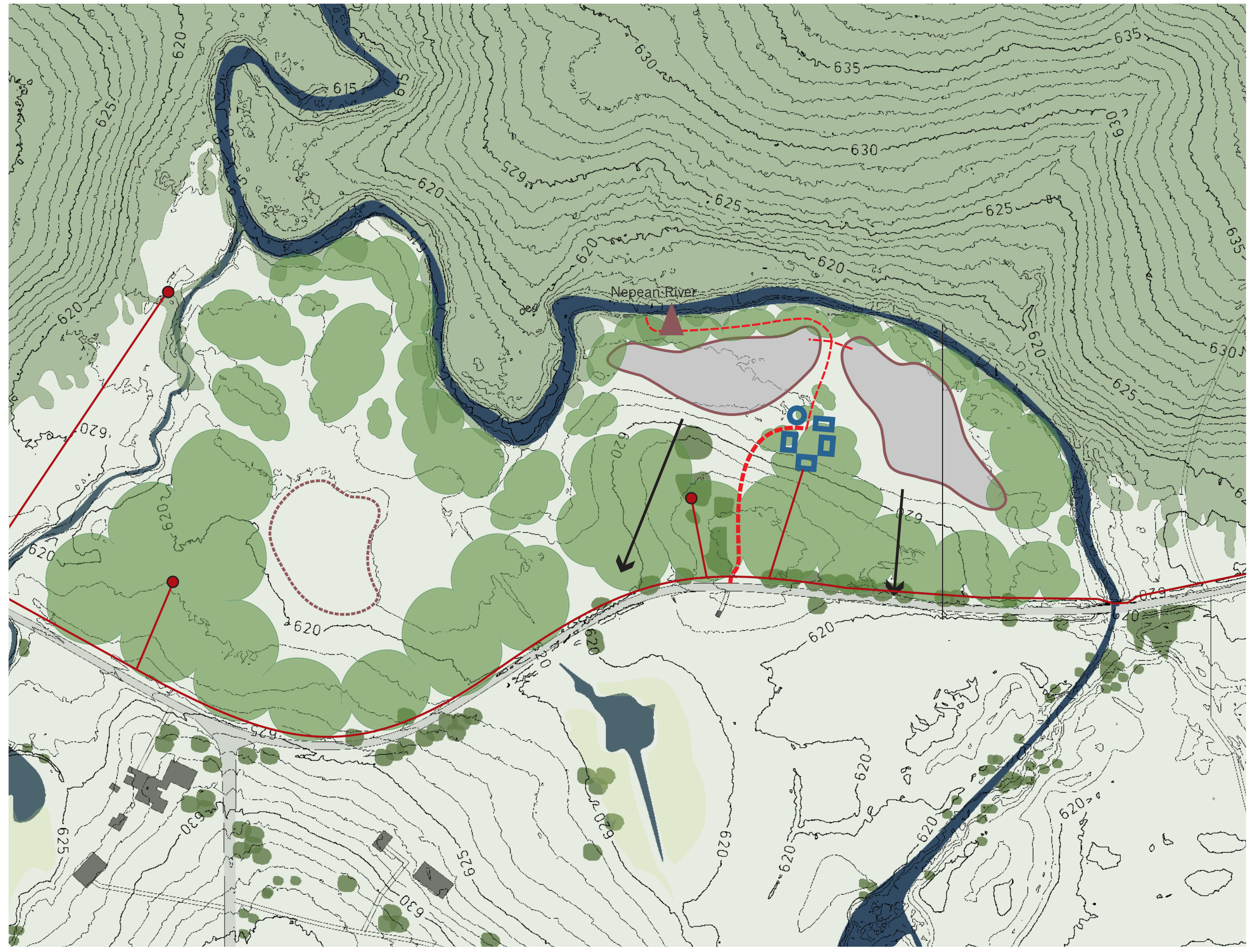
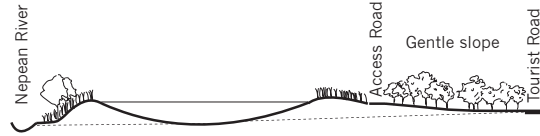
1. Respond to the natural setting
2. Provide long term screening and revegetation
3. Buildings to be modulated, farm like arrangement
4. Protect views from Tourist Road, through berm height and grading.











Option 1 Natural

-  **Ponds**  
Natural, organic shaped ponds.  
13500m2 total area.
-  **Future pond if required.**  
6750m2 total area
-  **Discharge point**
-  **Access Road**  
Vehicular access from the rise  
on Tourist Road opposite existing  
driveway.
-  **Site cut and fill**  
Cut and fill to create a gentle slope  
from the 1:100 year flood level at  
top of bank to the road, lessening  
the visual impact of the berms.  
Flood level height requirements  
require further investigation.
-  **Water treatment plant**  
Buildings to be located in a formal  
arrangement defining a yard or  
hardstand, to be in character with  
the groupings of farm sheds in the  
surrounding rural area.
-  **Re-vegetation**  
Long term re-vegetation.





Option 2 Structured

-  **Ponds**  
Symmetrical, formal ponds.  
13500m2 total area.
-  Option for future pond if required.
-  **Discharge Point**
-  **Access Road**  
Vehicular access from the rise  
on Tourist Road opposite existing  
driveway.
-  **Water treatment plant**  
Simple, contemporary shed design.
-  **Re-vegetation**  
Long term re-vegetation.

