



Douglas Partners

Geotechnics | Environment | Groundwater

Report on
Groundwater Impact Assessment
and Protection

Proposed Agricultural School
2964 Wisemans Ferry Road
Mangrove Mountain

Prepared for
Mangrove Mountain Agricultural School

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Report on Groundwater Impact Assessment and Protection

Proposed Agricultural School

2964 Wisemans Ferry Road, Mangrove Mountain

1. Introduction

This report presents the findings of an assessment of potential groundwater impact associated with the proposed new agricultural school development at 2964 Wisemans Ferry Road, Mangrove Mountain. The work was commissioned by Mr Tamour Tariq of Mangrove Mountain Agricultural School (site owners and developers) and was undertaken in consultation with Mr Ghazi Al Ali of Ghazi Al Ali Architect (site architect and development consultant). This assessment was undertaken as part of an application for redevelopment of the site as an agricultural school.

It is understood that the construction of a school with facilities for a maximum of 100 students (with up to 80 boarding residents) and 14 staff (with up to 3 boarding staff) is proposed. The school is located within the Central Coast Water Supply Catchment Area. The overall objective of the assessment is to provide an evaluation of potential groundwater impacts associated with development, based on the National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia and Gosford City Council (GCC) requirements. The report has been prepared to meet the requirements of a *Level 2 Groundwater Contamination Assessment Report* as specified in the *Guidelines for Groundwater Protection in Australia* (Ref 1).

This report outlines the information reviewed as part of a desktop study into the groundwater impacts, along with supplementary work carried out in connection with other investigations completed for the proposed development.

For the purpose of the assessment, a plan showing the proposed layout of the site was supplied by 360° Landscape Architecture Pty Ltd (Drawing 1, Appendix A).

2. Objectives and Scope of Work

The primary objectives for the assessment were to:

- Assess the geological and hydrogeological conditions at the site and local area ;
- Confirm the environmental value of the aquifer/s underlying the site; and
- Assess if there are any local recharge areas or if there are any nearby environmental receptors that may be impacted by the proposed development.

The scope of work included a desktop review of the available information comprising the following data sources:

- Previous contamination assessment and effluent disposal assessment reports (Douglas Partners (DP)),

- *1:250,000 Hawkesbury-Nepean Groundwater Vulnerability Map* (Department of Infrastructure and Natural Resources (DIPNR)),
- *Mangrove 1:25,000 Topographic Map* (LPMA),
- *Water Sharing Plan for the Kulnura Mangrove Mountain Groundwater Sources* (DIPNR);
- Groundwater bore database (NSW Office of Water),
- *Gosford-Lake Macquarie 1:100,000 Geological Series Sheet* (Department of Mineral Resources);
- *Soil Landscapes of the Gosford-Lake Macquarie 1:100,000 Sheet* (Department of Conservation and Land Management)

The assessment was carried out following a site inspection, preliminary subsurface investigations and laboratory testing of site soil samples for the effluent disposal assessment.

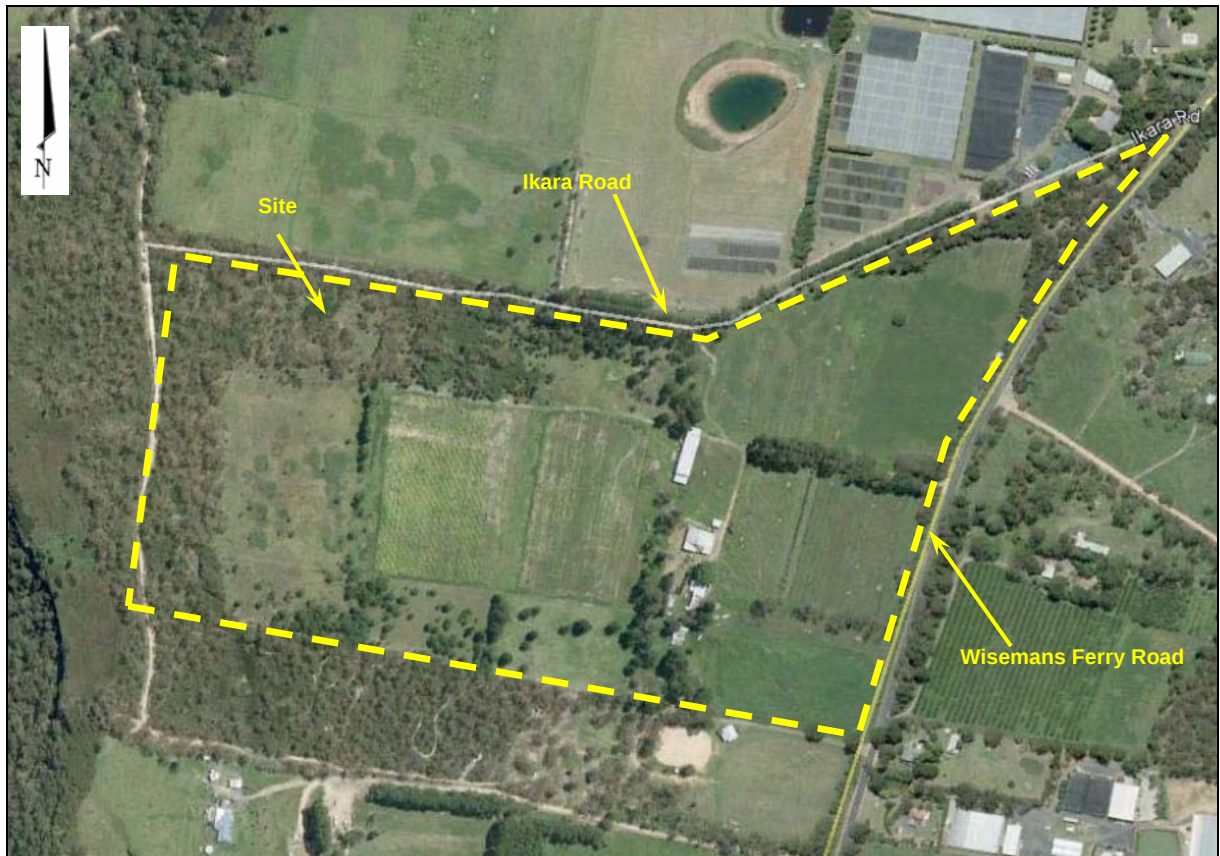
3. Site Description

3.1 Site Identification

The site is identified as Lot 87 in Deposited Plan 755253 in the Parish of Popran and the County of Northumberland. The site has a street address of 2964 Wisemans Ferry Road, Mangrove Mountain NSW, in the local government area of Gosford City Council. The site has an irregular shape and is located on the south-west corner of the intersection of Wisemans Ferry Road and the unformed Ikara Road. The site comprises an area of approximately 22.5 ha.

It is understood that property has a current land use zoning of 1(a) Rural Agriculture.

Figure 1, below, is an aerial view of the local area and shows the site in relation to the nearest cross street.



**Figure 1: Location of the site within Mangrove Mountain
(image sourced from Google Earth and dated February 2010)**

At the time of the assessment, the site appeared to comprise mostly fallow paddocks with some bushland adjacent to the northern and western site boundaries. Dilapidated farm buildings (former dwellings and sheds) were located in the central portion of the site.

Drawing 1, which is included in Appendix A, shows the existing layout of the site.

Surrounding land uses include the following:

- North (across slope) – wholesale nursery.
- West (down slope) – bushland (Popran National Park).
- South (across slope) – mix of paddocks and bushland (Pony Club).
- East (up slope) – mix of orchards and wholesale nursery.

It should be noted that the current intensive agricultural activities at surrounding sites were consistent with historical activities undertaken at the subject site.

3.2 Topography

Review of the local topographic mapping and a site survey plan indicates that the site is located on the western face of broad elevated ridge, with surface levels within the site falling from about RL 246 m AHD in the north east corner to approximately RL 200 m AHD in the south-west corner of the site. Observation suggests that the natural surface levels throughout the site have not been significantly modified.

The mapping indicates that Crafts Creek is located approximately 250 m to the west of the site. Any surface water runoff from the site is expected to migrate off site via overland flow to Crafts Creek and then flow to the north-east into Mangrove Creek. The site is located within the Mangrove Weir Water Supply Catchment Area.

3.3 Regional Geology

Reference to the interim Sydney 250,000 Geological Series Sheet indicates that the site and surrounding area is generally underlain by Hawkesbury Sandstone of Triassic Age. Lithologically, Hawkesbury Sandstone comprises medium to coarse grained quartz sandstones with some minor siltstone and shale lenses. It can be divided into a sheet sandstone facies and a massive sandstone facies, with a maximum thickness of about 250 m.

Rocks of the Terrigal Formation, which form part of the Narrabeen Group of Triassic Age, are also encountered in the valleys of Mangrove Creek, southwest of the site. The contact between this unit and the overlying Hawkesbury Sandstone is mapped at approximately RL 170 AHD. The Terrigal Formation is characterised by lithic quartz to quartz sandstone, siltstone, claystone and conglomerate.

Structurally, the area is relatively simple with Wollombi and Yarramalong synclines, as well as the Kulnura and Macquarie anticlines trending northeast-southwest across the Central Coast region.

3.4 Soil Landscape Mapping

Reference to the Gosford-Lake Macquarie Soil Landscape Mapping indicates that the site is located within the Somersby residual soil landscape area. This soil landscape group is described as gently undulating to rolling rises on deeply weathered Hawkesbury Sandstone plateau. Slopes are generally less than 15% and rock outcrops are generally absent.

The soil is described as moderately deep to deep, very low fertility, very to extremely acid and very low to low available water holding capacity. It is noted that the soils are described as deep and well drained and can be productive with suitable fertiliser and lime application. A moderate hazard is nominated for erosion under cultivation and urban development. With regard to development capabilities, there are generally low limitations for urban development and grazing, and moderate limitations for cultivation.

Whilst there are only slight limitations to grazing, the very low fertility, extremely acid soils and very low to low available water holding capacity will require further consideration for the operation of a agricultural school development.

4. Hydrogeology

4.1 Regional Setting

The main source of groundwater in the Somersby area is the Kulnura-Mangrove Mountain Aquifer (KMMA), which is controlled by the Water Sharing Plan for the Kulnura-Mangrove Mountain Groundwater Sources. Information indicates that there are in excess of 600 registered bores in the Somersby, Kulnura and Mangrove Mountain area with the existing volume of groundwater licensed for extraction totalling approximately 1,637 ML/year. The groundwater quality is generally reported as being very good, making it suitable for a broad range of uses.

4.1.1 Aquifer Characteristics

Previous investigation by Douglas Partners (Project 33357, June 2003) indicates that groundwater within the KMMA occurs in both primary porous layers and layers with secondary porosity such as faults or fractured zones.

The sheet sandstone facies of Hawkesbury Sandstone contains the primary porous layers that are generally utilised by the community for irrigation or domestic requirements. Transmissivities from production bores were assessed to be low and range from less than 5 m²/day, up to 50 m²/day. Groundwater flow through the aquifer is directly related to the transmissivity and hydraulic gradients, therefore depending on the gradients, groundwater flow velocities are typically relatively low and likely to be 1 – 20 m/year.

The massive sandstone facies has a lower permeability because of the higher clay content and less sedimentary structure. Unless the massive facies is highly fractured, such as faults or shear zones, the sequence acts more as an aquitard than an aquifer.

Recharge to the aquifer generally occurs through direct infiltration of rainfall and local run-off. Whilst the rolling topography of the Somersby area and presence of highly permeable sandy soils with low available water holding capacity would give rise to improved rainfall recharge, runoff can also be relatively high and usually only a small proportion of the rainfall actually recharges the aquifer.

Groundwater may also occur in a perched condition within the upper sandy soils above the sandstone bedrock. This groundwater is often observed as springs near rock outcrops.

4.1.2 Groundwater Quality

Previous investigation suggests that groundwater quality from the KMMA is generally very good, with salinity generally in the range 50 – 150 mg/L but up to 500 mg/L. The Australian Drinking Water Guidelines (2011) for total dissolved solids is 1000 mg/L.

It is noted that work undertaken by the Central Coast Public Health Unit 2000 indicated that a large proportion of groundwater samples taken from bores in the area failed to meet the criteria for pH and aluminium. Furthermore, some of the bores had elevated nitrate levels which were probably caused by the use of fertilisers on orchards, poultry waste and septic tanks. Of the raw domestic groundwater samples tested, 33% were considered unsuitable for drinking.

The groundwater quality of any perched aquifer is variable and would be largely impacted by local conditions and site usage.

4.2 Registered Groundwater Bore Database

Given the site's topography and geology it was considered likely that permanent groundwater would be present at least several metres below the existing ground surface within the sandstone bedrock rock. Shallower intermittent seepage maybe present the interface of localised permeability boundaries such as at the interface of the soil and weathered rock profile (perched aquifer).

A search for registered groundwater bores in the Department of Natural Resources groundwater bore database [Note: this function has been taken up by NSW Office of Water] indicated that there are approximately 13 registered groundwater bores within a 1 km radius of the site. Only one bore appeared to be located down-gradient and was approximately 100 m west of the site boundary.

The results of the groundwater bore search are summarised in Table 1 below and details of the individual bore construction, drillers logs (where available) and a plan showing their location is provided in Appendix A.

Table 1 - Results of Groundwater Bore Search

Bore No	Location	Depth (m)	Aquifer Depth (m)	Standing GWL (m)	Yield (L/sec)	Salinity
GW104143	Lot 229 DP727251	84	19.9/42.7/79.6	12.0	0.6	Fresh
GW101499	Lot 78 DP 723211	91	22/70.5	13.0	0.6	Fresh
GW066457	Lot 6 DP 757077	30	18.1/25.7/29.0	8.0	1.2	Fresh
GW103565	Lot 86 DP 661697	30	-	5.5	0.25	-
GW059875	Lot 1 DP 372493	28	18.1/25.9	10.0	1.1	Fresh
GW066467	Lot 8 DP 757077	46	18.9/28.6/37.2	6.0	0.5	Fresh
GW103002	Lot 155 DP 755253	38.1	-	-	0.88	-
GW101952	Lot 1 DP 510636	101	65.9/87.8/96.0	15.0	1.5	Fresh
GW072638	Lot 86 DP 755253	13	-	-	-	-
GW066461	Lot 8 DP 757077	32	-	8.0	0.4	-
GW057748	Lot A DP 360925	46	14/34.9/72/96	7.5	0.5	-
GW100030	Lot 86 DP661697	50	41.7/43.8	-	1.5	Fresh
GW072420	Lot 1 DP723211	49	15.6/45.6	15.0	0.9	Fresh

The results of the bore search indicate that the closest bore is located approximately 100 m west of the the western site boundary (GW104143) and had a authorised purpose of recreational (groundwater). All of the bores within a 1 km radius of the site rely on aquifers within Hawkesbury Sandstone. It is not known if these groundwater bores are still operational.

The bore data indicates that the aquifer within the sandstone is confined and the groundwater flows under confined conditions. This is shown by the standing groundwater level data (or potentiometric surface), which range between 1.5 m and 13.0 m depth, which are all above the upper level of the upper aquifer level within the boreholes which ranged between 14 m and 65.9 m depth. In a confined aquifer system such as thhe KMMA present beneath the site, the depth to the aquifer should be interpreted as the actual depth to groundwater when assessing its vulnerability to surface contamination. This is because when a borehole intersects the confined aquifer the pressure within the aquifer forces the standing water level to rise up the borehole above the top of the aquifer. Therefore the standing groundwater levels are not a level below which the subsurface is saturated.

Water quality within the bores were generally reported being “fresh” (non saline) and have authorised recreational, domestic, domestic irrigation, domestic industrial stock, irrigation, domestic industrial and commercial. A copy of the search results is provided in Appendix B.

4.3 Groundwater Vulnerability

The 1:250 000 Hawkesbury-Nepean Groundwater Vulnerability Map has assigned a moderately high vulnerability rating for the groundwater stored within this area of the KMMA. This indicates a potential for the groundwater to be impacted by surface activities or contamination.

The land use of the KMMA includes orchards, market gardens, wholesale nurseries and poultry farms. The use of fertilisers and chemicals for controlling weeds and insects are potential sources of groundwater contamination, as well as on-site effluent disposal.

The Water Sharing Plan for the Kulnura Mangrove Mountain Groundwater Sources also lists NSW agriculture chicken disposal pits, municipal landfills (such as that at Mangrove Mountain), Somersby industrial area, septic tanks and on-farm disposal pits as potential groundwater contamination sources.

Groundwater vulnerability is defined in the ANZECC National Water Quality Management Strategy (Ref 1) as a relative evaluation of the potential exposure of a groundwater resource and its beneficial use to contamination from planned and unplanned sources. The concept of vulnerability is based upon an assumption that the physical environment can provide some degree of protection from contamination through natural attenuation processes. The vulnerability assessment is a qualitative assessment based upon the hydrogeological regime, as well as the thickness and nature of the unsaturated zone overlying the aquifer. For example, a shallow unconfined aquifer with a permeable unsaturated zone would be highly vulnerable to surface contamination, whereas a deep confined aquifer would have a low vulnerability.

The groundwater resource present beneath the site comprises a confined sandstone aquifer at depths of greater than 14 m and a relatively low permeability unsaturated zone of non-fractured sandstone and clay soils. On this basis the aquifer vulnerability is considered to be low to moderate at this site.

4.4 Beneficial Groundwater Use

A published beneficial use map was not available for the Central Coast area, however available information indicates that most of the groundwater from the KMMA would be used for the following purposes:

- agricultural, including stock and orchard irrigation;
- domestic water supply;
- commercial uses; and
- drinking water.

It is noted that the Water Sharing Plan for the Kulnura Mangrove Mountain Groundwater Sources does not recommend consumption of raw groundwater, without prior treatment. Appendix 2 of the water sharing plan indicates that there are groundwater dependent ecosystems located in the locality of the site (perched swamp community). The perched swamp community is mapped as being adjacent to the western site boundary and has been identified as an endangered ecological community and that it would be susceptible to any significant increases in nutrient load.

5. Site History Review

Review of historical aerial photographs dating back to 1954 indicated that the site and local area appeared to be originally developed from native bushland for primarily orchard land uses. Since that time, development in the local area has diversified to include a mix of orchards, poultry, nursery and market gardens. It is noted that areas to the west of the site appear to have generally remained undeveloped.

Since the site's original development, land uses appear to have included both orchards and market gardens. Information also suggested that commercial agricultural production ceased around 15 years ago, although some orchards and possibly market garden uses appear to have remained over this time. The site is currently not actively farmed and with a significant portion of the paddocks fallow and activities understood to be generally limited to weed control.

6. Site Inspection

An inspection of the site was carried out on 17 January 2012 as part of other assessments completed by DP. No evidence of springs or seepages was noted within the site. No evidence of sandstone outcrops were observed at the site and test bore investigations completed as part of other investigations indicated that a reasonably deep soil profile (i.e. greater than 1.0 m) was present at the site. This is supported by review of drillers logs for nearby registered bores which indicated that sandy topsoil is underlain by sandy clay and clay to depths ranging between 3.9 – 8.2 m.

A single groundwater bore was identified at the site. It was understood that the bore supplied water to the existing residence at the site. This bore was not identified during the review of registered groundwater bores in the local area.

7. Proposed Development and Potential for Contamination

It is understood that construction of an agricultural school development is proposed for the site. The proposed school has a maximum of 100 students (with up to 80 boarding) and 14 staff (with up to 3 boarding). The school will be supplied with a reticulated or bore-water supply, and that domestic liquid waste is to be processed by an aerated wastewater treatment system prior to on-site application (disposal).

The proposed layout shown on Drawing 1, Appendix A. The drawing identifies the proposed location of educational facilities, stormwater management infrastructure and the treated effluent application area.

It is understood that the stormwater management infrastructure is to be designed based on a *Stormwater Management Report* (Ref 2) prepared for the proposed development by Cardno ITC. Furthermore, it is understood that the development includes the provision of a water quantity and quality pond downstream of the development.

The pond will have multiple functions such as on-site detention, water quality control, harvesting and reuse of stormwater. It is understood that the infrastructure has been designed based on a *Model for Urban Stormwater Improvement Conceptualisation* (MUSIC) and has the capacity to reduce the impacts of the stormwater quantity and quality discharge from the site to pre-development conditions. Cardno ITC concluded that the proposed stormwater management infrastructure can achieve a “zero impact” on the receiving environment.

On the basis of the proposed development, the principal sources of potential contamination to groundwater within the site are considered to be:

- livestock manure – elevated levels of nutrients and faecal coliforms produced by livestock;
- application fertilisers and pesticides – application of predominantly nitrogen and phosphorus based fertilisers applied to crops to enhance growth. Application of persistent organochlorine and/or organophosphate pesticides (OCP/OPP) associated with the fruit production; and
- effluent disposal system – effluent application area receiving secondary treated effluent from the proposed school facilities.

It is noted that the proposed agricultural land uses would be consistent with the historical land uses at the site and in the local area, and consistent with the 1(a) Rural Agriculture land use zoning. Therefore, based on the proviso that the proposed agricultural activities are appropriately managed, they are not expected to provide an net increase to impacts on the groundwater quality or the Water Catchment Area.

The primary potential impact to the local groundwater regime has been assessed, by Department of Primary Industries and Gosford City Council, as being the application of treated effluent to land within the site. It should be noted that as part of the proposed development the existing effluent disposal arrangements for site infrastructure (farm buildings), which are likely to comprise a septic tank and absorption trenches, would be decommissioned.

Douglas Partners (DP) have completed an *Effluent Disposal Assessment* (Ref 3) for the proposed development. The report recommended that the effluent be treated using an aerated wastewater treatment system (AWTS) with sufficient capacity for a wastewater flow rate of 13,275 L/day. The system selected for use should be approved by the NSW Health Department.

The AWTS should produce a secondary quality effluent with phosphate reduction to 10 mg/L and nitrogen reduction to 25mg/L prior to application to the land via subsurface irrigation (shallow subsurface drip irrigation). Subsurface irrigation involves the installation of shallow subsurface drip systems installed within the root zone (i.e. 100 mm to 150 mm) into topsoil in grassed or other suitably vegetated areas.

Effluent that has been treated in an AWTS has a lower biochemical oxygen demand (BOD), lower suspended solid level and much lower faecal coliform level than effluent that has been treated in a septic tank only. Application of secondary quality effluent via shallow subsurface drip systems facilitates a maximum level of nutrient uptake by vegetation within the application area, whilst minimising the potential for surface ponding and migration from the application area.

The area required for effluent disposal was assessed by considering the hydraulic conductivity of the soil receiving the effluent and the ability of the soil to accept the nutrient loading associated with the effluent. These calculations are referred to as the hydraulic balance and nutrient balance. With reference to site specific conditions, it was noted that nitrogen was considered to be the limiting nutrient on which sizing of the application area was based. It should be noted that minimum areas required based on the hydraulic or phosphorus loading were less than the area required based on the nitrogen loading. It should also be noted that the primary mechanism for nitrogen removal is through plant uptake. Regular maintenance of surface vegetation to encourage water and nitrogen uptake was recommended.

Whilst the proposed development is predicted to significantly increase the volume of treated effluent being applied to land, the proposed effluent treatment and application method is considered to be a significant upgrade compared to the existing effluent disposal system treatment previously operated at the site. The proposed effluent disposal system has been specified to produce a higher quality (secondary level of treatment) effluent from the water treatment unit, and then the application method and area has been designed to optimise both the hydraulic and nutrient uptake.

8. Comments

8.1 Potential Groundwater Impacts

The desktop review indicates that the groundwater quality of underlying KMMA can be good or fresh, making it suitable for a broad range of uses. It is noted that no site specific assessment of groundwater quality has been undertaken for this assessment.

The NSW Groundwater Protection Policy (DLWC, 1998) indicates that “for new developments the scale and scope of work required to demonstrate adequate groundwater protection shall be commensurate with the risk the development poses to a groundwater system and the value of the resource.” In general, this document has been developed to ensure that groundwater resources and groundwater dependent ecosystems within NSW remain sustainable; address any degradation which may have, or could occur; maximise economic benefit; and maintain beneficial uses.

It is considered that the main potential impact on the KMMA will be the disposal of effluent generated within the proposed agricultural school facilities. The NSW *Government Guidelines for On-Site Sewage Management for Single Households* (1998) and AS 1547-2000 *On site Domestic Wastewater Management* (Standards Australia, 2000) have been utilised for the effluent disposal assessment to ensure that this aspect of the proposed development has been designed with due consideration of the objectives outlined above.

In summary, the following criteria have been used to assess the suitability of the site for the proposed development:

Beneficial Groundwater Use

The site is underlain by the KMMA, which the DPI indicates is an important resource with very good groundwater quality suitable for a broad range of uses. It is noted that some studies indicate that the groundwater has been slightly degraded by the local land uses.

Groundwater Dependent Ecosystems

There are no groundwater dependent ecosystems within the site, although a groundwater dependent ecosystems is located in the locality of the site (perched swamp community). The perched swamp community is mapped as being adjacent to the western site boundary and has been identified as an endangered ecological community and that it would be susceptible to any significant increases in nutrient load.

Impacts on Bores and Natural Drainage Features

The NSW Government Guidelines for *On-Site Sewage Management for Single Households* indicate that the disposal of effluent should not be carried out within 250 m of a domestic groundwater well or 100 m of permanent surface waters such as creeks. The desktop review indicated that there are both the on-site groundwater bore and the registered off-site bores are located beyond the recommended buffer distances.

Depth of Groundwater

Groundwater depths at the site have been measured at greater than 1.5 m and therefore is generally assessed not to be a limitation to the disposal of effluent in accordance with the NSW Government Guidelines.

It is noted that registered groundwater bores in the local area identified confined groundwater conditions in the Hawkesbury Sandstone bedrock. The aquifer depth was identified as being greater than approximately 14 m and the stabilised groundwater levels or potentiometric surface (the level to which groundwater rises above the top of a confined aquifer) of greater than 5 m depth. Notwithstanding, it is suspected that possibly perched groundwater may be present near the interface of the residual soils and weathered rock. This perched groundwater is expected to be at depths ranging between 6 m – 8 m based on the driller log of nearby registered groundwater bores.

Nutrient Holding Capacity

The laboratory testing carried out in connection with the effluent disposal assessment indicates that the soils from the site have a moderate ability to hold plant nutrients and immobilise any excess phosphorous primarily due to the clay content of the soils. The nutrient holding capacity was not expected to be a significant limitation for effluent disposal at the site. However, application of secondary quality effluent via shallow subsurface drip systems was expected to facilitate a maximum level of nutrient uptake by vegetation and soils within the application area, whilst minimising the potential for surface ponding or migration of effluent from the application area.

8.2 Conclusions

The results of the investigation of groundwater impacts have indicated the following geological and hydrogeological conditions:

- the site is underlain by moderately deep to deep, low fertility, acidic soils with low to moderate available water holding capacity, which in turn are underlain by Hawkesbury Sandstone.
- the Kulnura Mangrove Mountain Aquifer (KMMA) occurs within the Hawkesbury Sandstone unit
- groundwater depths within the KMMA are typically 14 – 65 m on nearby properties.

- there are thirteen registered groundwater bores within a 1.0 km radius of the site, with the closest registered bore located approximately 100 m west of the western site boundary. It is not known if the closest registered groundwater bore is still in operation.
- the groundwater quality within the KMMA is generally described as “fresh” and is understood to provide an excellent source of water for stock, commercial and domestic purposes. Some information sources suggest that the groundwater quality has been impacted by local land uses, resulting in elevated nitrate and aluminium levels.
- a moderately high vulnerability rating is indicated for the site on the 1:250 000 Hawkesbury-Nepean Groundwater Vulnerability Map. However, groundwater beneath the site comprises a confined sandstone aquifer overlain by deep profile low permeability soils indicating the vulnerability is actually low at this site. The relatively impermeable confining layer above the aquifer would substantially restrict any infiltration of contaminants. It would also allow the natural attenuation processes to lower the contaminant levels before they infiltrate down to the top of the aquifer.
- No information on the groundwater within the upper perched aquifer was available in the locality of the site. It noted that the upper perched aquifer in some areas of the KMMA can be slightly degraded, with elevated concentrations of nitrogen, probably resulting from the use of fertilisers and grazing of livestock.

In summary, the KMMA has been described as an important groundwater resource with a number of beneficial uses. On-site effluent disposal associated with the proposed development has been identified as the main potential contamination source for the KMMA. However available information suggests that the soils at the site provide only minor limitations to the use of on-site effluent disposal systems.

The effluent disposal assessment carried out at the site indicates that the use of on-site effluent disposal systems in connection with the agricultural school development is feasible, provided that the minor limitations identified in the effluent disposal assessment report are addressed during the construction phase and that a comprehensive operations and procedures manual is prepared for the system and is implemented throughout the operation of the system.

Provided that the effluent disposal system is implemented as proposed, and given the site subsurface conditions and depth to the underlying confined aquifer, it is considered that the proposed agricultural school development is highly unlikely to contaminate groundwater in the KMMA, impact bores on adjoining properties or impact the nearby groundwater dependent ecosystems.

Verification of this conclusion could be undertaken through site-specific investigation with monitoring (i.e. Level III Assessment).

9. References

1. Agriculture and Resource Management Council of Australia and New Zealand, Australian and New Zealand Environment and Conservation Council (ANZECC) *Guidelines for Groundwater Protection in Australia*, September 1995.

2. Cardno ITC Pty Ltd, *Proposed Agricultural School, 2964 Wisemans Ferry Road, Mangrove Mountain, Stormwater Management Report*, January 2012.
3. Douglas Partners Pty Ltd, *Report on Effluent Disposal Assessment, 2964 Wisemans Ferry Road, Mangrove Mountain*, dated February 2012.
4. NSW Government - Environment & Health Protection Guidelines: *On-site Sewage Management for Single Households*, January 1998.
5. AS 1547-2000: *On-site domestic-wastewater management*, Standards Australia.

10. Limitations

Douglas Partners (DP) has prepared this report for the Proposed Agricultural School, 2964 Wisemans Ferry Road, Mangrove Mountain, NSW in accordance with DP's proposal WYG120067A dated 26 June 2012 and acceptance received from Mr Tamour Tariq of Mangrove Mountain Agricultural School dated 2 July 2012. The report is provided for the exclusive use of Mangrove Mountain Agricultural School for this project only and for the purpose(s) described in the report. It should not be used for other projects or by a third party. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions only at the specific sampling or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of anthropogenic influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be limited by undetected variations in ground conditions between sampling locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion given in this report.

Douglas Partners Pty Ltd

Appendix A

About this Report
And Drawings

About this Report

Douglas Partners



Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

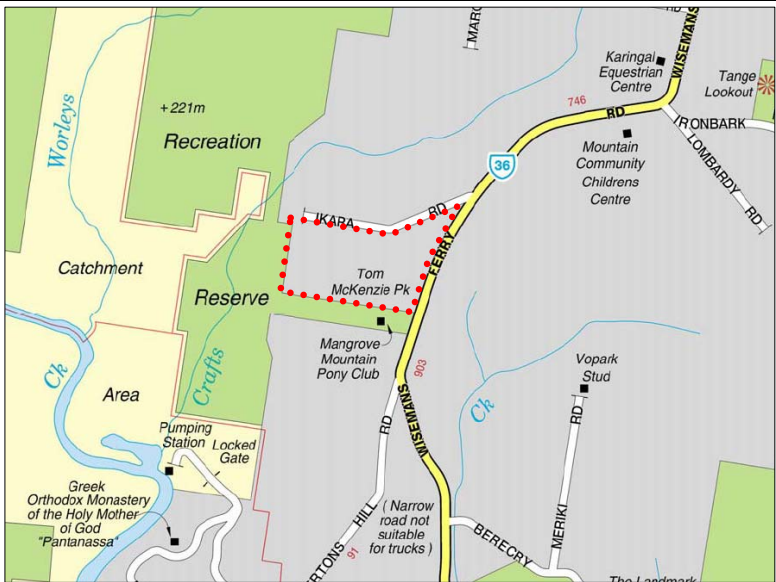
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.



LOCALITY



Notes:
1. Drawing adapted from plan provided by the 360° Landscape Architecture Pty Ltd

 Douglas Partners <i>Geotechnics Environment Groundwater</i>	CLIENT: Mangrove Mountain Agricultural School		TITLE: Proposed Site Layout Proposed Agricultural School 2964 Wisemans Ferry Road, Mangrove Mountain	PROJECT No: 75370.01
	OFFICE: Wyong	DRAWN BY: BJK		DRAWING No: 1
	SCALE: As Shown	DATE: July 2012		REVISION: A

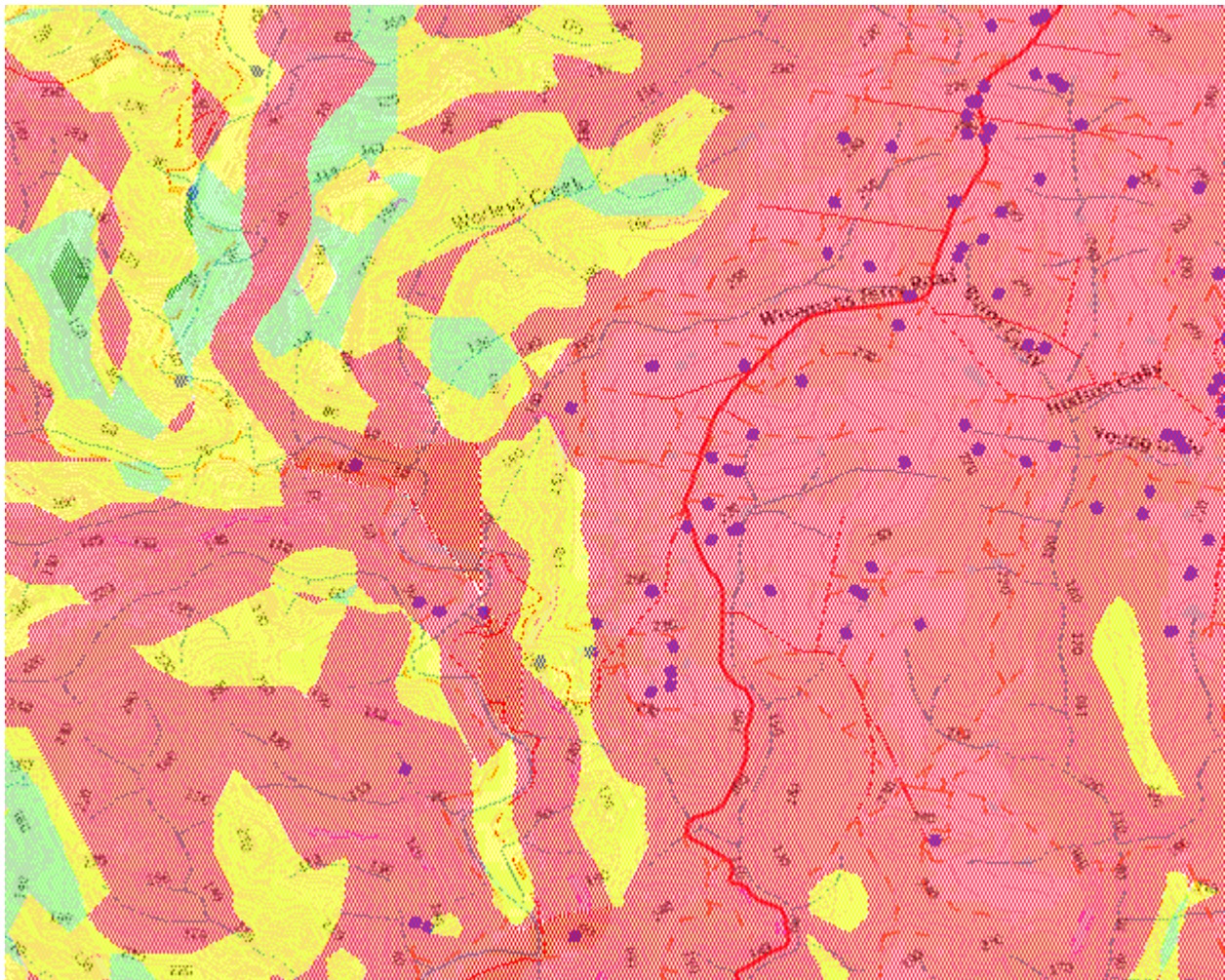
Appendix B

Desktop Search Results

GW Vulnerability

Map created with NSW Natural Resource Atlas - <http://www.nratlas.nsw.gov.au>

Friday, July 06, 2012



0

6 Km

Legend

Symbol	Layer	Custodian
	High Moderately high Moderate Low moderate Low Catchment Area Cities and large towns Populated places Towns Groundwater Bores Catchment Management Authority boundaries	Groundwater vulnerability maps renderImage: Cannot build image from features renderImage: Cannot build image from features



Major rivers



Primary/arterial road



Motorway/freeway



Railway



Runway



Contour



Background

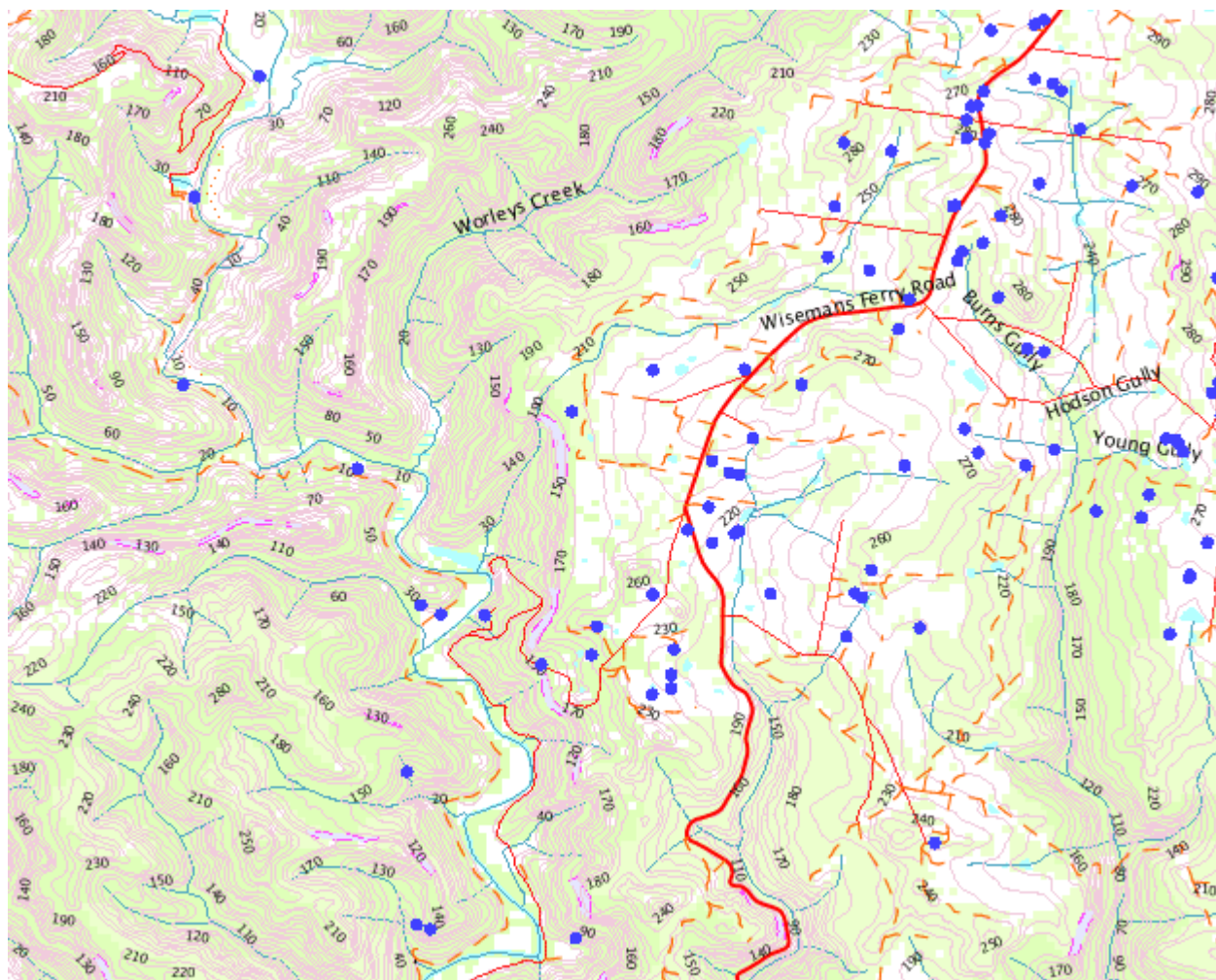
Topographic base map

Copyright © 2012 New South Wales Government. Map has been compiled from various sources and may contain errors or omissions. No representation is made as to its accuracy or suitability.

Mangrove Mountain

Map created with NSW Natural Resource Atlas - <http://www.nratlas.nsw.gov.au>

Friday, July 06, 2012



0

6 Km

Legend

Symbol	Layer	Custodian
	Cities and large towns	renderImage: Cannot build image from features
	Populated places	renderImage: Cannot build image from features
	Towns	
	Groundwater Bores	
	Catchment Management Authority boundaries	
	Major rivers	

Topographic base map



Copyright © 2012 New South Wales Government. Map has been compiled from various sources and may contain errors or omissions. No representation is made as to its accuracy or suitability.

NSW OFFICE OF WATER

Work Summary

GW066457

Converted From HYDSYS

Licence :	Licence Status	Intended Purpose(s)
Work Type : Bore	Authorised Purpose(s)	DOMESTIC
Work Status : Supply Obtained		
Construct. Method : (Unknown)		
Owner Type : (Unknown)		
Commenced Date :	Final Depth :	30.00 m
Completion Date : 25-Oct-1991	Drilled Depth :	30.00 m
Contractor Name :		
Driller :		
Assistant Driller's Name :		
Property :	Standing Water Level :	8.00 m
GWMA : -	Salinity :	
GW Zone : -	Yield :	1.20 L/s

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : WESTMORELAND	THURAT	6//757077
	Licensed :		
Region : 10 - SYDNEY SOUTH COAST		CMA Map : 8930-3S	KANANGRA
River Basin : 212 - HAWKESBURY RIVER		Grid Zone : 56/1	Scale : 1:25,000
Area / District :			
Elevation :	220.00 m (A.H.D.)	Northing : 6309158	Latitude (S) : 33° 20' 35"
Elevation Source : Est. Contour 8-15M.		Easting : 328672	Longitude (E) : 151° 9' 32"
GS Map : 0055A2	MGA Zone : 56	Coordinate Source : GD.,ACC.MAP	

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	P.V.C.	-0.30	5.70	168			Driven into Hole
1	1	Casing	Poured Concrete	0.00	5.70		0		

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
17.80	18.10	0.30	Consolidated	7.50		0.20			Fresh
25.30	25.70	0.40	Consolidated	7.50		0.50			Fresh
28.10	29.00	0.90	Consolidated	8.00		1.20			Fresh

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
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Remarks

Updated details as per existing data.

*** End of GW066457 ***

NSW OFFICE OF WATER

Work Summary

GW100030

Licence :20CA100233			Licence Status :Current	Intended Purpose(s) DOMESTIC IRRIGATION
Work Type :Bore			Authorised Purpose(s)	
Work Status :(Unknown)			DOMESTIC	
Construct. Method :Cable Tool			IRRIGATION	
Owner Type :				
Commenced Date :		Final Depth :	50.00 m	
Completion Date :22-Aug-1995		Drilled Depth :	50.00 m	
Contractor Name :J.H. ISELT				
Driller :1435		ISELT, John Hans		
Assistant Driller's Name :				
Property : - GALEA			Standing Water Level :	
GWMA :606 - MANGROVE MOUNTAIN			Salinity :	Fresh
GW Zone :007 - LOWER MANGROVE AND POPRAN			Yield :	
CREE				

Site Details

Site Chosen By		County	Parish	Portion/Lot DP
Driller		Form A :NORTHUMBERLAND	POPRAN	86 661697
		Licensed :NORTHUMBERLAND	POPRAN	86 661697
Region :10 - SYDNEY SOUTH COAST		CMA Map :		
River Basin :		Grid Zone :		Scale :
Area / District :				
Elevation :		Northing :6309222		Latitude (S) :33° 20' 33"
Elevation Source :		Easting :328800		Longitude (E) :151° 9' 37"
GS Map :		MGA Zone :56	Coordinate Source :	

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	50.00	150			Cable Tool
1	1	Casing	P.V.C.	-1.00	5.00	160			C: 0-5m; Driven into Hole

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
41.10	41.70	0.60		0.00	40.00	1.00	42.00	1.00	Fresh
43.30	43.80	0.50		0.00	40.00	1.50	50.00	1.00	Fresh

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.90	0.90	SANDY SOIL		
0.90	1.60	0.70	SANDY CLAY		
1.60	2.90	1.30	SAND WET UNSTABLE		
2.90	6.10	3.20	SANDSTONE GREY		
6.10	10.30	4.20	SANDSTONE YELLOW		
10.30	15.70	5.40	SANDSTONE BROWN		
15.70	28.50	12.80	SANDSTONE YELLOW		
28.50	28.80	0.30	CLAY GREY		
28.80	41.10	12.30	SANDSTONE GREY		
41.10	41.70	0.60	SANDSTONE GREY (W.B)		
41.70	43.30	1.60	SANDSTONE GREY		
43.30	43.80	0.50	SANDSTONE GREY (W.B)		
43.80	50.00	6.20	SANDSTONE GREY		

Remarks

*** End of GW100030 ***

NSW OFFICE OF WATER

Work Summary

GW103565

Licence : 20BL160045	Licence Status : Converted	Intended Purpose(s) DOMESTIC
Work Type : Bore	Authorised Purpose(s) DOMESTIC	
Work Status : (Unknown)		
Construct. Method :		
Owner Type :		
Commenced Date :	Final Depth : 30.00 m	
Completion Date : 23-Apr-2001	Drilled Depth :	
Contractor Name :		
Driller :		
Assistant Driller's Name :		
Property : - N/A	Standing Water Level : 5.50 m	
GWMA : 606 - MANGROVE MOUNTAIN	Salinity :	
GW Zone : 007 - LOWER MANGROVE AND POPRAN CREE	Yield : 0.25 L/s	

Site Details

Site Chosen By	County Form A : NORTHUMBERLAND Licensed : NORTHUMBERLAND	Parish POPRAN POPRAN	Portion/Lot DP 86//661697 86 661697
Region : 10 - SYDNEY SOUTH COAST	CMA Map :		
River Basin :	Grid Zone :	Scale :	
Area / District :			
Elevation :	Northing : 6309241	Latitude (S) : 33° 20' 33"	
Elevation Source :	Easting : 328823	Longitude (E) : 151° 9' 38"	
GS Map :	MGA Zone : 56	Coordinate Source :	

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	0.00	30.00				
1	1	Casing	0.00	0.00		150		

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
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(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
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Remarks

Form A Remarks:
DATA FROM AG FORM ONLY.

*** End of GW103565 ***

NSW OFFICE OF WATER

Work Summary

GW059875

Converted From HYDSYS

Licence :20WA100273		Licence Status :Current	
Work Type :Bore open thru rock		Authorised Purpose(s)	
Work Status :Supply Obtained		DOMESTIC	
Construct. Method :Cable Tool		INDUSTRIAL	
Owner Type :Private		STOCK	
Commenced Date :		Intended Purpose(s)	
Final Depth :		DOMESTIC	
Completion Date :01-Oct-1984		INDUSTRIAL	
Drilled Depth :		STOCK	
Contractor Name :			
Driller :1435			
Assistant Driller's Name :			
ISELT, John Hans			
Property : - CRUICKSHANK		Standing Water Level :	
GWMA :606 - MANGROVE MOUNTAIN		10.00 m	
GW Zone :007 - LOWER MANGROVE AND POPRAN		Salinity :	
CREE		Fresh	
		Yield :	
		1.10 L/s	

Site Details

Site Chosen By		County	Parish	Portion/Lot DP
		Form A :NORTHUMBERLAND	POPRAN	LOT1 DP372493
		Licensed :NORTHUMBERLAND	POPRAN	1 372493
Region :10 - SYDNEY SOUTH COAST		CMA Map :9131-3N	MANGROVE	
River Basin :212 - HAWKESBURY RIVER		Grid Zone :56/1	Scale :1:25,000	
Area / District :				
Elevation :		Northing :6309399	Latitude (S) :33° 20' 27"	
Elevation Source :(Unknown)		Easting :328649	Longitude (E) :151° 9' 31"	
GS Map :0055A2		MGA Zone :56	Coordinate Source :GD.,ACC.MAP	

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	0.00	28.00	152			Cable Tool
1		Casing	-0.30	8.70	168			C: 0-8.7m; Cemented

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
17.80	18.10	0.30	Consolidated	15.00		0.10	20.00		Fresh
24.70	25.90	1.20	Consolidated	10.00		1.10	28.00		Fresh

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.40	0.40	Soil Sandy	Soil	
0.40	5.60	5.20	Clay Sandy	Clay	
5.60	7.10	1.50	Sandstone Broken	Sandstone	
7.10	17.80	10.70	Sandstone Yellow	Sandstone	
17.80	18.10	0.30	Sandstone Yellow Open Water Supply	Sandstone	
18.10	24.70	6.60	Sandstone Yellow	Sandstone	
24.70	25.90	1.20	Sandstone Open Water Supply	Sandstone	
25.90	28.00	2.10	Sandstone	Sandstone	

Remarks

PREVIOUS LIC. NO:10BL131571

*** End of GW059875 ***

NSW OFFICE OF WATER

Work Summary

GW066467

Converted From HYDSYS

Licence :		Licence Status	Intended Purpose(s)
Work Type : Bore		Authorised Purpose(s)	DOMESTIC
Work Status : Supply Obtained			
Construct. Method : (Unknown)			
Owner Type : (Unknown)			
Commenced Date :	Final Depth :	46.00 m	
Completion Date : 11-Apr-1991	Drilled Depth :	46.00 m	
Contractor Name :			
Driller :			
Assistant Driller's Name :			
Property :		Standing Water Level :	6.00 m
GWMA : -		Salinity :	
GW Zone : -		Yield :	0.50 L/s

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : WESTMORELAND	THURAT	8//757077
	Licensed :		
Region : 10 - SYDNEY SOUTH COAST		CMA Map : 8930-3S	KANANGRA
River Basin : 212 - HAWKESBURY RIVER		Grid Zone : 56/1	Scale : 1:25,000
Area / District :			
Elevation : 230.00 m (A.H.D.)		Northing : 6309622	Latitude (S) : 33° 20' 20"
Elevation Source : Est. Contour 8-15M.		Easting : 328819	Longitude (E) : 151° 9' 38"
GS Map : 0055A2	MGA Zone : 56	Coordinate Source : GD.,ACC.MAP	

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing P.V.C.	-0.30	4.70	168			Driven into Hole
1	1	Casing Poured Concrete	0.00	4.70	0			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
18.60	18.90	0.30	Consolidated	8.00		0.10			Fresh
28.30	28.60	0.30	Consolidated	6.00		0.30			Fresh
36.90	37.20	0.30	Consolidated	6.00		0.50			Fresh

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
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Remarks

Updated details as per existing data.

*** End of GW066467 ***

NSW OFFICE OF WATER

Work Summary

GW101952

Licence :20CA100225			Licence Status :Current		Intended Purpose(s) DOMESTIC INDUSTRIAL
Work Type :Bore			Authorised Purpose(s) DOMESTIC INDUSTRIAL		
Work Status :Supply Obtained					
Construct. Method :Rotary					
Owner Type :Private					
Commenced Date :			Final Depth :		101.00 m
Completion Date :05-Nov-1997			Drilled Depth :		101.00 m
Contractor Name :J.H. ISELT					
Driller :1674			ISELT, Paul John		
Assistant Driller's Name :					
Property : - SCOTT			Standing Water Level :		Fresh
GWMA :606 - MANGROVE MOUNTAIN			Salinity :		
GW Zone :007 - LOWER MANGROVE AND POPRAN CREE			Yield :		
					1.50 L/s

Site Details

Site Chosen By		County		Parish		Portion/Lot DP	
		Form A :NORTHUMBERLAND		POPRAN		1//510636	
		Licensed :NORTHUMBERLAND		POPRAN		1 510636	
Region :10 - SYDNEY SOUTH COAST				CMA Map :			
River Basin :				Grid Zone :		Scale :	
Area / District :							
Elevation :				Northing :6309633		Latitude (S) :33° 20' 20"	
Elevation Source :				Easting :328762		Longitude (E) :151° 9' 36"	
GS Map :		MGA Zone :56		Coordinate Source :			

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	46.00	101.00	150			Rotary Air
1	1	Casing	P.V.C.	-0.50	5.50	160	150		C: 0-5.5m; Driven into Hole

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
64.50	65.90	1.40		15.00	70.00	0.38	70.00	1.00	Fresh
87.00	87.80	0.80		15.00	90.00	0.69	90.00	1.00	Fresh
95.20	96.00	0.80			101.00	1.50	101.00	2.00	Fresh

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
46.00	50.50	4.50	Yellow Sandstone	Sandstone	
50.50	64.50	14.00	Grey Sandstone	Sandstone	
64.50	65.90	1.40	Grey Sandstone W. B.	Sandstone	
65.90	87.00	21.10	Grey Sandstone	Sandstone	
87.00	87.80	0.80	Grey Sandstone W. B.	Sandstone	
87.80	95.20	7.40	Grey Sandstone	Sandstone	
95.20	96.00	0.80	Grey Sandstone W. B.	Sandstone	
96.00	101.00	5.00	Grey Sandstone	Sandstone	

Remarks

Form A Remarks:
Replaces 10BL156628 (Cancelled).
(Bore Deepened)

*** End of GW101952 ***

NSW OFFICE OF WATER

Work Summary

GW057748

Converted From HYDSYS

Licence :20WA100599		Licence Status :Current	Intended Purpose(s) DOMESTIC
Work Type :Bore open thru rock		Authorised Purpose(s) DOMESTIC	
Work Status :(Unknown)			
Construct. Method :Cable Tool			
Owner Type :Private			
Commenced Date :	Final Depth :	46.00 m	
Completion Date :01-Aug-1982	Drilled Depth :	0.00	
Contractor Name :			
Driller :1435		ISELT, John Hans	
Assistant Driller's Name :			
Property : - N/A		Standing Water Level :	
GWMA :606 - MANGROVE MOUNTAIN		Salinity :	Fresh
GW Zone :007 - LOWER MANGROVE AND POPRAN		Yield :	
CREE			

Site Details

Site Chosen By		County	Parish	Portion/Lot DP
		Form A :NORTHUMBERLAND	POPRAN	A 360925
		Licensed :NORTHUMBERLAND	POPRAN	PT35
Region :10 - SYDNEY SOUTH COAST		CMA Map :9131-3N	MANGROVE	
River Basin :212 - HAWKESBURY RIVER		Grid Zone :56/1	Scale :1:25,000	
Area / District :				
Elevation :		Northing :6309712	Latitude (S) :33° 20' 17"	
Elevation Source :(Unknown)		Easting :328662	Longitude (E) :151° 9' 32"	
GS Map :0055A2		MGA Zone :56	Coordinate Source :GD.,ACC.MAP	

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	120.00	150			Rotary Air
1	1	Casing	Welded Steel	-0.20	6.30	168			Driven into Hole
1	1	Casing	Pressure Cemented	0.00	0.00	0			(Unknown)
			Casing						

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
13.50	14.00	0.50	Consolidated	13.50		0.10			(Unknown)
34.50	34.90	0.40	Consolidated	7.50		0.30			(Unknown)
66.00	72.00	6.00				0.02		4.00	
90.00	96.00	6.00				0.08		2.00	

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	31.00	31.00	TOPSOIL		
31.00	64.00	33.00	SANDSTONE(YELLOW)		
64.00	67.00	3.00	SANDSTONE, GREY		
67.00	110.00	43.00	SANDSTONE		
110.00	114.00	4.00	SANDSTONE GREY / SHALES		
114.00	117.00	3.00	SANDSTONE WITHE		
117.00	120.00	3.00	SANDSTONE GREY		

Remarks

Previous Lic No: 10BL137147

*** End of GW057748 ***

NSW OFFICE OF WATER

Work Summary

GW066461

Converted From HYDSYS

Licence :	Licence Status	Intended Purpose(s)
Work Type : (Unknown)	Authorised Purpose(s)	
Work Status : Supply Obtained		
Construct. Method : (Unknown)		
Owner Type : (Unknown)		
Commenced Date :	Final Depth :	32.00 m
Completion Date : 29-Oct-1991	Drilled Depth :	32.00 m
Contractor Name :		
Driller :		
Assistant Driller's Name :		
Property :	Standing Water Level :	8.00 m
GWMA : -	Salinity :	
GW Zone : -	Yield :	0.40 L/s

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : WESTMORELAND	THURAT	8//757077
	Licensed :		
Region : 10 - SYDNEY SOUTH COAST		CMA Map : 8930-3S	KANANGRA
River Basin : 212 - HAWKESBURY RIVER		Grid Zone : 56/1	Scale : 1:25,000
Area / District :			
Elevation : 243.00 m (A.H.D.)		Northing : 6309870	Latitude (S) : 33° 20' 12"
Elevation Source : Est. Contour 8-15M.		Easting : 328892	Longitude (E) : 151° 9' 41"
GS Map : 0055A2	MGA Zone : 56	Coordinate Source : GD.,ACC.MAP	

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H P Component Type From (m) To (m) OD (mm) ID (mm) Interval Details

(No Construction Details Found)

Water Bearing Zones

From (m) To (m) Thickness (m) WBZ Type S.W.L. (m) D.D.L. (m) Yield (L/s) Hole Depth (m) Duration (hr) Salinity (mg/L)

(No Water Bearing Zone Details Found)

Drillers Log

From (m) To (m) Thickness(m) Drillers Description Geological Material Comments

Remarks

Updated details as per existing data.

*** End of GW066461 ***

NSW OFFICE OF WATER

Work Summary

GW103002

Licence :20CA100227		Licence Status :Current	Intended Purpose(s)
Work Type :Bore		Authorised Purpose(s)	IRRIGATION
Work Status :(Unknown)			
Construct. Method :			
Owner Type :			
Commenced Date :	Final Depth :	38.10 m	
Completion Date :01-Jan-1989	Drilled Depth :		
Contractor Name :J.H. ISELT			
Driller :		ISELT, J.H	
Assistant Driller's Name :			
Property : - BENBRU		Standing Water Level :	
GWMA :606 - MANGROVE MOUNTAIN		Salinity :	
GW Zone :007 - LOWER MANGROVE AND POPRAN		Yield :	0.88 L/s
CREE			

Site Details

Site Chosen By		County	Parish	Portion/Lot DP
		Form A :NORTHUMBERLAND	POPRAN	155//755253
		Licensed :NORTHUMBERLAND	POPRAN	155 755253
Region :10 - SYDNEY SOUTH COAST		CMA Map :		
River Basin :		Grid Zone :	Scale :	
Area / District :				
Elevation :		Northing :6310238	Latitude (S) :33° 20' 1"	
Elevation Source :		Easting :329162	Longitude (E) :151° 9' 52"	
GS Map :		MGA Zone :56	Coordinate Source :	

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	0.00	38.10				
1	1	Casing	0.00	0.00		152		

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
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(No Water Bearing Zone Details Found)

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
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Remarks

Form A Remarks:
DATA FROM AG FORM ONLY

*** End of GW103002 ***

NSW OFFICE OF WATER

Work Summary

GW072420

Converted From HYDSYS

Licence :	Licence Status	Intended Purpose(s)
Work Type : Bore	Authorised Purpose(s)	DOMESTIC
Work Status : (Unknown)		STOCK
Construct. Method : Cable Tool		
Owner Type : Private		
Commenced Date :	Final Depth :	49.00 m
Completion Date : 17-Dec-1994	Drilled Depth :	49.00 m
Contractor Name :		
Driller : 1435	ISELT, John Hans	
Assistant Driller's Name :		
Property :	Standing Water Level :	
GWMA : -	Salinity :	Fresh
GW Zone : -	Yield :	

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : NORTHUMBERLAND	POPAN	L1 DP723211
	Licensed :		
Region : 10 - SYDNEY SOUTH COAST		CMA Map : 9131-3N	MANGROVE
River Basin : 212 - HAWKESBURY RIVER		Grid Zone : 56/1	Scale : 1:25,000
Area / District :			
Elevation :	0.00	Northing : 6310336	Latitude (S) : 33° 19' 57"
Elevation Source :		Easting : 328838	Longitude (E) : 151° 9' 39"
GS Map :	MGA Zone : 56	Coordinate Source :	

Construction

Negative depths indicate Above Ground Level;

H-Hole; P-Pipe; OD-Outside Diameter; ID-Inside Diameter; C-Cemented; SL-Slot Length; A-Aperture; GS-Grain Size; Q-Quantity; PL-Placement of Gravel Pack; PC-Pressure Cemented; S-Sump; CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing	P.V.C.	-0.30	5.70	160			Driven into Hole

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
15.40	15.60	0.20	Consolidated	15.00		0.10			Fresh
45.10	45.60	0.50	Consolidated	15.00		0.80			Fresh

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.40	0.40	Top Soil	Soil	
0.40	0.90	0.50	Sandy Clay	Clay	
0.90	1.80	0.90	Cemented Gravel	Gravel	
1.80	2.90	1.10	Sandy Clay	Clay	
2.90	15.40	12.50	Yellow Sandstone	Sandstone	
15.40	15.60	0.20	Yellow Sandstone (w.b)	Sandstone	
15.60	34.10	18.50	Yellow Sandstone	Sandstone	
34.10	35.60	1.50	Brown Shale	Shale	
35.60	45.10	9.50	Brown Sandstone	Sandstone	
45.10	45.60	0.50	Brown Sandstone (w.b)	Sandstone	
45.60	49.00	3.40	Grey Sandstone	Sandstone	

Remarks

ACC = 7

*** End of GW072420 ***

NSW OFFICE OF WATER

Work Summary

GW101499

Licence :20WA100275			Licence Status :Current		Intended Purpose(s) COMMERCIAL
Work Type :Bore			Authorised Purpose(s) DOMESTIC		
Work Status :(Unknown)			INDUSTRIAL		
Construct. Method :Rotary Air			STOCK		
Owner Type :Private					
Commenced Date :		Final Depth :	91.00 m		
Completion Date :07-Apr-1998		Drilled Depth :	91.00 m		
Contractor Name :J.H. ISELT					
Driller :1674		ISELT, Paul John			
Assistant Driller's Name :					
Property : - N/A			Standing Water Level :		13.00 m
GWMA :606 - MANGROVE MOUNTAIN			Salinity :		Fresh
GW Zone :007 - LOWER MANGROVE AND POPRAN			Yield :		0.60 L/s
CREE					

Site Details

Site Chosen By		County	Parish	Portion/Lot DP	
Driller		Form A :NORTHUMBERLAND	POPRAN	LOT78 DP723211	
		Licensed :NORTHUMBERLAND	POPRAN	1 723211	
Region :10 - SYDNEY SOUTH COAST			CMA Map :		
River Basin :			Grid Zone :	Scale :	
Area / District :					
Elevation :			Northing :6310322	Latitude (S) :33° 19' 57"	
Elevation Source :			Easting :328315	Longitude (E) :151° 9' 19"	
GS Map :		MGA Zone :56	Coordinate Source :GIS - Geographic Information System		

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	5.50	210			Rotary Air
1		Hole	Hole	5.50	91.00	150			Rotary Air
1	1	Casing	PVC Class 9	-0.50	5.50	160	145		C: -.2-5.5m; Seated on Bottom

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
20.10	22.00	1.90		16.00	30.00	0.15	30.00	1.00	Fresh
68.90	70.50	1.60		13.00	91.00	0.60	91.00	2.00	Fresh

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	TOP SOIL	Topsoil	
0.30	1.80	1.50	SANDY CLAY	Invalid Code	
1.80	3.90	2.10	CLAY, YELLOW	Clay	
3.90	20.10	16.20	SANDSTONE, YELLOW	Sandstone	
20.10	22.00	1.90	SANDSTONE, YELLOW WB	Sandstone	
22.00	37.40	15.40	SANDSTONE, YELLOW	Sandstone	
37.40	51.20	13.80	SANDSTONE, GREY	Sandstone	
51.20	58.00	6.80	SANDSTONE, YELLOW	Sandstone	
58.00	68.90	10.90	SANDSTONE, GREY	Sandstone	
68.90	70.50	1.60	SANDSTONE, GREY WB	Sandstone	
70.50	91.00	20.50	SANDSTONE, GREY	Sandstone	

Remarks

*** End of GW101499 ***

NSW OFFICE OF WATER

Work Summary

GW104143

Licence :20WA100945			Licence Status :Current	Intended Purpose(s)
Work Type :Bore			Authorised Purpose(s)	RECREATION (GROUNDWATER)
Work Status :(Unknown)				RECREATION (GROUNDWATER)
Construct. Method :Rotary				
Owner Type :				
Commenced Date :	Final Depth :	84.00 m		
Completion Date :12-Jul-2001	Drilled Depth :	84.00 m		
Contractor Name :J.H. ISELT				
Driller :1674 ISELT, Paul John				
Assistant Driller's Name :				
Property : - N/A			Standing Water Level :	
GWMA :606 - MANGROVE MOUNTAIN			Salinity :	Fresh
GW Zone :007 - LOWER MANGROVE AND POPRAN CREE			Yield :	

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
Driller	Form A :NORTHUMBERLAND	POPRAN	LT DP 755253
	Licensed :NORTHUMBERLAND	POPRAN	229 727251
Region :10 - SYDNEY SOUTH COAST		CMA Map :	
River Basin :		Grid Zone :	Scale :
Area / District :			
Elevation :		Northing :6310033	Latitude (S) :33° 20' 6"
Elevation Source :		Easting :327858	Longitude (E) :151° 9' 1"
GS Map :	MGA Zone :56	Coordinate Source :	

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component	Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1		Hole	Hole	0.00	11.50	210			Down Hole Hammer
1		Hole	Hole	11.50	84.00	150			Down Hole Hammer
1	1	Casing	PVC Class 9	-0.40	11.50	160	147		C: 0-11.5m; Screwed and Glued; Seated on Bottom

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
19.40	19.90	0.50		12.00	24.00	0.15	24.00	0.50	Fresh
42.30	42.70	0.40		12.00	50.00	0.30	50.00	1.00	Fresh
79.10	79.60	0.50		12.00	84.00	0.60	84.00	2.00	Fresh

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
0.00	0.30	0.30	TOPSOIL	Topsoil	
0.30	8.50	8.20	CLAYS RED/BROWN	Invalid Code	
8.50	19.40	10.90	SANDSTONE YELLOW	Sandstone	
19.40	19.90	0.50	SANDSTONE YELLOW W.B.	Sandstone	
19.90	42.30	22.40	SANDSTONE YELLOW	Sandstone	
42.30	42.70	0.40	SANDSTONE YELLOW W.B.	Sandstone	
42.70	62.10	19.40	SANDSTONE YELLOW	Sandstone	
62.10	65.40	3.30	SHALE	Shale	
65.40	71.10	5.70	SANDSTONE GREY	Sandstone	
71.10	73.70	2.60	FRACTURED SANDSTONE	Invalid Code	
73.70	79.10	5.40	SANDSTONE GREY	Sandstone	
79.10	79.60	0.50	SANDSTONE GREY W.B.	Sandstone	
79.60	84.00	4.40	SANDSTONE GREY	Sandstone	

Remarks

*** End of GW104143 ***

NSW OFFICE OF WATER

Work Summary

GW072638

Converted From HYDSYS

Licence :	Licence Status	Intended Purpose(s)
Work Type : Bore	Authorised Purpose(s)	DOMESTIC
Work Status : (Unknown)		
Construct. Method :		
Owner Type : Private		
Commenced Date :	Final Depth :	13.00 m
Completion Date :	Drilled Depth :	0.00
Contractor Name :		
Driller :		
Assistant Driller's Name :		
Property :	Standing Water Level :	
GWMA : -	Salinity :	
GW Zone : -	Yield :	

Site Details

Site Chosen By	County	Parish	Portion/Lot DP
	Form A : NORTHUMBERLAND	POPAN	LPT86 DP755253
	Licensed :		
Region : 10 - SYDNEY SOUTH COAST		CMA Map : 9131-3N	MANGROVE
River Basin : 212 - HAWKESBURY RIVER		Grid Zone : 56/1	Scale : 1:25,000
Area / District :			
Elevation :	0.00	Northing : 6309242	Latitude (S) : 33° 20' 33"
Elevation Source :		Easting : 328531	Longitude (E) : 151° 9' 27"
GS Map :	MGA Zone : 56	Coordinate Source : GD.,ACC.GIS	

Construction

Negative depths indicate Above Ground Level;

H-Hole;P-Pipe;OD-Outside Diameter;ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity;PL-Placement of Gravel Pack;PC-Pressure Cemented;S-Sump;CE-Centralisers

H	P	Component Type	From (m)	To (m)	OD (mm)	ID (mm)	Interval	Details
1	1	Casing P.V.C.	0.00	0.00	150			

Water Bearing Zones

From (m)	To (m)	Thickness (m)	WBZ Type	S.W.L. (m)	D.D.L. (m)	Yield (L/s)	Hole Depth (m)	Duration (hr)	Salinity (mg/L)
(No Water Bearing Zone Details Found)									

Drillers Log

From (m)	To (m)	Thickness(m)	Drillers Description	Geological Material	Comments
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Remarks

*** End of GW072638 ***