FINAL REPORT

Soil and Water Management Plan (SWMP)

Newnes Junction Sand & Kaolin Extraction Project

Newnes Junction, NSW.

Prepared for

Sydney Construction Materials Pty Ltd

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SOIL & WATER MANAGEMENT PLAN

Sydney Construction Materials

Newnes Junction Sand & Kaolin Extraction Project, Newnes Junction, NSW.

Exploration Licence 4192 (EL4192)

Prepared by:

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C O N T E N T S

i) PURPOSE OF THE REPORT

GSS Environmental (GSSE) has been engaged by Sydney Construction Materials (SCM) to develop a comprehensive *Soil & Water Management Plan* (SWMP) for the Newnes Junction Sand & Kaolin Extraction Project. This plan addresses in detail all aspects of soil disturbance, erosion prevention, soil storage and movement, retention of any mobilised sediments and soil-related aspects of water management on and off the site. The plan is intrinsically related to the *Surface Water Management Plan* for the development prepared by Hughes Trueman Pty Ltd.

In addition, the report sets out to address the specific requirements identified by the various government agencies and as outlined in the Director General's Requirements provided by the Department of Infrastructure, Planning and Natural Resources (DIPNR), including specific requirements by (the former) National Parks & Wildlife Service, now part of Department of Environment & Conservation (DEC).

The following *SWMP* has been formulated by GSSE in accordance with the NSW Department of Housing's *"Managing Urban Stormwater: Soils and Construction Manual*" (2004) or the "Blue Book" as it is known in government circles.

ii) ACKNOWLEDGEMENTS

GSSE wishes to acknowledge the following significant references specifically prepared for this development:

- *Surface Water Management Plan* (Hughes Trueman Pty Ltd, May 2004); and
- The *Environmental Impact Statement (EIS)* for the development (International Environmental Consultants Pty Ltd, April 2003).

Information and designs developed within these documents have been integrated into this SWMP.

1. INTRODUCTION

The following section of the report provides a general project overview, including the location of the site and the scale of the proposed development.

1.1 Project Overview and Location

Newnes Kaolin Pty Ltd, (trading as Sydney Construction Materials) has proposed to develop an open pit quarry operation on Exploration Lease EL4192 to extract and primary crush high quality friable sandstone at Newnes Junction, some 10km east of Lithgow NSW. A location plan is provided in this SWMP as **Figure 1**. The proposed development is located adjacent to three existing extractive industries, being the Clarence Colliery and Pioneer sand quarry to the north and northwest respectively, and the Rocla sand quarry to the south, as shown on **Figure 1**. With total estimated reserves of over 20Mt, the pit life is expected to exceed 21 years. Approximately 1.1Mt per annum will be extracted on average, with a maximum expected of 1.4Mt p.a. Areas adjacent the quarry have been extensively quarried/mined for construction sands and coal. The major components of the proposed development proposal are described further in **Section 4** below.

An Environmental Impact Statement (EIS) for the development was prepared by International Environmental Consultants Pty Ltd (IEC) and lodged with DIPNR in May 2003. In response to comments by various regulatory authorities requesting further information to address certain issues for the EIS, a SWMP has since been developed by Hughes Trueman Pty Ltd (May, 2004). A significant component of the water management system is the control of sediment within the quarry area. The issues of erosion / sediment control and rehabilitation of the site, contained in the Surface Water Management Plan have been extended by GSSE to form the SWMP. The principle underlying design criteria heavily influencing both of these plans, as set by the proponents, is that **there will be no uncontrolled discharge of water from the site whatsoever.** A revised extraction program and significant water management modifications (including two retention ponds and a water treatment plant) for the development to achieve this objective were subsequently described in detail in the Hughes Trueman document. This SWMP incorporates these robust modifications.

The quarry operation will be located on the ridgeline between the Rocla Quarry (adjacent to the south) and the Clarence Colliery pit top (adjacent to the northwest). The proposed disturbance area is approximately twenty five (25) hectares. Bordering the east of the site is the Blue Mountains National Park (BMNP), which is part of the Greater Blue Mountains World Heritage Area, containing the headwaters of the Wollangambe and Coli Rivers wilderness areas. The proximity to, and importance of, the BMNP has been a driver for conservative and sustainable water and soil management for the development. Indeed, this resulted in the principle underlying design criteria set by the proponents that, to protect potential receiving waters, there will be no uncontrolled discharge of water from the site whatsoever.

An aerial photograph showing the location of the quarry in a regional context is included in this SWMP as **Plate 1**.

On 19 August 2004, Rod Masters from GSS Environmental conducted an inspection of the site in order to prepare this SWMP.

1.2 Objectives

This SWMP proposes erosion and sediment control measures and revegetation protocols designed to:

- Minimise erosion processes;
- Minimise sediment-laden ("dirty water") runoff into retention ponds that may require subsequent treatment by a water treatment plant prior to off-site release;
- Minimise maintenance costs for sustainable operation and closure of the quarry;
- Progressively revegetate and rehabilitate the active working quarry area to blend with the local environment.

2.0 NATURE OF THE DEVELOPMENT

The development as described in the EIS (IEC, 2003), and revisions/additions described in the Surface Water Management Plan (Hughes Trueman, 2004), result in a staged development of the quarry as described in detail in **Section 4** of this plan. In summary, the proposed development will essentially consist of the following elements:

- An open cut pit development, using accurate surface mining technology to achieve a 1% pit floor crossfall drainage (<u>in</u>fall) to retain all dirty water onsite for treatment and prevent any uncontrolled drainage offsite;
- Water quality controls - major dirty water retention (expanding in proportion with staged extraction and exposed surface of the quarry) and a water treatment plant for capture of any residual solids;
- A small primary crushing operation;
- Conveyors;
- Stockpiles;
- A train-loading facility; and
- Site office and amenities for approximately 10 staff.

The revised quarry plan utilizes a surface miner as the primary extraction unit and scrapers to deliver the material to the stockpiling area. A key feature of this method is the ability to slope the pit floor very accurately which will facilitate *in-pit drainage*, creating a graded surface that slopes at approximately 1% in a westerly direction towards the back of the pit throughout the extraction and rehabilitation processes, except for the final phase of Stage 4 when the slope will be reversed in preparation for the final landform. As the excavation expands, final slope batters and berms are formed and *progressively rehabilitated*. The extraction method also allows for windrowed material to remain in pit, where required, in order to contain runoff as well as reduce runoff velocity.

The proposed surface water management works will also be capable of retaining all runoff from storms in excess of the 100year average recurrence interval (ARI), 72 hour duration storm. As such, there will be no uncontrolled discharge from the site during operational and rehabilitation phases of the project. Any discharge will only be by means of controlled flow from the water treatment plant. Further details on the staging of the quarry's development are contained in **Section 4** of this plan.

3.0 EXISTING SITE CONDITIONS

The following section of the report outlines the existing conditions of the proposed site. It includes reference to geology, soils, vegetation, topography, drainage, receiving surface waters and groundwater. It also includes some detail on climate, with particular reference to rainfall and the impacts that this has on the management of water across the site.

3.1 Geology

In regional geology terms, the material sequence being quarried belongs to the Triassic Narrabeen Group that overlies the Permian Illawarra Coal Measures of the Sydney Basin. The site forms part of the *Banks Wall Sandstone* in what are known generally as the Newnes Plateau Sandstones. The rock types consist of non-marine fluviatile sediments (sandstones) with some claystones and shales.

3.2 Soils

The soils of the proposed site comprise, in the main, of a very shallow (<0.30m) cover of poor quality, sandy loam over most of the proposed kaolin mining area. The soils of EL4192 are generally very sandy, shallow and well drained, supporting open woodland vegetation. The sub-strata across the site is predominately weathered, medium-grained, cream to white sandstone. The sandstones at Newnes are soft and break readily with relatively little energy to disaggregate into kaolin, silica sand and fine silica. The *Banks Wall Sandstone* sequence is comprised of around 50-80% quartz and 5-30% clay, with a small percentage of lithic fragments. It typically contains approximately 20% of clay and silt sized (75µm) material which is comprised primarily of kaolinitic clays and a small proportion of fine silica, mica, and iron oxide. The 'kaolin fraction' includes very fine silica minerals sized at <10µm.

A characteristic of the sandstone within the project area is that it forms a thin hardened crust, but rarely exceeding a few mm, and mantles friable, crumbly sandstone with a clay matrix of kaolin and an overall absence of ironstone crusts. Soils derived from the friable sandstone are low fertility sandy soils with a moderate to extreme erosion hazard. They consist of sandy yellow loams with a brown to yellow sub soil, with no distinct differentiation between topsoil and underlying weathered sandstone.

Within the proposed mining lease area, two soil landscapes occur; the Medlow Bath and Wollangambe Soil Landscapes. The Medlow Bath soils are found across the majority of the site on the higher and flatter slopes, while the Wollangambe soils occur on the steeper slopes toward the eastern edge of the site.

- The Medlow Bath soils occur on narrow crests and moderately inclined sideslopes (typically 10-20%), and are characterised by localised rock outcrops supporting partially cleared open forest and open woodland. The soils on crests are generally shallow (<0.40m) organic rich sands overlying either bedrock or well-drained earthy sands (<0.8m deep). On the side slopes there tends to be modereately deep (<1.0m) yellow earths and earth sands. Associated with the rock outcrops are shallow (<0.06m) Lithosols/Siliceous sands.

- The Wollangambe soils landscapes consist of rounded convex crests and moderately to steeply inclined side slopes (typically <35%) on Narrabeen Group sandstones. Localised rock outcrops are common, including broken scarps, small rock ledges and cliffs. On the crests soils are shallow (<0.3m) siliceous sands/lithosols, earthy sands, yellow earths and red earths. Shallow siliceous sands / lithosols occur on rock ledges and low broken scarps.

3.3 Vegetation

The vegetation communities at the site can be generally described as open eucalypt woodland. Only one flora community was identified within the study area by investigations for the EIS (IEC, 2003). This was the *Silvertop Ash – Sydney Peppermint Forest*. The vegetation is dominated by the Sydney Peppermint (*Eucalyptus piperita*), with Silvertop Ash (*Eucalyptus sieberi*) being less abundant on the site. In the northwest corner of the site the dominant Sydney Peppermint is replaced by the dominating Scribbly Gum (*Eucalyptus sclerophylla*).

Understory species do not show a corresponding change with the above change in the dominating canopy species, a pattern that is observed within the Silvertop Ash - Sydney Peppermint Forest, and is therefore not considered as a separate vegetation unit.

The site shows evidence of severe impact by the 1997 wildfire (bushfire) that swept across the Newnes Plateau. The degree of disturbance and resulting re-emergence and regeneration of the canopy varies across the site, although there is abundant seedling development of the upper canopy species.

The lower strata flora (shrub and ground layer understorey plants) is fairly low in diversity, being dominated by a few species, which may be due to the fire. Weed species are not common. As described by the EIS (IEC, 2003), flora species found at the site in both the understorey layers and the upper canopy are described in **Table 1** below.

No *threatened* flora, as defined under both the NSW *Threatened Species Act* (1995) and the Federal *Environment Protection and Biodiversity Conservation Act* (1999), were identified on the site by the EIS investigations (IEC, 2003). However, the EIS compiled a list of Flora Species of Conservation Significance that can found in the surrounding region, as shown in **Table 2** below. Further details on the character and known distribution for each species listed in Table 2 can be found in section 5.6.4 of the EIS (IEC, 2003). Subsequent work carried out by Gunninah Environmental Consultants (2004) in the period following the submission of the EIS conferred the findings of the EIS that there are no threatened or endangered species on the proposed quarry site. Furthermore, it was established that riparian environments containing small patches of swampy vegetation do not have the characteristic features of Newnes Plateau Swamp (HWR, 2004) (White, 2004).

Appropriate species from <u>both</u> of these two lists in **Tables 1** and **2** respectively have been considered for quarry revegetation as described in **Section 6**. of this plan. Species proposed for use in the revegetation program are also marked with an asterisk (*) in **Tables 1** and **2** below.

TABLE 1: Dominant Flora at the Site (IEC, 2003)

Flora Strata	Genus/Species	Common Name
Upper Canopy	*Eucalyptus piperita**	Sydney Peppermint
	*Eucalyptus sieberi**	Silvertop Ash
	*Eucalyptus sclerophylla**	Scribbly Gum
Shrub Layer	*Lomatia silaofolia**	Crinkle Bush
	*Daviesia latifolia**	Broad-leaf Bitter-pea
	Platysace minearifolia	Narrow-leaf Bitter-pea
	*Banksia spinulosa**	Hairpin Banksia
	Boronia microphylla	Small-leaved Boronia
	*Acacia terminalis**	
	*Epacris pulchella**	
	*Telopea spesiosissima**	Waratah
Ground Layer	*Mirbelia platylobioides*	
	Phyllota squarrosa	
	*Dampiera stricta**	Blue Dampiera
	Goodenia dimorpha var. dimorpha	
	Grevillea laurifolia	
	Patersonia glabrata	Leafy Purple-flag

* = proposed for potential use in revegetation at the site as described later in this plan.

TABLE 2: Species of Conservation Significance in the Surrounding Region (IEC, 2003)

Genus/Species	Potential Habitat	Conservation Status
*Acacia byoeana**	Heath / Woodland	V
*Acacia flocktoniae**	Forest	N(v)
Almaleea incurvata	Swamp	E
Apatophyllum constablei	Forest	E
Boronia deanei	Swamp	V
Caladenia tessellata	Widespread	N(v)
Derwentia blakelyi	Forest	V
Diuris aequalis	Forest	N(v)
*Eucalyptus pulverulenta**	Rocky Outcrops	N(v)
Haloragodendron lucasii	Forest / Woodland	E
Persoonia acerosa	Forest	V
Persoonia marginata	Forest	V
*Prostanthera cryptandroides**	Forest	V
*Pultenaea glabra**	Forest/Shrub	N(v)
Thesium australe	Widespread	N(v)

V = *Vulnerable* under NSW legislation
E = *Endangered* under NSW legislation
N = Listed as Endangered (e) or Vulnerable (v) under Federal legislation
* = proposed for potential use in revegetation at the site as described later in this plan.

3.4 Site Topography and Surface Hydrology

The proposed site is located in relatively steep topography and elevation of the site ranges from 1090m in the western area of the site to 1010m AHD toward the east. The hill and ridge system that contains the site forms part of a catchment which generally drains eastward across the site toward the Wollangambe River located in the Blue Mountains National Park, and whilst there are no major watercourse through the site there are minor ephemeral creek drainage lines to the northeast and southeast of the site which are shown in **Figure 1**. The catchment areas of these two ephemeral creeklines are about 30 hectares (northern drainage line) and 16 hectares (southern drainage line). The northern drainage line flows into the

Wollangambe River approximately 400m from the site tributary, and the southern drainage line flows into another tributary of the Wollangambe River before joining the river about 1.5km from the site. As such, potential impact to the river is more sensitive via the northern drainage line due to its closer proximity. This drainage line will have the water treatment plant for the development dedicated to it.

The area supports relatively open woodland, with increased tree densities in the gullies. The two small ridges that cross the site are orientated southwest to northeast, rising to the southwest.

3.5 Land Capability

DIPNR (formerly DLWC) has classified the land in the area according to its capability for agricultural use. The classification depends on a number of factors including slope and soil fertility and results in eight (8) capability classes. Class VI comprises the least productive grazing land. In accordance with the DIPNR (formerly DLWC) classifications for land use capabilities, the EIS states that the area affected by the development falls within classification Class VI. This land is unsuitable for cultivation and has limited grazing capacity.

Following closure and rehabilitation, the land capability of the area will not alter from its current land capability. The land is currently not suited to grazing or agriculture and is best vegetated.

3.6 Existing, Neighbouring and Future Land Use

The proposed development site is situated on vacant Crown Land, vegetated with eucalyptus woodland and used primarily by local residents to access the adjacent Blue Mountains National Park. The shallow and infertile sandy soils of the site reflect very little agricultural potential.

Neighbouring land uses, identified in the EIS (2003), include:

- *Coal Mining* – industrial use of land north and northeast for the Clarence Colliery by Centennial Coal Co. for coal mining reject emplacement areas, pit top facilities and rail loading loop;
- *Sand Quarrying* – Rocla sand quarry is immediately to the south. Kable Sands is some 2km to the northwest of the Clarence Colliery, Boral formerly operated a sand quarry on the plateau nearby;
- *Recreational and Environmental Protection* – adjacent Blue Mountains National Park listed as part of the Greater Blue Mountains World Heritage Area based on eucalypt biodiversity, wilderness and cultural values;
- *Residential* – Newnes Junction village located immediately southwest of the site, consisting of six (6) dwellings;
- *Transportation Routes* – Main western railway line and the Bell Line of Road both to the south; and
- *Forestry Activities* – State Forests own extensive areas of land to the north and west of the site.

The EIS for the development proposes that the future land use of the site after closure and rehabilitation will be similar to that of the current site, but with substantially different topography. The final land use is to be determined in consultation with relevant community and government authority bodies closer to mine closure in over twenty years. The progressive rehabilitation of the site with native vegetation will result in a final landform consisting of a terraced (benched) vegetated basin with a free draining wetland located in the base of the basin providing a habitat and conservation area.

3.7 Receiving Waters & Surface Water Quality

The hill and ridge system that contains the site forms part of a catchment that generally drains eastward into the Blue Mountains NP and the headwaters of the Wollangambe River (feeding into the Colo River and Hawkesbury system). The Wollangambe and Colo Rivers have both been recognised as 'wild and scenic' rivers under section 61 of the National Parks & Wildlife Act, 1974. These rivers are important in that they are of significant conservation value, and are popular recreation areas.

Water quality within the upper reaches of the Wollangambe River catchment (into which site waters flow) is primarily controlled by runoff from:

- Vacant Crown Land;
- Industrial areas within the catchment, including the Clarence Colliery and the Rocla sand quarry. These sites have controlled discharges into the Wollongambe system and water management systems in place to minimize their impact;
- The main western railway at the top of the ridge;
- The township of Newnes Junction, including dirt roads, septic systems and cleared areas.

The waters into which the proposed site discharges are classified as *Class P Protected Waters*. The water quality of controlled discharge would need to meet a suspended solids standard of 15mg/L i.e. sensitive water standards according to current ANZECC guidelines. There would also need to be a dilution factor of 19:1 such that discharge cannot raise background suspended solids levels by more than 15mg/L.

Water quality in the Wollangambe River is generally good, being naturally low in pH (4.5-5.5), iron, manganese and suspended solids. A summary of background water quality parameters upstream and downstream of the site are detailed below in **Table 3** provided by the EIS (IEC, 2003).

TABLE 3: **Background Surface Water Quality** (IEC, 2003)

Parameter/Analyte	Units	Upstream	Downstream
Acidity			
To pH 3.7 (as $CaCO_3$)	mg/L	<1	<
To pH 8.3 (as $CaCO_3$)	mg/L	4	4
Alkalinity			
CO_3 (as $CaCO_3$)	mg/L	<1	<1
HCO_3 (as $CaCO_3$)	mg/L	2	2
OH (as $CaCO_3$)	mg/L	<1	<1
Calcium	mg/L	1.3	0.8
Chloride	mg/L	9.0	6.0
Specific Conductance	μS/cm	31	27
Iron (total)	mg/L	0.06	0.39
Iron (filterable)	mg/L	<0.05	<0.05
Potassium	mg/L	0.9	1.4
Langelier Saturation	-	-6.7	-6.9
Magnesium	mg/L	0.7	0.4
Manganese (total)	mg/L	<0.05	<0.05
Manganese (filterable)	mg/L	<0.05	<0.05
Sodium	mg/L	4.8	2.9
pH	-	4.5	4.5
Total Sulphur (as SO_4)	mg/L	3.7	2.3
Total Dissolved Solids (TDS)	mg/L	20	15
Total Hardness (as $CaCO_3$)	mg/L	6.1	3.6
Total Suspended Soilds (TSS)	mg/L	<1	3

3.8 Groundwater

An assessment of hydrogeology for the site was undertaken as part of the EIS process (refer section 6.4.8 of the EIS (IEC, 2003) for details), which considered both hydraulic and water quality issues and potential impacts.

Groundwater onsite occurs in both primary and secondary structures in the Triassic sandstone geology and is supplied entirely by infiltration and recharge to a shallow groundwater system in the upper sandstone. This aquifer is distinct from additional and much deeper aquifer zones beyond 100-200m and more within the underlying Permian coal measure strata. Varying depths to ground water can be expected across the site ranging from 2m to 25m below ground surface (bgs). These depths are consistent with seepages in the lower lying gullies that cross the western boundary of the site. In summary, the predominant groundwater flow occurs in an easterly to norh-easterly direction with some groundwater being re-directed towards the Rocla sand quarry to the south. Beyond the main western railway line groundwater flow would be generally in a south-westerly direction toward Dargans Creek.

Existing groundwater quality from the shallow aquifer system in the area is variable, but generally very good with low to moderate salinity, low dissolved solids, generally low metals (with the exception of slightly elevated managanese which will require removal to meet discharge criteria), and variable pH typical of 'soft' water. The material to be quarried at the site is well above the aquifer used for domestic water supply to Clarence Village as well as a commercial bottled drinking water company. Expected groundwater quality is shown in **Table 4** below.

TABLE 4: Expected Groundwater Quality (IEC, 2003)

Parameter/Analyte	Units	Ponded Groundwater Sample 1	Ponded Groundwater Sample 2	Fresh Groundwater
Acidity				
To pH 3.7 (as $CaCO_3$)	mg/L	<1	<1	<1
To pH 8.3 (as $CaCO_3$)	mg/L	<1	4	20
Alkalinity				
CO_3 (as $CaCO_3$)	mg/L	4	<1	<1
HCO_3 (as $CaCO_3$)	mg/L	17	6	6
OH (as $CaCO_3$)	mg/L	<1	<1	<1
Calcium	mg/L	5.0	1.9	1.9
Chloride	mg/L	11.0	11.0	10.0
Specific Conductance	µS/cm	60	30	35
Iron (filterable)	mg/L	<0.05	<0.05	<0.05
Potassium	mg/L	1.5	1.4	0.9
Langelier Saturation	-	-0.4	-5.3	-0.6
Magnesium	mg/L	0.7	0.4	1.1
Manganese	mg/L	0.11	0.09	0.06
Sodium	mg/L	9.0	3.7	5.4
pH	-	9.2	5.3	4.6
Total Sulphur (as SO_4)	mg/L	3.6	1.8	8.7
Total Dissolved Solids (TDS)	mg/L	40	20	20
Total Hardness (as $CaCO_3$)	mg/L	15.5	6.6	9.2
Total Suspended Soilds (TSS)	mg/L	10	27	1350

During excavation of the pit, the shallow aquifer and local water table will be intersected, and as quarrying progresses water make will flow into pit voids. Whilst water table levels will ultimately stabilise by reaching an equilibrium when quarrying depth stabilizes at the end of quarrying, the creation of a drawdown zone during quarrying will cause groundwater flow directions to be directed toward the pit. Outside of this zone of influence groundwater flow directions will remain unaffected. It is not expected that the development will have any hydraulic effect on the Clarence Village system. Any significant drawdown influence will be restricted to within approximately 500m or so of the pit under maximum development. Final pit inflow is expected to be approximately 0.2ML/day, with a major proportion of that lost to evaporation from the high walls.

At least three groundwater monitoring sites are proposed in a westerly direction at increasing distances from the western boundary of the proposed pit, and will be established prior to development to establish background levels. A 6 week baseline monitoring period commenced in October 2004 at 3 sites within the corners of the Mining Lease Application area. Each monitoring site will consist of a shallow and deep test borehole. The aim of the initial monitoring will be to obtain accurate parameters for inclusion in the groundwater model. Samples will be analysed for major ionic constituents and water levels on a monthly basis (initially) to establish seasonal trends. Quarterly monitoring will eventuate after sufficient data are acquired and trends established.

3.9 Climate

The climate of the Newnes Plateau region is typically cool and temperate, characterised by mild summers and cold winters. It is influenced predominantly by the local topography, altitude, aspect and exposure. The rainfall is generally seasonally distributed with higher falls occurring during the summer months, however temperature ranges, frosts, fog and snow incidence increase with increasing altitude. Frosts and snow occur from April to November.

With respect to site soil and water management issues, climatic rainfall and evaporation characteristics are described both in the EIS (IEC, 2003) and the *Surface Water Management Plan* (Hughes Trueman, 2004).

Total mean annual rainfall for Lithgow is 1070.6mm, with maximum falls during January, February and December. The months with the lowest rainfall are July and September. There is a marked seasonality in rainfall with higher rainfall in the summer months and drier conditions from April to September. Based on Australian Rainfall & Runoff (1987) data, the rainfall for the 100year ARI, 72hour duration storm event (as used for current surface water management for the development) is 4.27mm/hr. **Table 5** from the *Surface Water Management Plan* below shows the monthly rainfall (mm), including percentile distribution of the rainfall for each month.

Table 5: Monthly and Annual Rainfall and Evaporation Percentiles

Month	Rainfall (mm)				Evap Average (mm)
	Average	Percentile			
		10%	50%	90%	
1	92.9	25.4	79.8	176.4	181
2	84.3	12.1	65.6	175.3	133
3	85.1	22.1	68.8	155.8	124
4	63.9	11.6	50.6	128.7	86
5	65.1	18.1	46.8	131.2	60
6	67.4	17.5	53.3	145.4	51
7	67.9	15.0	51.3	140.3	56
8	62.9	15.9	46.6	116.5	77
9	59.4	20.4	53.5	104.7	99
10	67.2	19.5	58.9	133.6	137
11	69.6	18.0	65.4	139.2	154
12	75.6	18.6	65.2	143.6	178
Year	859	623	860	1,087	1,336

The *Surface Water Management Plan* adopted the 30 year period 1973 to 2002 for water balance modeling and surface water control (eg ponds) design purposes because both rainfall and evaporation records were available for the whole period. In order to verify that this period is representative of the longer term records a number of checks were carried out on the annual total rainfall as well as rainfall sequences from 1 day to 60 days duration. **Tables 6** and **7** summarise the statistics for these two periods. For comparative purposes Table 7 also includes the 50 and 100 year ARI rainfall estimates for Newnes Junction derived from the rainfall intensity : frequency : duration data contained in Volume 2 of "Australian Rainfall & Runoff" (1987).

Table 6: Highest Rainfall Years in the Lithgow Record

Year	Rainfall (mm)
1990	1363.1
1978	1345.0
1973	1296.5

1893	1266.0
1934	1229.9

Table 6 shows that three of the top five rainfall years at Lithgow are included in the period 1973 -2002 which has been adopted for water balance analysis.

Table 7: Maximum Cumulative Rainfall (mm) over Consecutive Days

Days of Rainfall	Historic Record 1889-2004	Historic Record 1973-2002	Australian Rainfall & Runoff 50 year ARI	Australian Rainfall & Runoff 100 year ARI
1	179	179	195	214
2	268	268	252	273
3	310	310	279	307
4	332	332		
5	338	338		
10	342	342		
15	359	359		
20	360	360		
30	385	385		
45	465	461		
60	595	488		

The data in **Table 7** shows two noteworthy features:

- The rainfall during the period 1973 – 2002 contains the highest periods of rainfall for durations up to 30 days that occurred in the whole historic record. In other words, the period 1973 – 2003 contains rainfall data that is representative of the wettest periods that have been recorded at Lithgow.

- For a three day rainfall event, the 1973 – 2004 historic record contains a sequence of wet days that are slightly above the three day 100 year ARI rainfall derived from *"Australian Rainfall and Runoff"*. It follows that if the water management system can handle the runoff from the 1973 – 2002 historic rainfall sequence it could also cope with the 100 year ARI three day rainfall.

4.0 Proposed Development

A summary overview of the project and a list of the key aspects of the nature of development are contained in **Sections 1** and **2** of this plan, respectively. Detailed descriptions of the development proposal are contained in the EIS (IEC, 2003).

A detailed description of the revised staged extraction plan for the quarry development is described in the *Surface Water Management Plan* (Hughes Trueman, 2004), as detailed below.

4.1 Site Preparation Stage

The site preparation stage of the project is shown in **Figure 2**. This stage will involve the establishment of the site infrastructure including the following water management facilities:

- Construction of a small in-pit retention pond to collect runoff from the working surface for transfer by pumping to the main retention pond located outside the pit.
- Construction of a main retention pond (32 ML) in a location and with sufficient capacity to subsequently serve Stage 1 of the extraction process.
- Construction of a lower retention pond (10 ML) located so as to collect runoff from the haul road and maintenance facility.
- Construction of a clean water diversion channel located on the ridge above the high wall. This diversion channel will convey clean runoff from the hillside above the pit into the creek channel located towards the southern end of the final pit extremity.
- Construction of a water treatment plant capable of treating 1 ML/day to a suitable standard for discharge to the Blue Mountains National Park and for use in the village of Newnes Junction.
- Construction of a pipeline from the treatment plant to a storage tank located on the hilltop to the west of the pit. This tank will act as a reservoir for water supply to the village.
- Construction of a collection drain approximately along the 1032 m contour as shown on **Figure 2** to divert runoff from the hillside into the main retention pond for provision of water for dust suppression during the early stages of quarry development.

The water management facilities will be operated in the following manner:

- Runoff collected in the small in-pit retention pond will be pumped to the main retention pond for storage and settlement of coarse sediments. The exception to this would be in the event of an extreme rainfall event when the main retention pond was approaching full capacity. Under these circumstances, water would be allowed to temporarily pond within the working area (which will slope down from east to west at about 1% providing about 4 ML of in-pit storage at this stage). Under no circumstances would sediment laden water from the working area be transferred to the main retention pond so as to cause an overflow of untreated water from the main retention pond.
- Water in the main retention pond will be retained and pumped as required to the lower retention pond and used for dust suppression purposes or treated for use by the village, or discharged into the northern creek that drains to the Blue Mountains National Park. If the water level in the main retention pond rises above the design storage zone level (see **Section 5.6** for further details), water will be pumped for treatment and released in order to return the water level to the design storage level as soon as practicable.
- Runoff from the area of the haul road and conveyor will be collected in the lower retention pond and given first priority for use for dust suppression or treatment and re-use or discharge to the creek flowing into the World Heritage Area, according to the requirements at the time.

4.2 Stage One

Stage 1 will involve the downward excavation of the working area as product is extracted and the consequent expansion of the excavation area from an area of about 1.6 ha at the end of the Site Preparation Stage to about 10 ha at the end of Stage 1 as shown in **Figure 3**. During this stage, the water management system will remain essentially the same as for the Site Preparation Stage. The main difference will be an increase in the available storage capacity within the excavation pit to retain runoff from extreme storms to approximately 50 ML.

The proposed extraction method creates a series of windrows of excavated material as the surface miner passes over the pit floor. These windrows are then collected by a scraper which delivers the material to the stockpiling area. This process essentially creates a series of absorption banks on the leading edge of the pit. The banks will reduce runoff velocity during rainfall. They will be constructed along the contour (essentially north to south) and therefore perpendicular to the natural flow of water (east to west). The windrows will act as "contour banks" that will reduce slope lengths of uninterrupted slope and hence reduce the erosion capacity of overland flow. This will reduce the erosion potential within the working area and reduce the overall solids loading entering the retention ponds. Additional erosion and sediment controls are outlined in **Section 5.6.4** of this SWMP.

The main retention pond will be retained at a total capacity of 32 ML and the lower retention pond will be retained at a total capacity of 10 ML.

Water will continue to be drawn from the lower retention pond for dust suppression and treatment as described for the Site Preparation Stage. Similarly, water will be transferred from the in-pit retention pond to the main retention pond except when there is a risk of overflow from the main retention pond. When water level rises above the design storage zone level in the main retention pond (see **Section 5.6** for definition of zones within the retention pond) , water will be pumped for treatment and discharge to restore the water level to the designated storage level as soon as practical after a storm.

4.3 Stage Two

The configuration of the site and the water management facilities at the end of Stage 2 are shown on **Figure 4**. At the completion of Stage 2, the working area will have expanded to about 18 ha. This stage will involve the following alterations to the water management facilities:

- Construction of a new main retention pond (45 ML capacity) in the north western corner of the excavation.
- Extension of the clean water diversion channel around the southern end of the pit and then linking back to the southern creek that drains to the Blue Mountains National Park.

The enlargement of the excavation area will provide in-pit water storage capacity of approximately 220 ML in addition to the 55ML of storage capacity in the retention ponds.

The main retention pond will continue to be operated in a manner that seeks to restore the water level to the design storage level as soon as practicable after a storm.

The leading edge windrowed topsoil system will continue throughout this stage to prevent sediment leaving the site.

4.4 Stage Three

The main change to occur between the end of Stage 2 and the end of Stage 3 will be a further lowering of the working area and a corresponding increase in the excavation area to about

20.4 ha as shown on **Figure 5**. The water management facilities will remain the same as for Stage 2. The total available water storage within the pit will be about 350 ML.

4.5 Stage Four

During Stage 4 the extent of the pit will only increase slightly (by about 0.5 ha), as shown in **Figure 6**. The main changes will be the lowering of the base of the pit and the gradual reworking of the slope of the floor so that, by the end of Stage 4, the pit will slope towards the north eastern corner in preparation for final rehabilitation and the provision of a free draining outlet from the site after rehabilitation is complete. In order to preserve sufficient in-pit water storage capacity to retain all runoff from exceptionally heavy storms, a minimum low wall height of 2 m will be retained on the eastern side of the pit. This will provide a minimum of 120 ML of in-pit storage above the level of the main retention pond.

The main changes in the water management system during Stage 4 will be:

- The pre-existing low level retention pond on the eastern side of the pit will be enlarged to provide sufficient capacity (22.5 ML) to meet the water supply requirements.
- For this final stage of operations only, and in order to minimise any backfilling required of the retention pond prior to rehabilitation of the site, no separate provision will be made for a sediment settlement zone within the retention pond. Any water in excess of the water storage requirements will be allowed to pond in the pit. While this may cause some interruption to mining operations, it will only affect a small proportion the pit in the lowest portion. The ability of the treatment plant to treat and discharge 1 ML/day will allow normal operations to be restored rapidly.
- Drainage from the stockpiling conveyor and maintenance facilities will continue to be directed into the enlarged retention pond.
- As the surface level is gradually altered to slope towards the east, the former main retention pond will be subsumed as the extraction of material occurs from the area surrounding the retention pond.
- All water for dust suppression and treatment will be sourced from the remaining retention pond.

4.6 Surface Water Flow Changes

There are ephemeral drainage lines within the proposed site. The *Rivers and Foreshore Act (1948)* contains approval requirements for some developments on protected lands as defined in the Act. Although there are works proposed on protected lands (eg drainage lines), an approval is not required as the works will be within a Mining Lease Area and covered by a mining approval in accordance with Section 22H of the Act.

4.7 Water Demand and Water Balance

A significant and detailed analysis of the demand for water for all identified uses on site, and a detailed water balance analysis using hydrological modeling for the development and revised quarry extraction plan, was undertaken by Hughes Trueman Pty Ltd as part of the *Surface Water Management Plan (May 2004)*. The assessment included stormwater runoff in the 100 year ARI, 72hour (3 day) storm event, and groundwater seepage assessments. The results predicted varying water levels in water control structures onsite over a 30 (thirty) year climate sequence. The statistics of the assessments showed the following key aspects of the expected performance of the water management system:

- During all stages, the total storage capacity of the site will be in excess of the 1 in 100 year, 72 hour duration storm event. Even during Stage 4, when there is the largest contributing catchment and only a relatively small retention pond (in preparation for rehabilitation), the maximum depth of ponded water above the edge of the retention pond would be about 1.5 m, corresponding to a maximum volume of excess stored water of about 65 ML. This volume compares to the total volume of the pit below the eastern lip of about 120 ML at this Stage of the project. There would therefore be a large factor of safety against any uncontrolled discharge draining into the adjoining Blue Mountains National Park. During Stages 2 and 3 the available in-pit storage (220 ML and 350 ML respectively) is about 10 times the maximum required storage outside the retention pond (27 ML and 36 ML respectively).

- If a rainfall sequence occurred that led to storage of about 65 ML above the level of the retention pond during Stage 4, it would only take nine weeks of operation (pumping at a rate of 1 ML/day) of the treatment plant to remove all water from the section of the working area that had been inundated (about 9 ha). For Stages 2 and 3 the maximum require time would be four to five weeks.

- For all Stages the water management system has sufficient capacity to provide the estimated water required for dust suppression and vegetation establishment.

The *Surface Water Management Plan* should be referenced for further detailed information if required.

5.0 Erosion and Sediment Control

All proposed erosion and sediment control measures have been formulated by GSSE in accordance with the NSW Department of Housing's (Landcom) *Managing Urban Stormwater: Soils and Construction Volume 1* (4^{th} Edition, 2004) manual or the "Blue Book" as it is known in government circles.

Given the significant sensitivity of the site's soils to erosion processes and the sensitivity of the potential receiving waters of the National Park, the principal objective of surface water management for the project is to ensure that there is no uncontrolled discharge of water from the site whatsoever, and that the controlled water quality leaving the site meets the appropriate quality standards. This objective is intrinsic to erosion and sedimentation designs and controls for the project.

The principle design aspect of the development to achieve this goal is the use of accurate surface miner machinery to create *infall* benches to drain all dirty water into the pit only and eliminate out-of-pit runoff. Dirty water is then processed through primary and secondary retention ponds for settling of coarse sediments prior to a tertiary water treatment plant that will remove fine suspensions of sediment to a quality suitable for controlled release into the creeks leaving the site into the Blue Mountains National Park. The design of the retention system and the onsite pit-storage capacity has been designed to more than withstand the rainfall of the 100 year ARI, 72 hour duration (3 day) storm event and ensure no uncontrolled offsite discharge in such an event. Exposed slopes are not planned between the quarry pit and the National Park to further reduce potential for runoff and erosion issues.

This extensive level of sediment treatment and control is complimented by a number of minor erosion and sediment controls and management processes to minimise the amount of sediment entering the dirty water system and hence requiring treatment. This will be achieved by implementing the following controls:

- Conducting best practice land clearing procedures for all proposed disturbance areas;
- Separating *undisturbed* runoff from *disturbed* runoff where possible to minimise and isolate the amount of disturbed or "dirty water" runoff;
- Directing sediment-laden runoff into designated sediment control retention ponds and the water treatment plant;
- Diverting "clean water" runoff unaffected by the operations upstream into natural depressions;
- Constructing the haul road and working pit face with effective surface drainage;
- Maintaining sediment control structures to ensure that the designed capacities are maintained for optimum settling of sediments; and
- Implementing an effective revegetation and maintenance program for the site.
- Maintaining the proposed 50m buffer between the quarry pit and the National Park boundary.

5.1 Minimal Disturbance

Land disturbance will be minimised by clearing the smallest practical area of land for the shortest possible times. This will be achieved by:

- limiting the cleared width to that required to accommodate excavation within the quarry area and haul road corridor; and
- programming the works so that only the areas which are actively being excavated are cleared, therefore limiting the time the areas are exposed and limiting the potential for erosion and sedimentation.

Figure 7 shows the timing of excavation and development of the quarry pit over time. Clearing will coincide with this quarrying sequence.

Prior to the commencement of clearing, an internal site clearance permit will be issued by the Quarry Manager. General clearing and grubbing will not be undertaken until earthwork operations are ready to commence. All proposed erosion and sediment control measures will be implemented in advance of, or in conjunction with, clearing and grubbing operations. Prior to clearing commencing, the limits of clearing shall be marked by pegs placed at intervals on each side of the disturbed area. All operations will be planned to ensure that there is no damage to any trees outside the limits to be cleared.

5.2 Management of Soil Stockpiles

A number of soil stockpiles will be established around the western and northern edges of the pit. Both open and covered stockpiles will be utilized where relevant to operations. Due to material characteristics, handling requirements require the main resource stockpile (of around total 12, 000t split into two areas of premium and standard grade product) located to the north of the site near the loader to be <u>fully covered</u> by a protective roof over the entire stockpile area.

Stockpiles will be protected with sediment fencing and planted with a sterile cover crop (annual species) to ensure stabilisation. Surface drainage in the vicinity of the stockpiles will be configured so as to direct any runoff into the pit. As previously outlined, the surface of the pit is designed to control all runoff as infall to the dirty water management system (ponds and treatment plant), with no uncontrolled discharge from the pit.

Topsoil stripping within the disturbed area will be undertaken when the soil is in a slightly moist condition thus reducing damage to soil structure. The soil materials will not be stripped in either a dry or wet condition. Stripped material will be placed directly onto the disturbed areas and spread immediately if excavation sequences, equipment scheduling and weather conditions permit.

If longer term stockpiling (ie greater than 6 months) is required, a maximum stockpile depth of two (2) metres will be maintained to preserve viability and reduce soil deterioration. Soil stockpiles will be sown with the sterile cover crop (annual species).

Where the stockpile is not wholly contained within the “closed loop” water management system, temporary sediment control measures such as sand bags and silt fences will be used to prevent sediment from leaving the area. Stockpiles will be placed in areas so as to avoid impediment of natural localized drainage lines and minimise the likelihood of water ponding against the stockpile.

Topsoil will be re-spread in the reverse sequence to its removal, so that the organic layer, containing any seed or vegetation, is returned to the surface. Topsoil will be spread to a minimum depth of 50 mm on 3:1 or steeper slopes and to a minimum depth of 100 mm on flatter slopes. Re-spreading on the contour will aid runoff control and increases moisture retention for subsequent plant growth.

Re-spread topsoil will be leveled to achieve an even surface, avoiding a compacted or an over-smooth finish.

5.3 Clean Water Diversion Works

Two sections of clean water diversion banks will be utilised as permanent mitigation controls on the site to minimise erosion and divert run-on water around the disturbed areas and re-direct contaminated runoff into the existing internal drainage system that will ultimately report to the main sediment retention dam as shown **Figures 2** to **6**. A typical cross section for the proposed clean water diversion banks is illustrated in **Figure 8**.

The first section of diversion channel will be constructed during the initial stage of site preparation. It will run in a southerly direction approximately parallel to the western edge of the pit, and discharge into the southern creek that discharges from the extraction pit area. This channel will intercept clean runoff from a catchment area of approximately eight (8) hectares located to the west of the pit.

To avoid a small swampy area within the southern drainage line, a second diversion channel will be constructed as part of the Stage 2 works to redirect clean water runoff from the catchment area from above the pit. This diversion channel, which has a total catchment area of about sixteen (16) hectares, will commence at about the same location as the first channel joins the southern creek to convey water around the southern end of the pit.

Both channels will be designed to convey the 100 year ARI, 72 hour duration peak flow for the catchment concerned (approximately 4 m^3/s and 6.5 m^3/s, respectively). The routes of both channels will require excavation in rock and in some places the channel will need to be cut 2-3 m deep in order to achieve a satisfactory grade. In other locations, the channels are required to convey water down grades in excess of 10%. In these locations, the diversion bank channels will be reinforced with durable, competent rip rap to prevent soil erosion and prevent scour of the friable sandstone, as described in **Section 5.4** below. All completed banks will be topsoiled and sown with sterile cover crops.

5.4 In-Pit Water Management

Through the use of accurate surface mining machinery, infall drainage of the pit floor and quarry benches will be constructed to contain runoff to the internal dirty water control system throughout all stages of active quarrying. The only exception will be the final phase of Stage 4 when the site is prepared for the final landform wetland design requiring outfall drainage with runoff reporting to a designed wetland. A schematic representation of the proposed bench drainage system is provided in **Figure 9**.

The benched terraces will be developed to discharge water in a controlled fashion to the next bench using stabilised drop-down structures. Drop-down structures will be constructed between each of the benches to provide controlled drainage of water down slope toward the pit floor and into the dirty water management system. The drop structures will be stabilised using concrete slurry ("shotcrete") to prevent erosion of the terraces. Once shotcreted, the drop structure areas will become far more competent and remain stable in the long term. **Plate 2** shows the benching system in the adjoining Rocla quarry.

Plate 2: Adjoining Rocla sand quarry bench system.

The wall height between the benches will be far shorter for the proposed SCM quarry. The terraced walls will have slopes equal to or greater than eighty (80) degrees to minimise the amount of rainfall on them and the erosion risk over the long term. Each bench will be progressively rehabilitated to reduce erosion and improve aesthetics by proving visual screening of the quarry walls as discussed in **Section 6** of this plan. A typical cross-section of the proposed quarry benching system is shown in **Figure 10**.

All water collecting inside the pit area during the initial stages of quarrying will report to a minor in-pit retention pond (de-watering pond) located in the northwest corner of the pit. Dirty water will be pumped to the Main Retention Pond, as shown in **Figures 2** and **3.**

During Stages 2 to 4, all pit water will report directly to the Main Retention Pond which is located in-pit during those stages, as shown in **Figures 4, 5** and **6**.

5.5 Quarry Haul Roads

The quarry haul road will be constructed to ensure surface drainage is optimised and stabilised thereby reducing roadside erosion and sedimentation. Cross-fall drainage structures and mitre drainage will be implemented for the entire length of the haul road. Ramp gradients will be no greater than 10% to allow use in wet weather. Crowning will generally be implemented on any steeper sections of the haul road. Outfall drainage will be constructed where the road traverses small fill batter areas and in-fall drainage will occur where the road traverses larger fill batter areas.

Mitre drains will be constructed to take water from the shoulders or table drains of the haul road to the Main Retention Pond or Lower Retention Pond where relevant.

Road runoff will be intercepted at regular intervals to reduce runoff velocity in each mitre drain. Drain spacing will not exceed fifty (50) metres. Drain outlets will be ponded using silt fencing and sand bags to ensure effective sediment control at the periphery of the small haul road.

5.6 Sediment Control

Runoff from the quarry area will report to the dirty water management system consisting of retention ponds and treatment plant. The maximum contributing dirty water catchment to the Main Retention Pond will be 20.9 hectares during Stage 4 of quarry development, progressively increasing from 1.6 hectares during site preparation stage and 10.0 hectares during Stage 1 of the quarry. The Main Retention Pond and Lower Retention Pond will be responsible for optimising the retention of sediment carried in stormwater runoff prior to final removal of unsettleable sediment (eg colloidal) suspensions by the Water Treatment Plant before water is released into the natural drainage system.

The Main Retention Pond will serve as:

- the main collection point for stormwater runoff;
- the storage for supply of water for dust suppression requirements;
- the primary settlement pond for water that will be pumped to the Lower Retention Pond and then to the Water Treatment Plant for treatment to a standard suitable for use by the village or release into the natural creek system.

Both rentention ponds have been designed in accordance with the "Blue Book" for the most conservative scenario using Type F and Type D soils (where finer suspensions of solids have the most stringent requirements for settling) for the 100 year ARI, 72 hour storm event. The capacity of the ponds increases in each stage of quarry development in response to increased disturbed catchment area and water treatment requirements, and is described in significant detail in the *Surface Water Management Plan* (Hughes Trueman, 2004). Extracts of designs from that plan are contained in the following sections.

5.6.1 Design of the Main Retention Pond

The main retention pond will serve as a storage reservoir for on-site water needs and as a primary settlement pond for water that will subsequently be treated prior to discharge from the site, or reuse by the village. Excess runoff from that retained within the retention pond will be temporarily stored within the extraction area Accumulated pit water will be prevented from draining off-site due to the large storage capacity.

Four different water and sediment storage zones have been designed. In sequence, starting from the bottom of the retention pond, these are:

- Sediment storage zone that has been designed in accordance with the "Blue Book". The required settlement storage capacity, allowing for retention of all sediment over the life of the retention pond, will increase in proportion to the disturbed area with a requirement of 2.5 ML (2,500 m3) at the end of Stage 4 of extraction.
- Water storage zone which has been designed to provide sufficient capacity to provide for the on-site water needs. The required volume has been established using a long term water balance analysis (see **Section 4.7**). The required storage volume at the end of Stage 4 of extraction is 18 ML.
- Sediment settlement zone which has been designed on the basis of settlement basins for Type F or Type D soils as set out in the "Blue Book". The adopted design criteria for this component of the retention pond are the most conservative listed, namely:
  - 20 day 95th percentile rainfall 135 mm
  - Volumetric runoff coefficient 0.8

  The design capacity of the sediment settlement zone for the end of Stage 3 is 22 ML.
- Surcharge zone which will accommodate all excess runoff from the site in the event of extreme rainfall events such as the 100 year ARI 72 hour storm (307 mm). Runoff will be temporarily stored within the pit above the level of the top of the retention pond. The adequacy of the pit to accommodate the excess runoff is demonstrated by the water balance analysis set out in **Section 4.7.**

The capacity of the main retention pond will increase progressively as extraction progresses, as shown in **Table 8**.

Table 8: Main Retention pond Capacity for Various Stages of Extraction

	Quarry Development Stage				
	Preparation	1	2	3	4
Disturbed Area (ha)	1.6	10.0	18.0	20.4	20.9
Sediment storage zone (ML)	0.5	2.5	2.5	2.5	2.5
Water storage zone (ML)	13.0	16.0	17.5	18.0	18.0
Sediment settlement zone (ML)	1.7	10.8	19.5	22.0	2
Required pond capacity (ML)	20.2	31.3	40.0	42.5	20.5
Proposed pond capacity (ML)	32	32	45	45	22.5

Table 9 below compares the available surcharge water storage capacity within the pit with the volume of runoff that would occur from a 100 year ARI 72 hour duration design storm. The surcharge storage capacity within the pit arises because of the proposed 1% downward slope from east to west that forms a wedge shaped storage area with the lowest sections of the pit along the western high wall. As the base of the pit is lowered and width of the pit enlarges, so the width and depth of water that can be stored below the level of the eastern edge of the pit increases. **Table 9** shows that, even if the main retention pond was full at the commencement of a 100 year ARI 72 hour design storm, there would be ample excess water storage capacity within the

pit. In practice (see water balance analysis in **Section 4.7**), the average water level in the retention pond will be close to the level corresponding to the water storage zone. Therefore, the volume of the sediment settling zone can also be expected to be available for the retention of runoff from a major storm event.

Table 9: Comparison Between In-pit Storage Volume and 100 year ARI 72 Hour Design Storm Volume

	Quarry Development Stage			
	1	2	3	4
100 year ARI runoff volume (ML)	25	45	50	52
Surcharge zone capacity (ML)	50	220	350	70

5.6.2 Design of the Lower Retention Pond

The lower retention pond will act as the capture point for runoff from the area immediately north of the pit. This area contains the haul road leading to the main office and stockpile area, the stockpiling conveyor, the maintenance area and topsoil stockpiles. The total area draining to the lower retention pond is approximately 3.5 ha. The lower retention pond will also act as a balancing storage for water transferred from the Main Retention Pond.

Water retained in the lower retention pond will be given priority for providing:

- water for dust suppression,
- water for treatment and release off-site or transferred to the storage tank for use in the village.

The capacity of the lower retention pond will be 10 ML comprising:

- 7.2 ML temporary holding capacity to accommodate runoff from the contributing catchment resulting from a 100 year ARI, 72 hour storm (307 mm of rainfall);
- 2 ML balancing storage for water transferred from the main retention pond. This is equivalent to two days' pumping to the treatment plant;
- 0.8 ML allowance for sediment accumulation.

As the lower retention pond will act as the primary distribution point for serving various water needs, the water level will be maintained at a low level in order to maintain the design capacity for runoff capture. In the event of a 100 year ARI storm, it would only require 7 days operation of the treatment plant to restore the design capacity to the pond.

5.6.3 Water Treatment Plant

As stated in the EIS (IEC, 2003), the slowest settling, most mobile particles in the runoff from the extraction area will be those that consist of the finest kaolin clays. The treatment plant designed by Worley International Pty Limited will be capable of extracting this fine component at a capacity of around 1ML/day. In order to achieve maximum efficiency from the treatment plant, settlement of the coarser fraction will primarily occur within the Main Retention Pond. The fully automated chemical treatment plant will involve several processes, including coagulation and flocculation to remove finer clays and colloidal suspensions, and additional treatment to remove the more elevated manganese levels naturally occurring in sediments.

The proposed plant proposed will meet the required discharge standard of 15 mg/L of suspended solids. The treatment plant will only be operated periodically. This will occur immediately after stormwater runoff fills the Main Retention Pond above the storage zone level.

Water released from the treatment plant will flow to the Wollangambe River via a rip rap lined channel and drop structure.

5.6.4 Additional Erosion & Sediment Controls

The current proposed extraction method creates a series of windrows of excavated material as the surface miner passes over the pit floor. These windrows are then collected by a scraper which delivers the material to the stockpiling area. This process essentially creates a series of absorption banks within the pit, which will reduce runoff velocity during rainfall. The windrows will be constructed along the contour (essentially north to south) and therefore perpendicular to the natural flow of water (east to west). The windrows will serve several purposes including:

- Act as "contour banks" that will reduce slope lengths of uninterrupted slope and hence reduce the erosion capacity of overland flow. This will reduce the erosion potential within the working area and reduce the overall solids loading entering the retention ponds;
- Pond water behind the bank and allow settling of the coarser sand fraction.

Silt fencing will be installed downslope of the entire length of the windrowed material. Prior to any construction work onsite (including clearing of vegetation, soil stripping or access road construction), temporary erosion and sedimentation control structures will be put in place. Additional control works including, but not limited to, sediment filter fencing, sand bag sediment filters and revegetation will be employed. These will be particularly used during construction of drainage line crossings or other activities near depressions. Silt traps will be constructed downstream of each crossing and remain in place (and be regularly inspected for functionality) for the life of the quarry.

Sediment filter fencing and sandbag weirs will be installed in the longitudinal drainage adjoining the roads / disturbed areas and will be in advance of, and in conjunction with, earthworks to prevent contaminated water leaving the site. The weirs will be installed at fifty (50) metre intervals.

The filter fabric used in the silt fences will have a permeability coefficient of about 0.02m/s to allow sufficient flow during minor storms without water buildup, and have a retention efficiency of at least 75%. Having two fences in parallel will increase the overall retention efficiency.

Sand bag sediment filters will be used "as required" during the construction of drainage and road works, however the use of sand bags will be limited to situations only where erosion and sediment control is required for a short period (i.e. maximum of three (3) months).

Any batters will be constructed to minimise exposed areas and minimise potential surface for erosion. Batters that may require treatment include those on access roads and other construction areas, and as these areas may be steep and erodable, stabilization, revegetation and rehabilitation works will be undertaken quickly to minimise erosion. Hydromulching will be used to immediately protect underlying fill material from wind and water erosion. Hydromulching applications will typically consist of sterile annual grasses (to eliminate weed issues for the nearby National Park), bitumen or polymer binder, seed and fertiliser. Materials used in hydromulching are biodegradeable and decompose to form a beneficial organic humus.

5.7 Maintenance Area

A small maintenance area will be established near the eastern end of the conveyor. This area will include a workshop for maintenance of machinery and re-fuelling facilities. All maintenance work will be conducted within the workshop. The fuel storage area will be appropriately bunded in accordance with DEC and Australian Standard (AS1940) requirements for spill containment.

The hardstand area outside the workshop and adjacent to the refueling facility will be sealed and graded so as to drain all runoff to an oil and grease trap before discharging into the drainage system connected to the lower retention pond.

6.0 Revegetation

Revegetation of disturbed areas is an integral component of the site SWMP and as such will be undertaken as soon as possible after disturbance occurs. The benefits of progressive, active revegetation of disturbed areas include reduced erosion, improved water quality, increased fauna habitat, improved aesthetics and visual screening.

The proposed techniques for vegetative stabilisation of the site include, but are not limited to, the following:

1. Conservation and re-spreading of topsoil;
2. Scarification of the topsoiled areas;
3. Broadcasting endemic native tree and shrub species , and
4. Hydromulching using sterile annual cover crop species and native ground covers.

6.1 Roads and Infrastructure Areas

This section relates specifically to the rehabilitation associated with infrastructure areas that are established outside the active quarry area.

In accordance with undertakings in the EIS (IEC, 2003), rehabilitation works will be conducted on all exposed batters associated with access roads, stockpile areas and water management structures. These works will be progressively implemented as soon as practicable after construction to stabilize surfaces, prevent erosion and protect water quality in those areas.

Revegetation of all minor cut and fill batters within the haul road corridor will be undertaken for effective embankment stabilisation. A vegetative surface cover will inhibit erosion of the batter surfaces and will reduce sedimentation in table drains.

6.1.1 Conservation and Re-spreading of Topsoil

As the quarry proceeds, topsoil will be stripped and stockpiled from successive areas and stored prior to use in progressive, active rehabilitation activities. In accordance with the EIS (IEC, 2003), only topsoil that has been derived from the site area will be used in the rehabilitation programme to ensure exotic weed species are not brought onsite and protect potential release to the adjacent National Park. Some 38,000m^3 of topsoil will be produced, and a shortfall of material is not expected due to much of the surface area of the final landform comprising wetland that will not require extensive topsoil for revegetation.

The biologically useful component of available topsoil ranges from the top 10cm or more within or near drainage lines to less than 5cm over the remaining area. As such, the available useful topsoil is a highly valuable resource, containing weed-free soil and seeds of species naturally found onsite, in addition to nutrients and organic matter that will assist in the revegetation of the area.

Topsoil will be stripped and placed in *controlled* topsoil stockpiles (in accordance with controls listed **Section 5.4** of this plan) in areas adjacent to the initial quarrying areas. These areas will have silt fencing controls constructed downslope to contain sediment movement downslope. A small dozer will be used for stripping and/or placement of topsoils to avoid excessive compaction and subsequent loss of important soil structure. Topsoil stripping within the disturbed area will be undertaken when the soil is in a slightly moist condition thus reducing damage to soil structure, achieving a higher standard of revegetation and reducing maintenance requirements. The soil materials will not be stripped in either a dry or wet condition. Stripped material will be placed directly onto the disturbed areas and spread immediately if excavation sequences, equipment scheduling and weather conditions permit. This will be used for the initial landscaping works to be carried out on the pit benches.

If longer term stockpiling (ie greater than 6 months) is required, a maximum stockpile depth of two (2) metres will be utilised. Stockpile side slopes of 3H:1V and of variable length will be maintained to preserve viability and reduce soil deterioration that can occur from anaerobic conditions in larger stockpiles. Longer term soil stockpiles will be sown with sterile cover crops as soon as possible after stockpiling to stabilise the surface and maintain biological activity in the soil. Stockpiles will be placed in areas so as to avoid impediment of natural localised drainage lines and minimise the likelihood of water ponding against the stockpile.

When the outer edge of a bench is ready for rehabilitation, topsoil will be recovered from the stockpiles and placed on the strip that has been prepared for revegetation.

Topsoil will be re-spread in the reverse sequence to its removal, so that the organic layer, containing any seed or vegetation, is returned to the surface. Topsoil will be spread to a minimum depth of 50 mm on 3:1 or steeper slopes and to a minimum depth of 100 mm on flatter slopes. Re-spreading on the contour will aid runoff control and increases moisture retention for subsequent plant growth.

Re-spread topsoil will be leveled to achieve an even surface, avoiding a compacted or over-smooth finish.

6.1.2 Scarification

In order to optimise seedbed condition, scarification will be conducted when the soil is moist to produce a loose and friable seed bed which is essential for good vegetation establishment from seed.

Cultivating on the contour will be conducted to assist in delaying runoff, increasing infiltration and controlling erosion of the seed bed until an effective vegetative cover is established. As a minimum treatment, steep batters (>2:1) will be scarified using a tined bucket on an excavator to achieve surface roughness prior to sowing.

6.1.3 Hydromulching

Hydro mulching will be undertaken to provide cover for the soil to improve vegetative growth and modify the soil surface to control erosion. Securely pressed against the surface of the soil, the wood fibre mulch will provide a high degree of erosion control and improve moisture availability to establishing cover crops and ground covers. The mulch will also have the effect of protecting the soil surface against raindrop impact, improving the micro-environment for seed germination and establishment by reducing evaporation losses and assisting in the control of surface erosion caused by raindrop impact and overland water flow.

Hydromulching will be used to immediately protect underlying fill material in steep areas such as batters (eg access road, construction areas) from wind and water erosion. Hydromulching applications will typically consist of <u>sterile</u> annual grasses (to eliminate weed issues for the nearby National Park), polymer binder, seed and fertiliser. Materials used in hydromulching are biodegradeable and decompose to form a beneficial organic humus.

Hydromulching will ideally be undertaken during the period October to March. The extent of soil moisture will not be a determinant for initiating the operation. The wood fibre mulch will afford sufficient seed protection and moisture conservation to optimise the level of germination success if the pre-existing soil moisture levels are low.

6.2 Active Quarry Disturbance Areas

6.2.1 Progressive Rehabilitation Strategy and Objectives

The objectives of the proposed rehabilitation strategy are to:

- Minimise the environmental impact of the expanding operation during development and operational phases, ensuring that protection of water quality and erosion control works are key priorities, and that progressive rehabilitation is completed as soon as possible;
- Ensure that site drainage and sedimentation structures remain stable and functional under extreme rainfall events;
- Ensure that vegetative matter and topsoil is made available for the site rehabilitation as required;
- Guarantee that the resource is extracted and the site rehabilitated in a manner that will ensure the quality of surface runoff and groundwater infiltration at all times; and
- Produce a final "walk away" landform that is geotechnically stable and blends aesthetically into the surrounding landforms, yet as far as possible does not limit possible future land uses.

Native open woodland vegetation cover currently occurs over most of the proposed quarry site. It is proposed to re-establish a similar cover to the majority of the post-quarrying landform. Native vegetation will largely be established using directly applied seed and from the seed store within re-spread topsoil. Supplementary native pasture and/or tubestock seeding will be undertaken where specific species combinations are required. A plant nursery will be established at the site to propagate all tubestock to be used during the rehabilitation process.

The revegetation program ("terrace landscaping") will progressively re-establish native tree / shrub / ground cover and will stabilise reshaped and benched areas. Benches will be deep ripped to actively promote infiltration of water which will enhance soil moisture requirements for direct tree seeding and minimise surface runoff to underlying benches and the pit floor dirty water control system. Surface preparation is further described in **Section 6.2.2** below. Revegetation will also visually screen disturbed areas and will re-establish habitat for native fauna. A successful example of progressive revegetation of benching in an active friable sandstone quarry on the Somersby Plateau, NSW is illustrated in **Plates 3** to **6**.

Plate 3: Revegetated sand quarry benches.

Plate 4: Native tree & shrub seeding on sand quarry benches (6 months old).

Plate 5: Native tree & shrub seeding on sand quarry benches (2 years old).

Plate 6: Established native trees & shrubs on sand quarry benches (2 years old).

6.2.2 Surface Preparation

The decompaction of soil is important in assisting rapid tree growth through deep root growth and enhanced soil water infiltration. Ripping depth must be sufficient to penetrate any near-surface rock or clay. Inadequate site preparation and weed control are often the two biggest single factors responsible for tree revegetation failure. Thorough site preparation will be undertaken to ensure rapid establishment and growth of seedlings. All proposed seeding areas will be deep ripped to an indicative depth of 400 – 500 mm.

6.2.3 Direct Seeding

Direct seeding (via broadcasting) is preferred over tube stock planting as it enables a far greater success rate, limits the need for ongoing maintenance (e.g watering) and is the most effective method in achieving a successful rehabilitation outcome.

Proposed species for revegetation have been selected from selected from local native species identified in **Tables 1** and **2** in this plan. Not all native trees and shrubs are suited to direct seeding due to their innate germination requirements. In cases, it may be required to supplement with some tubestock to increase biodiversity. A mixture of native trees and shrubs will be sown onto the majority of the reshaped and benched pit areas following topdressing and site preparation. Tree and shrub seeding using endemic species will complement natural regeneration from seed contained within the soil seed bank. The mix used for revegetation of the disturbed quarry area will include many of the major tree and shrub species shown in **Table 10** below.

TABLE 10: PROPOSED SPECIES MIX FOR QUARRY DIRECT SEEDING

RECOMMENDED SPECIES MIX
Eucalyptus piperita
Eucalyptus sieberi
Eucalyptus sclerophylla
Lomatia silaofolia
Daviesia latifolia
Banksia spinulosa
Acacia terminalis
Epacris pulchella
Telopea spesiosissima
Acacia byoeana*
Acacia flocktoniae*
Eucalyptus pulverulenta*
Prostanthera cryptandroides*
Pultenaea glabra*

* = denotes flora of conservation significance from surrounding region

Seed will be sourced from local NPWS licenced seed collectors. Some native species have difficult dormancy mechanisms that need to be broken before germination can occur. Native seed for revegetation of the quarry will be appropriately pre-treated in order to break dormancy restrictions. Subject to sufficient follow up rain, high initial tree densities can be expected. These high densities will quickly help stabilise and screen the site and will result in healthy mature tree stands over time. It is intended to create, over time, a mosaic of variable native species and plant densities representative of that currently occurring in the area. Growth rates of between 1 and 2 metres per year can be initially expected for many of the more dominant trees and shrubs.

Correct treatment and application of seed in the appropriate ratios is important in controlling emerging weeds and in allowing the tree stand to develop in a positive direction. The native tree and shrub seed mix will be sown at a total combined rate of approximately 7 kg/ha. Seed will be broadcast evenly onto topdressed areas. It will not be buried. Seeding will be conducted in late spring, summer and early autumn giving superior results due to higher ground temperatures.

6.2.4 Scheduling of Works

Some twenty five (25) hectares of native woodland vegetation will be disturbed by quarrying over the duration of the project. Rehabilitation work will be undertaken *progressively* as soon as reshaped, benched and topsoiled areas become available. **Figure 7** illustrates the timing and sequencing of active quarrying for the revised staged extraction plan and therefore provides an indication of revegetation scheduling given that seeding will be undertaken immediately after extraction areas are exhausted.

6.2.5 Final Land Use

The area currently supports open eucalyptus woodland forest. The broad rehabilitation objective for the post-quarrying landform is to establish a similar land use. The topography of the final landform will consist of a large number of small, stepped sandstone benches formed in an amphitheatre configuration , each with a revegetated berm. The amphitheatre void will be some 450m wide and 400m long at its western edge, and 650m long at its eastern edge. Until such time as extraction has ceased, rehabilitation will occur around the edges of the pit only, and will not involve the pit floor. Once operations have been completed, all buildings and infrastructure will be removed from the pit. These areas will be reshaped and ripped where necessary for topsoiling and revegetation. It is proposed that the haul road will remain for use in the ongoing management of the site rehabilitation and for fire fighting purposes. The pit floor will be vegetated with appropriate native species to create a stable, free-draining wetland.

A final Closure Plan (including a detailed wetland design) will be developed prior to the commencement of Stage 4 of the quarry. The plan will reflect current understanding, best management practice, and design criteria requirements at the time, to refine design issues of the concept envisaged prior to the quarry development to establish a stable and sustainable wetland. Whilst it us understood that standards are likely to change within the active mine period, it is anticipated that the wetland will be designed in accordance with the equivalent of the Constructed Wetlands Manual 1998 (DIPNR, formerly DLWC). This will involve input from, and consultation with, government regulatory agencies including DEC (comprising the former NPWS and EPA), Dept of Mineral Resources, and DIPNR.

The concept for a functioning wetland in the final void is illustrated in **Figures 11** and **12**. At the completion of operations, the extraction pit will have an expected floor level grading from RL 989.5 m AHD on the eastern side adjacent to the retention pond to 993 m AHD on the western side. The final operational activity will be to excavate sufficient extra material to fill the remaining retention pond (located on the eastern side of the pit) to a level consistent with the surrounding excavated area. A small retention pond (about 20 m^3) will be retained to provide an extraction point for water to be pumped to the treatment plant.

During the initial phase of rehabilitation the water management system will continue to operate in a similar manner to the final operational phase with off site discharge only occurring by means of water released from the treatment plant. The treatment plant will be operated so as to retain a wetland swamp area with a maximum depth of 0.5 m in the centre of the remnant depression.

The wetland will be formed as a shallow depression with the low point in the location of the final retention pond in the north east corner of the pit. The area surrounding the location of the final retention pond will be graded at flatter slopes (typically 0.5%) than used elsewhere in the pit (1.0%) in order to create a free form shallow depression with a total area of about 4 ha. It is anticipated that sedges and other wetland plants endemic to the area will colonise this wetland area to form a swamp ecosystem analogous to that in Gooches Crater, a natural crater feature located approximately 2 km north west of the project area, as shown in **Plate 7** below.

Plate 7: Gooches Crater *(courtesy Hughes Trueman, 2004)*.

Once vegetation has fully established (approximately 5 years), the site will be reconfigured to permit free drainage of water from the site once the wetland/swamp is filled to a depth of 0.5 m. A channel will be excavated through the rock at an elevation of 990 m AHD (0.5 m above the base of the wetland swamp) to allow free drainage from the pit into the existing northern creek that drains into the Blue Mountains National Park.

Once a channel has been excavated to allow overflow from the wetland to discharge off-site, the wetland will be dependant on water supply from the contributing catchment of about 24 ha. The water balance model developed for the operational phases of the project has been modified to account for the expected runoff characteristics of the rehabilitated catchment and used to assess the wetting and drying behaviour of the wetland as a result of surface runoff.

6.2.6 Fencing and Weed Control

Fencing will be erected and maintained to exclude and prohibit the movement of persons and vehicles into areas that have been rehabilitated. The fencing will be routinely checked and repaired where necessary.

Weeds present one of the most significant problems to the creation of forest ecosystems. The minimisation of grass and weed competition over the first six (6) to twelve (12) months after seeding is critical to successful tree establishment. Weed control will be undertaken on an "as required" basis should cyclical weed invasion events. As trees establish and mature they will compete and eventually eliminate most weeds and grass underneath. For this reason, dense direct seeding (as opposed to planting) is an effective long-term weed control mechanism that reduces maintenance significantly, particularly ongoing weed control. Weeds in most tree-seeded stands typically disappear after 18 months to two years.

6.2.7 Maintenance

Due to the hardiness of young direct tree seedlings (compared to planted tubestock), sown trees require minimal maintenance. Direct seeded seedlings require no watering while planted seedlings (tubestock) may require extensive watering if conditions remain dry. No maintenance fertiliser will be required for tree areas. Effective control of weed species within rehabilitated areas will be a critical and essential component of the proposed revegetation plan. Weed and noxious animal control will be undertaken on all rehabilitation areas according to relevant state and local government legislation and policy.

All erosion and sediment control measures will be maintained in a functioning condition until individual areas have been deemed "successfully" rehabilitated. Structural soil conservation works will be inspected after high intensity rainfall so that de-silting and prompt repairs and/or replacement of damaged works can be initiated as required.

7.0 Operation and Monitoring

The following section describes the operation and monitoring program for soil and water management at the proposed development. The Quarry Manager (or their nominated representative) is responsible for the Environmental Monitoring program at the site.

7.1 Maintenance of Surface Water Controls

Site drainage and sediment control structures will be inspected regularly after runoff events (>20mm of rain) to check for scouring of diversion drains and accumulation of materials in sediment traps (e.g. silt fences & sand bags) and settling dams. Sediment control structures will be de-silted when the design capacity of the structure has been reduced by 30% (or as necessary). All scouring of drains will be stabilised as soon as possible.

7.2 Surface Water Monitoring

All water quality monitoring will be undertaken in accordance with the water sampling and analysis Guidelines as prescribed by DEC and the relevant Australian Standards.

Water samples will be taken in accordance with Development Consent requirements and the EPL licence issued for the site by the DEC. It is envisaged that this will include analysis for selected, relevant key parameters from the background surface water quality testing program. The analysis will be undertaken by a NATA (or equivalent) laboratory.

7.3 Rehabilitation Monitoring

Revegetation works will be monitored in order to assess success, effectiveness of techniques, and fine tune rehabilitation methodologies to ensure that a suitable vegetation community is established in the open pit area. A number of aspects of the rehabilitation program will be required to be monitored and inspected to help ensure a successful result. Both quantitative (eg stem density measurements) and qualitative (eg photographic records and inspections) monitoring and assessment will be undertaken.

It is noted that some mortality is expected for a proportion of tree and shrub revegetation seedlings, providing benefits of nutrient and organic decomposition to the soil. Changes in stand composition will occur as direct-seeded stands are initially very dense, with numbers declining rapidly over the first five years as quick-growing and short-lived species (such as Acacias) die out and as more dominant canopy species emerge. As tree seeded stands mature the ratio of different species changes. The initial fast-growing understorey species provide useful functions in stabilising soils, shading out weeds and assisting in nitrogen and organic buildup in soils to encourage long-living canopy species to emerge.

Eventually the stand will thin even further as individual eucalypt species dominate over others. Stem densities will show decline quickly during this process. In the first five years stem densities may decline from around 20,000 to 5,000 stems per hectare.

7.4 Reporting & Review

All water quality monitoring data will be recorded and the original laboratory report maintained on site. Details of all monitoring required by Development Consent or DEC (formerly EPA) Licence will be reported in the *Annual Environmental Management Report (AEMR)*.

Details of all monitoring required under an Environmental Protection Licence (EPL) issued in accordance with the *Protection of the Environment Operations Act (1997)* will be reported in the Annual Return. This Management Plan will be reviewed in accordance with the requirements of Development Consent or at a minimum of every three (3) years.

8.0 Workforce Training & Awareness

Sydney Construction Materials will develop and maintain a training and awareness program that will provide the workforce (including sub-contractors) with the knowledge and skills necessary to meet the objectives of this SWMP.

It will include, but not be limited to, the following key principles:

- Ensuring that prior to the commencement of site works all erosion and sediment control requirements have been installed;
- Ensuring that erosion and sediment control works are regular maintained and are operational; and
- Familiarisation with Environmental Incident Reporting requirements and the Emergency Response Procedures relevant to the site.

9.0 References

1. International Environmental Consultants Pty Ltd (May, 2003), *"Environmental Impact Statement: Multi-Commodity Sand Extraction and Kaolin Project for Supply of Construction Materials to the Sydney Region From Newnes Plateau";*
2. Hughes Trueman Pty Ltd (May, 2003), *"Surface Water Management Plan: Newnes Junction Sand & Kaolin Extraction Project";*
3. NSW Department of Housing (Landcom) (4th Edition, 2004), "*Managing Urban Stormwater: Soils and Construction Volume 1*", known as the "Blue Book".
4. Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) October 2000, ***Water Quality Guidelines***, Paper No. 4 - Volume 1 (Chapters 1-7);
5. HWR (2004), *"Flora Assessment. Sand Extraction and Kaolin Project, Newnes Junction".*
6. White, A.W. (2004), *"Survey for Habitat of the Blue Mountains Water Skink (<u>Eulamprus leuranensis</u>) at Newnes Kaolin Site"*. Biosphere Ecological Consultants, Sydney.
7. Gunninah Environmental Consultants (2004), "*Proposed Sand Extraction and Kaolin Mine, Newnes Junction. Supplementary submission to DIPNR; Flora & Fauna Issues".*