- haul roads 15 m wide and at 1:10 grade;
- rock density of 2.65 tonnes per cubic metre;
- topsoil one metre thick
- weathered rock 10 m thick; and
- quarry floor level sloped at one percent to a drainage sump.

3.6.1 *Stage 1.*

This stage involves expanding the quarry to the west as shown in *Figure 3.6.*

Where possible, the first action will be to develop an excavated slot along the southern rim of the quarry through the topsoil and weathered rock, leaving the final south face at a stable angle suitable for plant growth, and replanting. When the active quarry face extends south to meet this revegetated slot, much of the final visual impact will be mitigated. Where the development of the slot is not possible due to the location of the existing southern quarry face, revegetation will be commenced as soon as possible following completion of the final southern face.

At the same time a sump will be dug into the floor of the quarry to trap all runoff from disturbed areas. This will be enlarged from time to time to meet sediment control specifications from time to time as the quarry void increases.

Benches will be developed at RL 50, 62, 74, 84 and 96. It has been calculated that this development will generate 61,900 m^3 of overburden, 619,300 m^3 (1.55 million tonnes) of weathered rock and 1,685,800 m^3 (4.47 million tonnes) of fresh rock (see *Appendix E)*. It is expected that most of the weathered rock will be processed and sold as road base type product.

As terminal faces are developed on the southern and western limits overburden and topsoil will be placed on the benches and rehabilitated. The proposed method as described in Section 3.11 was used successfully by CSR at its Ferntree Gully Quarry in Melbourne.

The prior rehabilitation of the top 10 m of overburden and the weathered rock along the southern slot and the retention of vegetation above the northern rim of the quarry will assist in significantly reducing visual impact when the site is viewed from the north. In fact, remediation of the currently exposed face is now in progress and will reduce the current visual impact as vegetation becomes established.

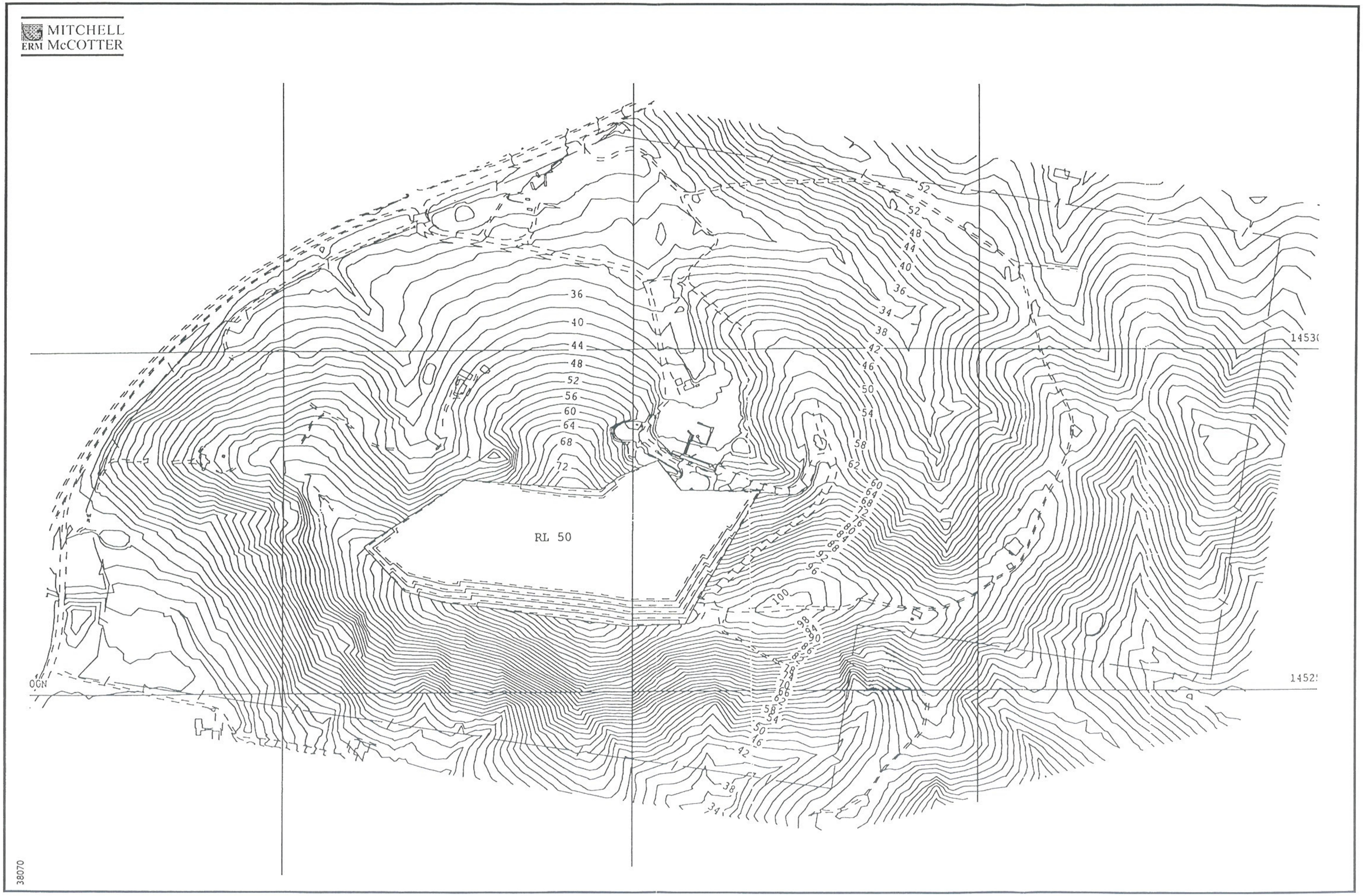

Figure 3.6 STAGE 1 DEVELOPMENT

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3.6.2 *Stage 2*

This stage involves the easterly development of the RL 50, 62, 74, 86 and 98 faces half way to the proposed eastern limit of the quarry and developing a new bench to RL 35 in the latter part, as shown in *Figure 3.7*.

Again, a preliminary slot will be cut along the southern rim to enable rehabilitation of the top bench in weathered rock before it is exposed to view from the north. Terminal faces on the southern rim, not needed for access or the haul road, will be rehabilitated.

This stage will yield some 44,200 m^3 of overburden, 489,100 m^3 of weathered rock (1.22 million tonnes) and 1,640,800 m^3 of fresh rock (4.35 million tonnes).

Visual impact will again be diminished by a combination of prior rehabilitation of the weathered rock face and the screening affect of the vegetation to be retained on the northern rim of the quarry.

Early in Stage 2 the existing haul roads will need to be relocated, and it is proposed that access from the RL 50 bench to the higher benches will be via a ramp developed along the northern and eastern faces. The higher sections of this ramp will be live and will have to be relocated from time to time.

All run off from the disturbed area will be gathered either on the RL 35 level, or in a sump below RL 35. After settling all water will be pumped out into the existing water management system.

Towards the end of this stage operations will get very close to the south-east corner of the CSR property. A formal legal agreement between CSR and the owners of the adjoining property (YALA) restricting activities on the adjoining land during blasting in the proposed eastern extension only is currently being negotiated. A non-binding letter of intent has been signed by both parties to indicate the intention to enter into a formal coexistence agreement. A copy of this letter is provided as *Appendix F*.

3.6.3 *Stage 3*

This stage sees the continued development east of the RL 35, 50, 62, 74 and 98 benches to their most eastern limit (as shown in *Figure 3.8*). At no stage will the most eastern ridge of the site be breached. Towards the end of this stage a section of the new bench at RL 20 may be developed.

Again the weathered rock profile along the southern rim will be rehabilitated, and after development visible terminal faces will be rehabilitated.

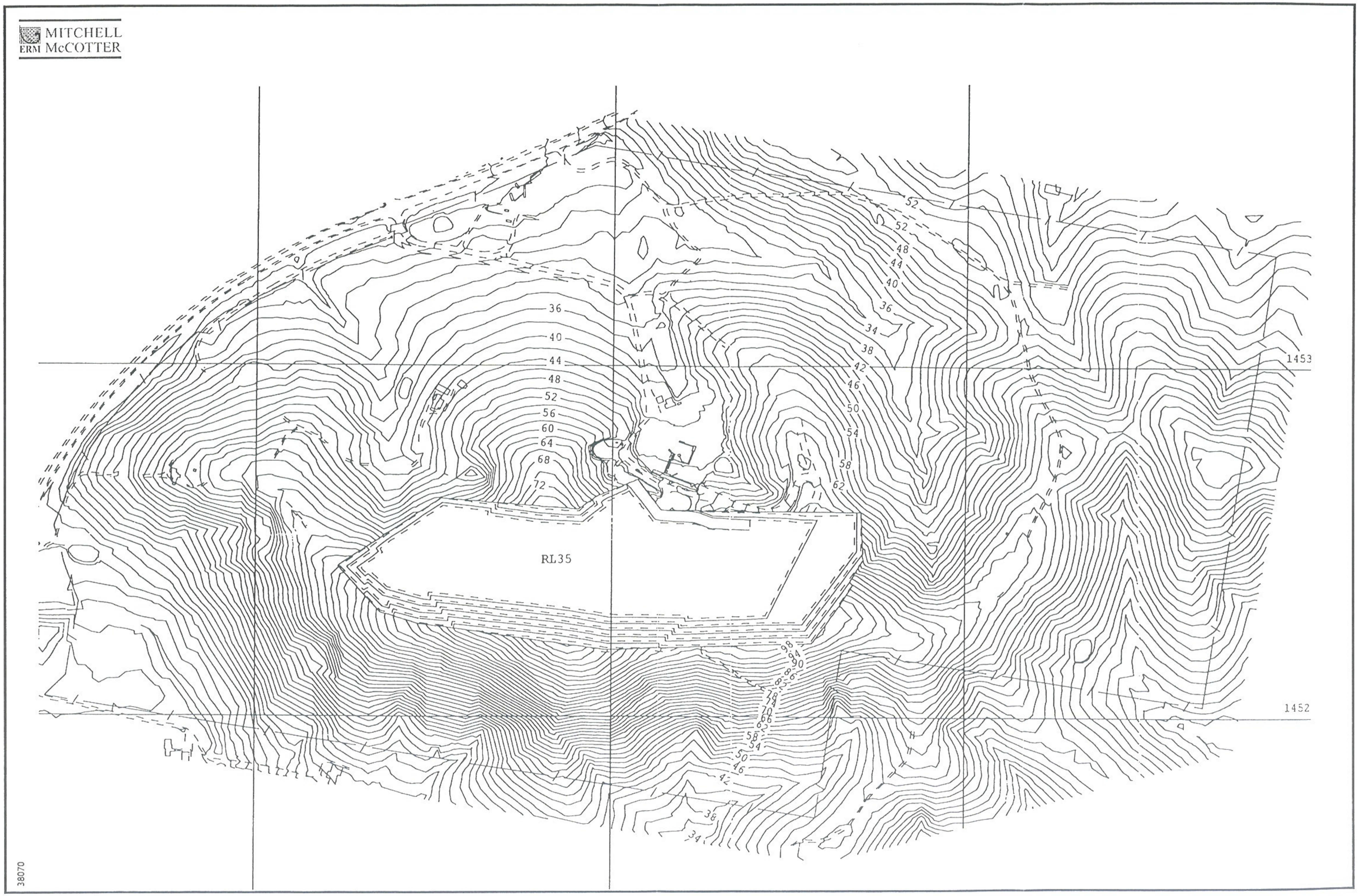

Figure 3.7 STAGE 2 DEVELOPMENT

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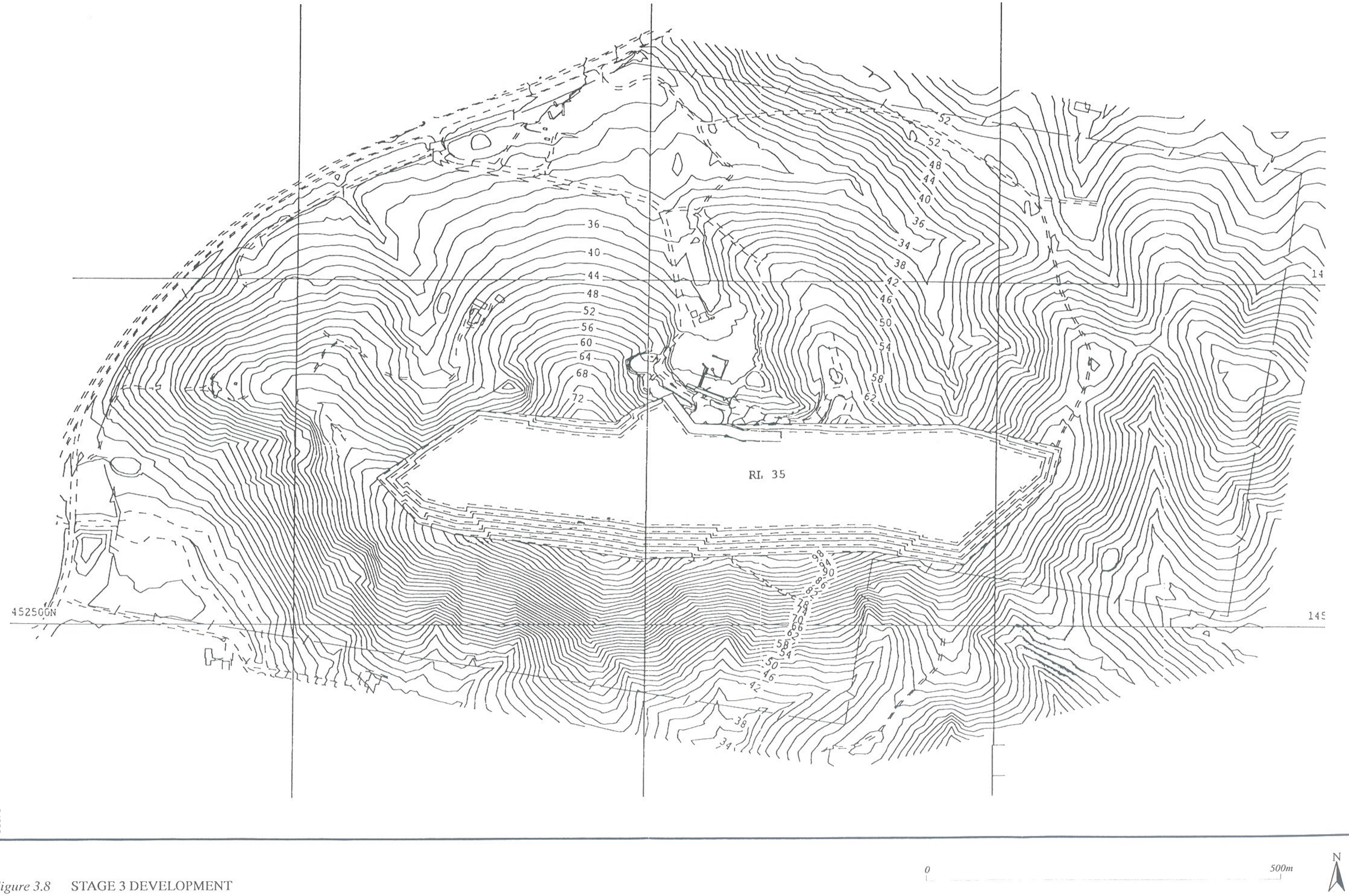

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Figure 3.8 STAGE 3 DEVELOPMENT

During this stage the operation will extract 34,500 m^3 of overburden, 300,700 m^3 of weathered rock (751,700 tonnes) and 1,371,600 m^3 of fresh rock (3.6 million tonnes).

Completion of this stage will represent the end of any disturbance of the site, the quarry having practically reached its final rim position.

3.6.4 Stage 4

In this stage (shown in *Figure 3.9)* effort is concentrated on removing the bottom RL 20 bench, and some peripheral clean up. It will release 4,500 m^3 of overburden, 45,000 m^3 of weathered rock (112,700 tonnes) and 1,537,600 m^3 of fresh rock (4.1 million tonnes).

Other than maintenance of existing rehabilitation there will be little rehabilitation.

At the end of this stage the floor will be approximately 750 metres long and 100 metres wide. Below RL 20 there is the potential to yield in excess of 2.5 million tonnes of fresh rock. Approval for extraction of this additional resource is not part of this application.

3.7 QUARRY OPERATION

Essentially the quarry will be operated in a similar fashion to the current practices. Significant variations will occur in blast design and operating hours, but as the company has recently purchased the property of its nearest neighbour, Mr Ralph Williams, the potential impact of these changes have been greatly reduced.

3.7.1 Site Preparation

Site preparation includes:

- the installation of drainage systems, sedimentation dams and geofabric filter fencing;
- clearing of existing vegetation;
- removal and stockpiling of overburden; and
- construction of hardstand areas for site facilities and stockpiling.

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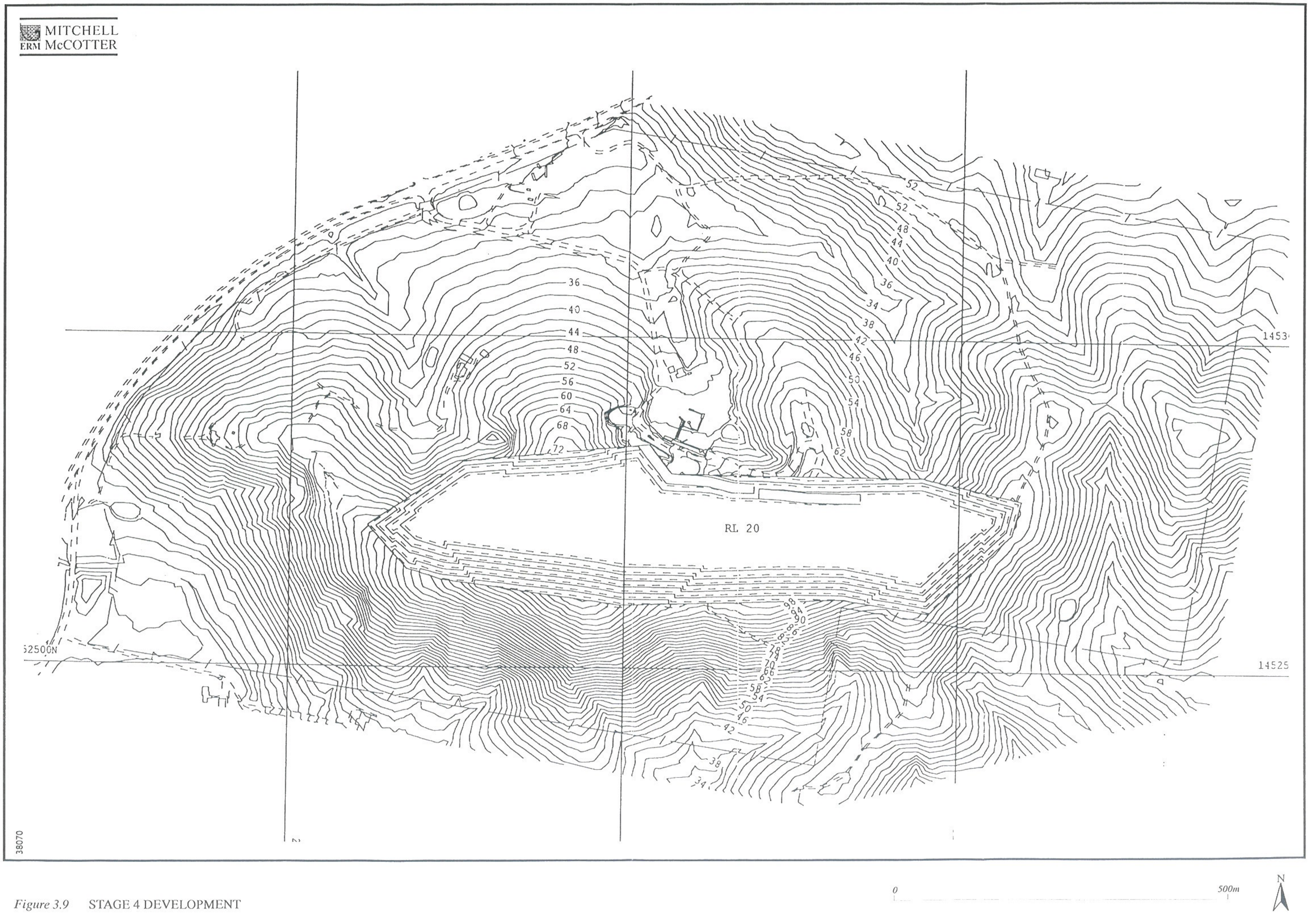

Figure 3.9 STAGE 4 DEVELOPMENT

i. Site Drainage

Extraction of material from the quarry extension will progress from the existing quarry pit into new extraction areas. Similarly, the extension of the site facilities area will progress from the existing area. This will ensure that drainage of newly disturbed areas will always be directed back to sedimentation dams in order to contain sediment and to prevent this material from entering existing watercourses.

At times during the expansion it will be necessary to separate runoff flows with runoff from undisturbed vegetated areas being directed to existing watercourses. Water control structures will be constructed and these will include diversion banks. Geofabric filter fences and hay bales will be installed prior to vegetation clearing and construction of diversion bunds in order to trap any water-borne silt. The diversion bunds will then be stabilised using fast growing grasses.

ii. Vegetation Clearing

Vegetation will be cleared progressively as the quarry develops. Clearing is generally undertaken using a Dozer (D8 or equivalent). Loggable timber will be sold to a mill. Wherever possible, selected foliage and branches from cleared vegetation will be placed immediately on rehabilitation areas. When no rehabilitation areas are available, it will be windrowed at the periphery of the quarry areas, outside of the area to be extracted and adjacent to future rehabilitation areas.

Natural vegetation buffers will be retained, adjacent to the extraction area. Such buffers will be left:

- between the southern extent of the quarry and the southern property boundary;
- between the eastern extent of the quarry and the eastern property boundary (this area to be revegetated to provide a wildlife corridor);
- the western extent of the quarry and the western property boundary; and
- between the northern extent of quarry and site facility disturbance and the northern property boundary.

iii. Removal and Stockpiling of Overburden

Quarry overburden comprises topsoil and underlying weathered rock profiles that are unsuitable as a blending agent in road pavement.

Topsoil will be stripped using a dozer on more gentle slopes and a hydraulic excavator on steeper sections. Where possible, stripped topsoil will be immediately re-spread on rehabilitation areas to optimise regeneration of naturally occurring seed stock.

Where immediate re-spreading is not possible, topsoil will be stockpiled in the overburden stockpile area. Topsoil stockpiles will be constructed 1.5 metres high with 1 (vertical) : 3 (horizontal) batters and will be vegetated to protect the material which will be used in subsequent rehabilitation programs. When possible, topsoil stockpiles will also be protected by windrowed vegetation.

Weathered rock excavated as overburden will also be stockpiled in the overburden stockpile area. This material will be used for a wide range of purposes including bunding, road repairs, upgrading of drainage works, revegetation areas and sedimentation dam construction.

Sediment control for the overburden the overburden stockpile area will include the use of geofabric filter fences.

iv. Hardstand Areas

Hardstand areas include:

- the existing site facilities area and its proposed extension;
- explosives magazine storage area;
- secondary stockpile area; and
- overburden stockpile area.

With the exception of the extension to the site facilities area, the hardstand areas already exist as a component of the existing quarry operation. Works required to complete the extended hardstand area include:

- cut and fill to approximately RL 43 the extension to the site facilities area. This level will allow the extended site facilities area to drain to the existing sedimentation dam;
- installation of central and peripheral drainage systems (flowing to the sedimentation dam) to control disturbed area runoff;
- rehabilitation and revegetation of any externally draining peripheral batters; and

- placement and compaction of ripped and/or crushed rock on all product storage and vehicle turn-around areas to prevent product contamination and to support trucks, moveable plant and proposed concrete pads for the weighbridge and office and for the pre-coating and pugmill plant.

3.7.2 Blasting

The current practice is to use Orica Quarry Services with a "Rock on Ground" contract under which environmental performance is guaranteed. This practice will continue, at least until CSR has adequately demonstrated that the revised drill hole parameters can be easily managed. Part of the contract is to monitor the overpressure and ground vibration of each blast.

It is proposed that a typical blast in fresh rock would have the following parameters, for a 12 m high bench.

Table 3.6 TYPICAL BLAST DESIGN

Parameter	Specification
Hole Diameter	89 mm
Burden	3.2m
Spacing	3.7m
Hole Depth	13 m
Hole Angle	10°
Stemming	3 m
No. of Holes	54
Subdrill	0.9 m
Density of Wet Product	1.2 g/cm^3
Density of Dry Product	1.1 g/cm^3
Charge per Hole	75 kg

As the holes would be initiated using the proven non-electric method, the Maximum Instantaneous Charge (MIC) would typically be 75 kilograms, as each hole will be initiated separately. The actual blast design used will be determined on a blast by blast basis to ensure that EPA criteria will be met at all nearby residences.

A blast of these typical parameters would release approximately 20,000 tonnes and there would be a need for 12 to 14 blasts a year which is just over one per month.

However, it is anticipated that not all blasts will be that large and there will be two blasts a month on average.

In weathered rock the burden and spacing would be increased giving fewer holes. For the bottom two 15 metre faces, the MIC would typically increase to 97 kilograms. Details are given in *Appendix G*, a copy of a communication from Orica Quarry Services.

These parameters have been used in assessing the likely impact of blasting as reported in Section 6.1.

The proposed quarry plans indicate that potential blast locations cover an estimated area 900 m by 250 m. At any one location the distance between the blast site and the nearest residence vary between 300 m to 900 m. With significant variations in distances to receptors it is extremely inefficient to limit blasts to a specific MIC. It is CSR's intention to monitor numerous blasts at multiple locations to gather data sufficient for confident impact predictions. The design of blasts will then be optimised to limit the possibility of EPA criteria exceedences when blast locations are closer to residences and preferred blast designs can be used for blast locations with adequate distances to residences.

CSR has developed a specific set of standard procedures to control blasting at Jandra, and this is reproduced in *Appendix H*. These procedures are amended by CSR to reflect best management practices as they arise. It should be noted that there will be no secondary blasting.

Blasting will conform to current EPA guidelines. As a dust control measure, the shot rock will be well watered down before loading out is commenced.

An explosives magazine store is located to the east of the site facilities area. CSR hold a Licence for the Keeping of Dangerous Goods (No. 35/025571) for the store.

3.7.3 Raw Materials Processing

Current mobile equipment used to load and haul shot rock is a Caterpillar 980C loader, a Hitachi EX 300-2 excavator, Komatsu HD352 35 tonne dump truck and an 18 tonne Volvo dump truck. As the haul distance increases it is likely a second 30-35 tonne rigid dump truck will be brought into service to replace the 18 tonne Volvo dump truck.

The shot rock will be loaded into the dump trucks and transported to the processing plant and after being deposited into the hopper will pass through the following equipment for processing:

- Primary feeder 46 inch by 16 inch;
- Primary crusher Kueken 42 inch by 30 inch double toggle crusher;
- Screen No 1 20 foot by 6 foot Austral;
- Secondary crusher 1,200 autocone Pegson;
- Screen No 2 16 foot by 6 foot Allis Chalmers triple deck;
- Tertiary Crusher 3 foot short head Symons;
- Barmac 990 rotor;
- Screen No 3 16 foot by five foot triple deck Jaques; and
- Screen No 4 16 foot by 5 foot triple deck Jaques.

In the plant, dust extraction and control is effected by:

- two DCE Vokes Dust extraction units;
- one Hosokawa Mikropul Dust extraction unit;
- misting sprays at primary boot and product discharge points; and
- all screens having dust covers and are sealed.

The crushing and screening plant is electrically powered.

After the final products exit the plant from screens three and four they are transported to their stockpiles by one of the two sales front-end loaders (CAT 960C or equivalent). The water cannon on the 10,000 litre capacity water truck is used to spray the stockpiles (as well as haul roads and other unpaved manoeuvring areas), before products are loaded out. This dust control measure in the stockpile area is part of the dust management plan.

A secondary stockpile area is located adjacent to the Pacific Highway. This area is screened from the highway by a revegetated earth bund. Stockpiles in this area are kept to heights such that they are unable to be sighted by highway traffic users.

After load-out into road trucks all products are weighed over the on-site weighbridge before being dispatched to their respective markets.

The existing pre-coating area will be relocated to the expanded site facilities area where a concrete pad will be constructed to contain the pre-coating plant. The pre-coating process involves a feed hopper loading aggregate into a mixing chute where pre-coat is added. The coated aggregate is then discharged into two product bins. The pre-coat storage tank will be stored in the bunded fuel storage area. The current annual production of approximately 6,000 tonnes of pre-coated product is expected to remain at similar levels in the future.

It is proposed to periodically bring a mobile pugmill onto site as required by contracts for road base. The pugmill will be located on the concrete pad used for pre-coating. A pugmill is used either to add water in a controlled way so that road base can be delivered at Optimum Moisture Content or to add a stabiliser such as lime or cement to the product (see *Figure 3.10*). Water will be sourced from one of the sediment control dams. The mobile pugmill will include a lime or cement filler silo. The filler silo will have an appropriate filter bag system to control air discharge.

3.7.4 *On-Site Facilities*

The present weighbridge is of insufficient length and split weighing is required. It is planned that when CSR's Manning River site is closed the full sized weighbridge (20 m x 3 m) will be relocated to Jandra. It will be located on-site closer to the highway than the existing weighbridge. A new office will also be installed, relieving the current office and toilet block for use as a lunchroom, training room/crib room, locker room and amenities. The new office will be located adjacent to the new weighbridge, and will incorporate a managers office, weighbridge office, kitchen, toilet and effluent treatment system. The new office will have dimensions of approximately 8 m x 7 m, a conceptual design of which is shown in *Figure 3.11*.

The existing workshop includes facilities for all mechanical work and welding, grease and oil changes and general maintenance. All oil is stored in a bunded lubricant store and averages 900 litres.

A new storage shed will be constructed in the expanded site facilities area to house up to four quarry trucks. The shed will have dimensions of approximately 6 m x 15 m.

Diesel is contained in a 40,000 litre above ground tank, which will be relocated to a fully bunded storage area within the expanded site facilities area.

3.7.5 *Workforce*

The proposed workforce is set out in *Table 3.7*.

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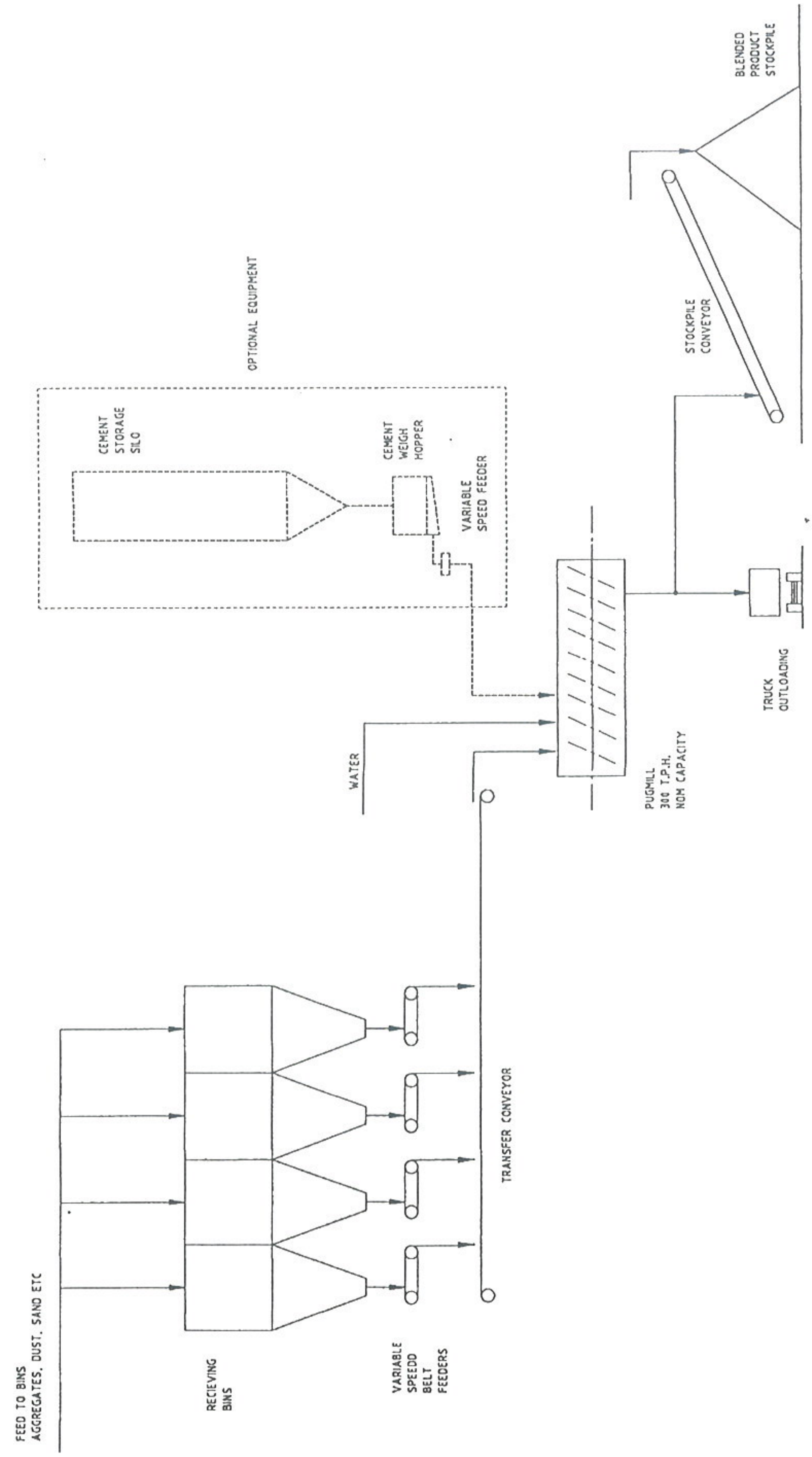

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Figure 3.10 SCHEMATIC FLOW DIAGRAM FOR MOBILE PUGMILL BLENDING PLANT

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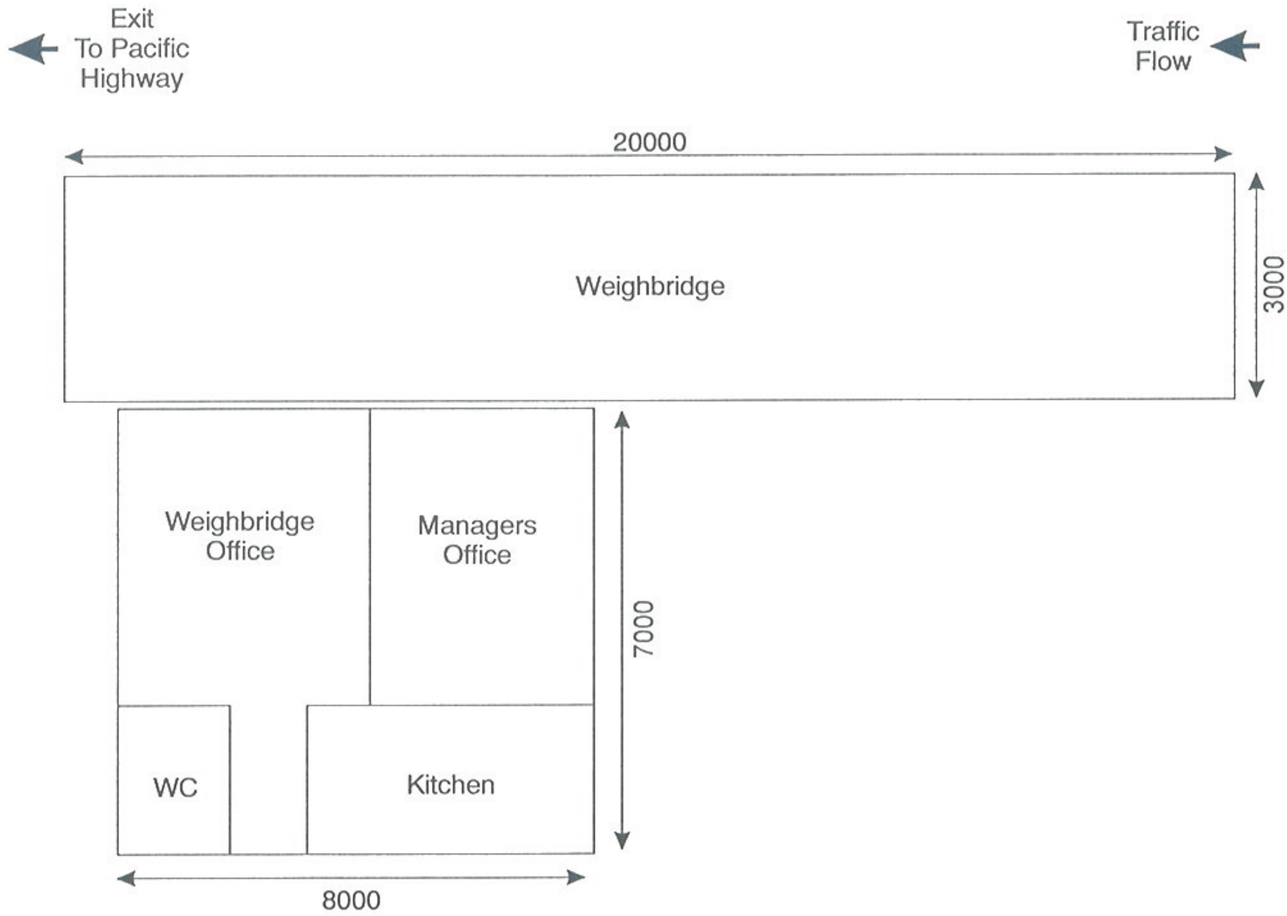

Figure 3.11 CONCEPTUAL PLAN OF PROPOSED WEIGHBRIDGE AND SITE OFFICE

Table 3.7 PROPOSED WORKFORCE

Employee	Number Required
Quarry Manager	1
Weighbridge Operator/Dispatcher	1
Yardman/Water Cart Operator	1
Processing Plant Operator	1
Sales Loader Operator	1
Dump Truck Operator	1
Face Loader/Excavator Operator	1
Truck Drivers	4
TOTAL	11

During increased production periods one additional casual dump truck operator and one additional face loader/excavator operator are likely to be employed. As indicated in *Table 3.7*, the company will be positioning four aggregate trucks and drivers at the quarry.

A significant number of local people will also be indirectly employed as drivers and maintenance contractors as well as through service industries (fuel, spare parts, etc.).

3.7.6 Operating Hours

Quarrying in the proposed expansion will occur between 6.00 am and 6.00 p.m. Monday to Friday and 6.00 am to 3.00 p.m. Saturdays. Ancillary operations such as refuelling, servicing and maintaining plant will be undertaken between 6.00 am and 9.00 p.m. Monday to Saturday. Whenever possible blasting will be restricted to between 9.00 am and 5.00 p.m. Monday to Friday and 9.00 am to 3.00 p.m. Saturday.

In order to supply specific contracts, operations outside normal hours may be required. In such circumstances agreement in writing by Council will be obtained prior to proceeding with such operations.

3.7.7 Waste Management

Small quantities of waste will be generated throughout the quarry's operational life. These include:

- domestic type refuse and workshop wastes that will be stored in approved containers and transported regularly to an approved waste disposal area; and

- sullage wastes and septic wastes from staff amenities will be discharged into the approved effluent disposal system;

3.7.8 *Services*

i. Power

The quarry is currently connected to the local electricity grid. Electric powered water pumps are used to provide water to the water cart.

NorthPower has visited the site to be briefed on the proposed expansion and hence identify an alternate route for the powerline servicing the quarry. The route as advised by NorthPower (A Penfold) is shown on *Figure 3.4*.

ii. Water

Potable water demands will be provided by a roof collection system from the site facility buildings and/or imported. Non-potable water uses will be provided by a system of on-site sedimentation dams.

iii. Telephone

Telephone services are available to the quarry site.

iv. Sewage

Quarry personnel will generate small volumes of domestic sewage. These will be treated and disposed on-site through an approved effluent treatment system.

3.7.9 *Energy Demand*

The quarry is a net consumer of energy. The company recognises the need to conserve energy in all aspects of the operation. Currently the operation uses 10,000 to 20,000 litres of diesel per month depending on production. According to records from Advance Energy (February 1999) electricity usage for the month was 11,497 kilowatt hours. As production increases, so the energy requirements will rise proportionally.

Additional diesel (8 litres per tonne of product) and electricity will be consumed when the asphalt plant is in operation.

All available measures to reduce energy usage will be utilised.

3.8 ASPHALT PLANT

It is proposed that a mobile asphalt plant capable of producing around 100 - 200 tonnes per hour will be located on-site on an as needed basis. The mobile plant would operate under a current production license with the EPA. An area 60 metres by 50 metres will be prepared for the plant components in the expanded site facilities area south-east of the existing weighbridge complex. The plant will be located in a position that is not visible from neighbouring properties or the Pacific Highway. With the nearest residence some 600 m from the site it is unlikely that the asphalt plant will be audible over the general quarry operation.

The asphalt plant will combine crushed stone that is produced on-site, with bitumen to produce asphalt. For the process, deliveries of bitumen, lime and sand will be made to the site via tankers and tip trucks. Hydrated lime or fly ash will be stored in a silo and used as filler. In addition, small quantities of toluene and methylated spirits will be used in routine laboratory testing. Front-end loaders will be used to transport materials around the site. The plant will comprise the following components:

- dryer drum unit, incorporating wet scrubber;
- filler silo;
- bitumen tank;
- hot storage trailer unit;
- cold feed trailer unit; and
- control room and portable laboratory.

Figure 3.12 shows the components and typical layout of the asphalt plant.

Minimum staff required to operate the plant will include one plant operator, one loader operator and one laboratory technician. In addition, there will be two management staff associated with the plant as well as the asphalt laying crew.

In the process, aggregates are fed into the plant. As they pass through the dryer where all moisture is driven off, the aggregates are mixed with a filler and hot bitumen to form asphalt, which then must be transported by truck to the required construction sites and laid before it gets too cold. The filler acts as a void filler,

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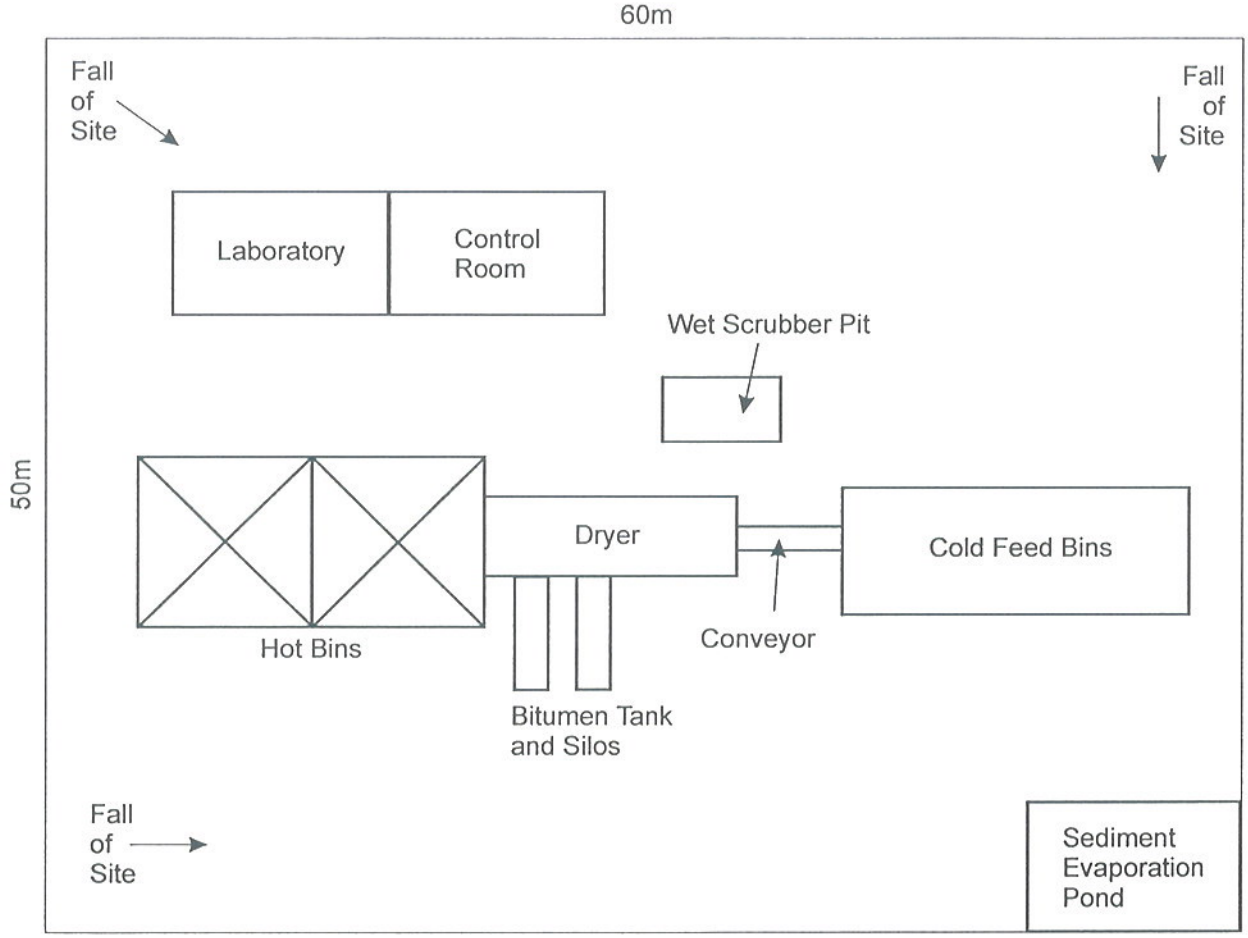

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Figure 3.12 CONCEPT LAYOUT OF ASPHALT PLANT SHOWING MAJOR COMPONENTS

replacing bitumen and creating a product less likely to flow or bleed. In properly fitted trucks asphalt can be transported for over 100 kilometres.

The asphalt plant will be powered using on-site electricity rather than diesel fuelled generators. This will significantly reduce potential noise generation of the plant.

The asphalt plant stack will be fitted with a wet scrubber flow meter with an audible and visual alarm. The filler silo will have an appropriate filter bag system to control air discharge (i.e. a reverse pulse silo filling filter or equivalent). Either lime or flyash will be used as the filler. Depending on prevailing wind conditions, odours emitted from bitumen storage facilities will be adequately dispersed within a 100 metre radius of the source.

Water quality controls will include bunding of liquid storages. A wet scrubber in-ground lined interceptor pit will be constructed to trap scrubber particulate and recycle water back through the plant. Solids from the pit will be bioremediated in a clay lined cell which will be constructed as required within the site facilities area. The water recycling pit will have a minimum capacity to serve daily usage.

3.9 TRANSPORT

The quarry access road has no shared access with the public and links directly to the Pacific Highway. The markets for quarry products are located both north and south of the quarry site. Generally, traffic volumes have been split 60 percent to the south and 40 percent to the north. This split is likely to change to 50/50 once CSR's Manning River operation closes.

Road transport is the most economic and practical means by which transport requirements can be met due to the accessibility of the Pacific Highway.

3.10 SOIL AND WATER MANAGEMENT

3.10.1 Introduction

A soil and water management plan for the quarry was developed to:

- ensure adequate water supplies under most climatic conditions, and
- safeguard the integrity of downstream watercourses.

The following sections assess water management controls, erosion and sediment controls, water requirements and available water sources.

3.10.2 *Water Management Controls*

To manage the various water flows within and around the quarry, it is proposed to segregate flows of differing quality and preferentially use poorer quality water first. Water flows include runoff from undisturbed areas, the quarry, haul roads and the site facilities area.

i. Clean Water Diversion

Runoff from undisturbed areas above the quarry, site facilities area and stockpile areas will be diverted around working areas. Vegetated diversion banks will be used to divert runoff to a stable downstream location. Catchments above the working areas are generally small and diversion drains will be sized for storms with a duration equal to the catchments time of concentration and an average recurrence interval of 20 years.

ii. Groundwater

Diamond drilling into the floor of the quarry has shown the greywacke to be massive with a very low to zero porosity. No groundwater was recorded during geological investigations. Any groundwater is likely to be located in fractured material above the basement rock. This groundwater would have limited flow potential. It would dissipate quickly following blasts as it would originate from subsurface flows following recent rainfall events rather than from interception of the watertable. As the catchment is limited to the ridge to be quarried, any significant groundwater inflow to the quarry pit is expected to be negligible. Geological drilling and local experience at nearby quarries indicate that the sedimentary sequence containing the greywacke does not contain good aquifers.

iii. Storage and Sediment Control Dams

Three dams will be constructed or reconstructed to provide water supply and sediment controls for the quarry. Water from the dams will be used for dust suppression, additions to products and vehicle washing. Water will preferentially be used from the these dams before clean water dams located elsewhere on CSR's property. If these four dams have insufficient supplies then water will be pumped from the clean water dams. Further details on the sediment dams are provided in section 3.10.3.

iv. Fuel Oil Storage Area

The bunded fuel oil storage area will be bunded in accordance with Australian Standard AS1940 (Storage and Handling of Flammable and Combustible Liquids). The bund area will be covered to prevent the entry of rainfall and will have a volume of at least 110 per cent of the fuel tank volume. Its floor will be sloped to a sump with a gate valve outlet. Any fuel oil collected in the sump will be removed by an approved contractor.

3.10.3 Erosion and Sediment Controls

Erosion and sediment control will be achieved in three ways:

- collection and treatment of stormwater flows from disturbed areas;
- temporary and permanent rehabilitation of disturbed areas of high erosion potential; and
- control of soil erosion at source using suitable control measures.

The potential for erosion and sediment movement will be highest during development operations when topsoil and overburden are being stripped and stockpiled. However, there will be ongoing potential for sediment movement from the quarry working benches.

To control erosion and sediment movement the following measures will be used:

- preparation of an erosion and sediment control plan for the site will be included in the quarry environmental management plan. This will entail design and description of all erosion and sediment control structures, both temporary and permanent;
- use of sedimentation control dams;
- minimisation of disturbed areas. Quarry and ancillary area boundaries will be marked and no activity permitted outside designated areas;
- diversion of clean water from undisturbed areas around working areas;
- the installation of temporary erosion and sediment controls, such as geofabric filter devices, prior to commencement of topsoil and overburden removal;
- sequential clearing and rehabilitation of the quarry as extraction of the hardrock material proceeds; and

- the regular maintenance of erosion and sediment control structures, particularly after rainfall, to ensure their efficiency.

The quarry operation will involve the construction/enlargement of four permanent sediment control dams at the quarry site:

- one dam will be relocated and resized within the main quarry pit;
- the existing primary sediment dam for the site facilities area will be resized to cater for any projected increase in sediment loading;
- one additional dam will be constructed downstream of the proposed extension to the site facilities area; and
- one dam will be constructed downstream of the secondary stockpile area.

The proposed locations of the permanent sediment control dams is shown on *Figure* 3.4.

The dam to be located in the quarry pit will be a combined sedimentation pond and de-watering sump. The area of the quarry will gradually increase as the working face extends to the north. This dam will be progressively enlarged to ensure it has the capacity to control sediment from the maximum extent of the then current quarry operations.

The function of the dams is to catch all stormwater runoff from the disturbed areas and to minimise the concentration of fines in overflow waters.

i. Design Criteria

The design criteria for the dams are based on the procedure detailed in Chapter 6 of *Managing Urban Stormwater - Soils and Construction*, NSW Department of Housing (1998). The dams were sized based on a conservative assumption that all disturbed areas consist of Type D soils, which have more than 33% of soil material finer than 0.02 mm and more than 10 percent dispersible materials (see soil test results provided in *Appendix I*).

The design of the sediment dams provides sufficient storage capacity for quarry operational water demands including dust suppression, process needs and rehabilitation requirements. The EPA generally require the design of the sediment dams to caters for the 1 in 10 year average recurrence interval (ARI), 2 hour storm and/or provide 500m^3 of storage per hectare of catchment. Further discussions with the EPA's Technical Officer indicated that the EPA considered the NSW Department of Housing's *Managing Urban Stormwater - Soils and Construction* (1998) to be the most recent applicable reference for sediment dam design (Shane Trengrove, pers. comm.)

Design aspects of the sedimentation ponds are discussed below.

ii. Volume Requirements

The volumetric requirements of the sediment basins were determined by following the procedures detailed in *Managing Urban Stormwater* (Dept. of Housing, 1998) for Type D soils. Parameters used in the calculations include:

- C_V - Volumetric Runoff Coefficient = 0.9
- 5-day total rainfall depth not exceeded in 80% of rainfall events = 41.1 mm
- Sediment Storage Zone Volume = 50% x Settling Zone Volume

The design characteristics of the dams are shown in *Table 3.8* below.

Table 3.8 PERMANENT SEDIMENT DAMS

Dam	Catchment Area (ha)	Minimum Volume (ML)	Runoff Storage per Hectare (m^3)	Peak Flow Retention (hours) 10 year ARI	Peak Flow Retention (hours) 20 year ARI
Quarry Area					
- Existing	4.7	2.6	553	0.8	0.7
- Stage 1	9.2	5.1	554	0.9	0.8
- Stage 2	13.0	7.2	554	1.0	0.8
- Stage 3	17.1	9.5	556	1.0	0.9
- Final Stage	17.6	9.8	557	1.0	0.9
Facilities Area	6.7	3.7	552	0.8	0.7
Secondary Stockpile Area	2.4	1.3	540	0.7	0.6

The calculated volumes for the sediment dams exceed the storage volume per hectare design criteria specified above. As a guide to their flow retention capacity the retention time for peak flows from storms with average recurrence intervals of 10 and 20 years is also provided. The dams will provide a minimum retention time of between 0.6 and 1.0 hour.

iii. Sedimentation Pond Management

Water from the sedimentation ponds will be utilised to satisfy non-potable quarry water demands as required. Water from the ponds will be pumped out by an electrically powered pump to the site facilities area and used for dust suppression, material processing and rehabilitation works. Excess water from the quarry pit sediment dam/sump will be pumped to the watercourse downstream of the site facilities area.

The pump inlet will be located on a floating pontoon at the end of the pond furthest from the inflow area to ensure bottom sediments are not disturbed or entrained during pumping. As an additional measure, a geofabric covered screen cage will be constructed around the pump inlet to filter out sediments coarser than 0.02 millimetres. This screen will be inspected quarterly and cleaned or replaced if necessary.

Soil test results indicate the soils in the vicinity of the quarry have a dispersion percentage ranging from 15 to 67 percent. These results indicate there is a potential for fine dispersible soils being suspended in water. Flocculation may therefore be required to settle out the suspended solids. Should water quality monitoring of the dam identify that total suspended solids are in excess of 50 mg/L, an artificial flocculation program would be carried out in accordance with the guidelines shown in Department of Housing (1998).

3.10.4 Water Demands

Water will be required in the following areas:

i. Employee Use

Water will be required for toilet and hand basin use with smaller quantities being used for personal consumption. An average of 100 litres per person per working day has been assumed for design purposes. A workforce of 11 permanent staff and two additional truck drivers will have an annual demand of 0.25 megalitres.

ii. Process Water

Water is used in the processing plant for dust suppression. It is applied in the form of fine mist sprays. For the water balance model, it is assumed for that water is applied at a rate of 1.5 percent by weight of product throughput.

iii. Dust Suppression

Water will be required for dust suppression on internal access roads and haul roads within the quarry. The volume will vary with each stage of quarry development and the prevailing weather conditions. Demand has been conservatively estimated assuming the requirements will be 150 per cent of the pan evaporation rate per unit area.

iv. Product Moisture

Certain types of material such as road bases and other road pavement materials are required to have a moisture content of around seven percent. Quarried material is basically dry and water will be added to these products during processing. It was assumed that 25 per cent of annual production will require the addition of water.

v. Truck Washing Facilities

Mobile plant used in quarry operations will need to be cleaned as part of general maintenance and prior to servicing. Water used in vehicle washing will be treated to remove coarse grit and oil before being recycled back into the quarry water system by discharging to the process area sediment dam. A nominal allowance of 10,000 litres a month was made to allow for water lost through evaporation and vehicle wetting.

A summary of annual water demands for key quarry intervals is shown in *Table 3.9*.

Table 3.9 ANNUAL WATER DEMANDS (MEGALITRES)

Water Use	Stage 1	Stage 2	Stage 3	Stage 4
Production (tonnes)	250,000	250,000	250,000	250,000
Potable Use	0.25	0.25	0.25	0.25
Dust Suppression	16.5	20.8	25.2	25.2
Process Water	3.7	3.7	3.7	3.7
Product Moisture	4.4	4.4	4.4	4.4
Truck Washing	0.1	0.1	0.1	0.1

3.10.5 *Water Supply*

Water of different qualities can be used to meet quarry demands. Drinkable quality water (potable) will be used for domestic and employee uses while poorer quality water (non-potable) will be used for all other purposes.

i. Potable Water

Potable water will be sourced from a roof collection system attached to the office and workshop buildings. During dry periods water will be brought onto site from a commercial supplier.

ii. Non-Potable Water

Non-potable demands will be supplied from on-site storages, both sedimentation and clean water dams. These will serve all non-potable water requirements for the site. Water from the storages will be pumped using an electrical pump mounted on a floating pontoon to prevent entrainment of settled sediment.

3.10.6 Water Balance Model

i. Methodology

A water balance model was used to compare quarry water demands with the volume of water which would be generated within the site. The objective of the model was to determine the magnitude of either water surplus or deficit at various stages of development under different climatic conditions.

A computer model was developed to simulate the water cycle of the quarry. Water requirements were based on the demands discussed above. Water supply was determined from rainfall runoff into the four sediment control dams.

The model assessed monthly and annual water balances for dry, average and wet rainfall years. Dry, average and wet years were defined as follows:

- dry year, an annual rainfall with a probability of exceedance greater than 90 per cent;
- average year, an annual rainfall having a probability of exceedance greater than 50 per cent; and
- wet year, an annual rainfall having a probability of exceedance greater than ten per cent.

Analysis of available rainfall records at Taree show that a dry year has an annual rainfall of 750 mm, an average year 1,132 mm and a wet year 1,699 mm. To simulate real rainfall conditions years with annual rainfalls close to the statistical requirement were used. Representative years were 1936 (annual rainfall 751.4 mm), 1981 (annual rainfall 1,148.7 mm) and 1962 (annual rainfall 1,692.4 mm) respectively.

Evaporation rates are relatively constant under different climatic conditions and average evaporation data were used.

To enable assessment of the quarry's water balance at various stages of development the model was run under the following conditions:

- at stages 1, 2, 3 and 4;
- for each year under the three rainfall conditions; and
- at the start of each year the dams were 50 per cent full.

ii. Results

The model was used to prepare estimates of:

- monthly and annual runoff from the dam catchments;
- monthly and annual demands;
- any overflows from the dams; and
- any deficits in the quarry's water supply.

Appendix J contains an example of the model results for Stage 1 of the quarry production while *Table 3.10* summarises the results for all years and climatic conditions considered.

Table 3.10 QUARRY WATER BALANCE (MEGALITRES)

Stage	Annual		Annual		Peak Monthly	
	Demand	Runoff	Deficit	Discharge	Deficit	Overflow
Stage 1 - Dry	29.8	44.7	0.0	14.9	0.0	5.2
- Average	29.8	68.4	0.0	38.5	0.0	14.1
- Wet	29.8	100.7	0.0	70.9	0.0	24.5
Stage 2 - Dry	35.2	51.3	0.0	17.7	0.0	6.2
- Average	35.2	78.3	0.0	45.6	0.0	16.7
- Wet	35.2	115.4	0.0	83.9	0.0	29.0
Stage 3 - Dry	40.7	62.0	0.0	23.0	0.0	7.6
- Average	40.7	94.8	0.0	56.6	0.0	20.2
- Wet	40.7	139.7	0.0	102.7	0.0	35.0
Stage 4 - Dry	40.8	63.3	0.0	24.1	0.0	7.8
- Average	40.8	96.8	0.0	58.5	0.0	20.7
- Wet	40.8	142.7	0.0	105.5	0.0	35.8

The water balance model demonstrates that the system of dams is capable of satisfying the quarry's water demands under the climatic conditions considered. Overflows will occur from the site under dry, average and wet rainfall conditions.

3.11 LANDSCAPE AND REHABILITATION

There are two primary aims of the landscape and rehabilitation plan. Initially the plan will be introduced to stabilise disturbed areas, mitigate any loss of visual amenity as a result of quarry operations and enhance the wildlife corridor to the east of the quarry pit. The landscape and rehabilitation plan will also outline the revegetation of quarry operations including the site facility area and stockpile areas.

The quarry area will be progressively rehabilitated to produce a stable landform which is compatible with the surrounding area. Topsoil and weathered overburden will be stockpiled and placed progressively on completed quarry areas with the revegetation program to establish endemic plant communities.

Landscaping and rehabilitation of the proposed expansion will be undertaken as described below, however this only provides an outline of the rehabilitation process.

A detailed landscape and rehabilitation plan will be included in the quarry environmental management plan. *Figure 3.13* shows the principle areas that will be rehabilitated during the life of the quarry.

3.11.1 Landform Design

Landform design will be a result of the quarry extraction design which includes

- terminal bench width of half the height; and
- final face angle of 75°.

The resulting quarry void will have the following physical dimensions:

- quarry rim approximately 1,000 m x 500 m;
- benches developed at 12 metre heights to RL 50;
- benches developed at 15 m heights from RL 50 to RL 20; and
- quarry floor approximately 750 m x 100 m.

3.11.2 Topsoil Management

Although topsoil resources in the quarry area have good rehabilitation properties and have low to moderate erosion potential, the use of stockpiled weathered overburden may be necessary to supplement the limited topsoil stocks for rehabilitation activities. Weathered overburden has been used successfully as suitable material for revegetation of quarry sites (EPA, 1995). This material potentially requires additional treatment to increase organic matter content and nutrient status. Whenever necessary, topsoil products will be imported to supplement site topsoil and overburden in order to ensure ongoing success of the rehabilitation program.

3.11.3 Revegetation

The aim of the revegetation program at Jandra Quarry is to rehabilitate the quarry site with indigenous species to conform with existing vegetation. As the quarry is to be sequentially developed, the immediate objectives will be:

- to minimise visual impact;
- to control runoff and therefore prevent erosion and siltation; and

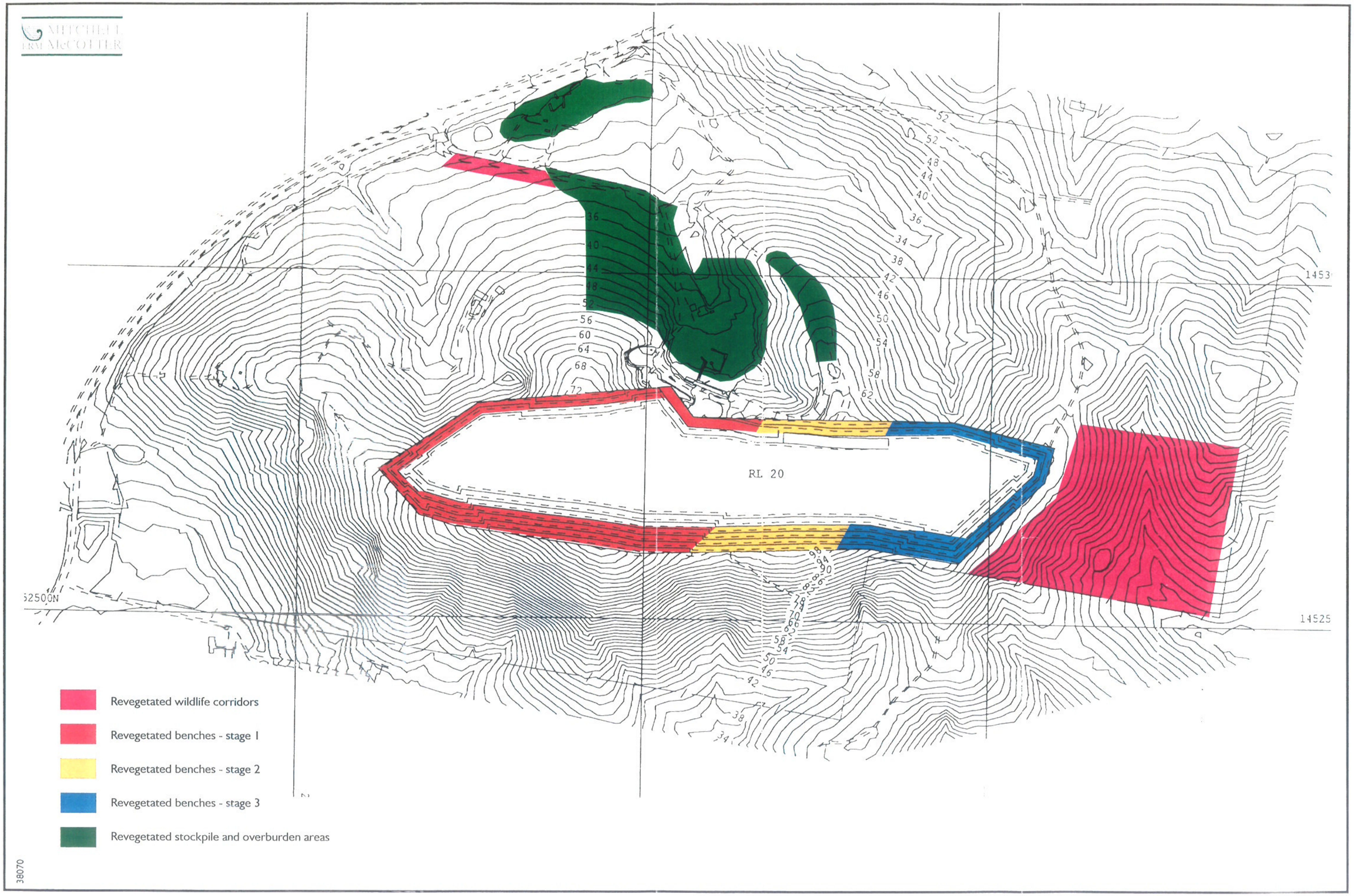

Figure 3.13 REHABILITATION PLAN

- to re-establish native flora for the above listed reasons as well as to provide habitat for native fauna and flora species. This point incorporates the revegetation of the semi-cleared remnant of vegetation to the east of the study area, as well as the provision of aquatic vegetation and sheltering resources surrounding dams on-site to act as compensatory habitat for amphibian species (refer to *Appendix L* and the EMP for further details).

The adopted revegetation programs include consideration of site preparation, plant species and maintenance. Species planted will be endemic with seed and other propagation material to be collected from surrounding undisturbed areas. This will ensure that the genetic variability of the site is maintained. Ideal planting time is March to September and preferably after good rain.

The main structures that will require revegetation include:

- temporary and permanent bunds
- overburden stockpiles;
- haul roads;
- site facility and stockpile areas; and
- quarry benches.

i. Revegetation of Bunds and Overburden Stockpiles

As the bunds and overburden stockpiles will consist of excavated fill material covered with re-spread topsoil, the final structure should not be heavily compacted. Hence, decompaction in the form of deep ripping, should not be a prerequisite for planting. Care should be taken to avoid compaction of the bunds during their construction. Keeping heavy vehicles off bunds (as much as possible) during construction, should help reduce compaction. Generally, the less the compaction of soil, the better the water penetration and plant growth (easier root penetration). As soon as they are formed, temporary bunds and overburden stockpiles will be planted with quick growing native grasses. Permanent bunds such as the visual bund currently shielding the secondary stockpile area from Pacific Highway traffic will be grassed and planted with trees.

ii. Revegetation of Haul Roads and Hardstand Areas

Revegetation of haul roads and hardstand areas will be required at the end of the quarrying operations. The areas will initially be deep ripped to aid in water ingress and retention of the final landscape. Overburden material previously stockpiled will then be spread over the areas to provide a suitable deep bed for revegetation. Topsoil will be spread on the overburden and planted out with grasses and saplings of endemic trees and shrubs. Additional local seed will also be thrown over the topsoil to aid in regeneration of native species.

iii. Revegetation of Quarry Benches

Rehabilitation of the quarry benches will be undertaken progressively. Those benches above the self draining elevation (approximately RL 50) will be revegetated. Benches of the lower quarry void will be stabilised.

Generally, site preparation and planting details for bunds and hardstand areas apply to benches. Variations to these details where applicable to the rehabilitation of benches are outlined below.

Benches should slope backwards towards the upright face. The base rock on all benches should be partially fractured to facilitate root development and the subsequent stability of taller trees. Care must be taken when depositing topsoil in benches to avoid undue compaction. Immediately behind the rim of the quarry disturbed areas will be grassed by hand casting. A schematic representation of quarry bench rehabilitation is shown in *Figure 3.14*.

3.11.4 *End Land Use*

Once extraction has been completed, the quarry will be rehabilitated using the methods described above. Benches of the lower quarry void will be stabilised. Rehabilitation of the upper quarry area will provide similar vegetation communities and fauna habitats, as previously occurred over the site. The establishment of a dense shrub understorey in the site facilities area will be planned to function as a sustainable ecosystem which reflects the natural ecology of the area.

A final void in the order of 1 to 2 million cubic metres is an outcome of the proposed operation. As the life of the extractive resource is expected to be a minimum of 66 years and there is further potential to expand the operation within the greywacke resource, a detailed evaluation of end land use has not been undertaken. However, post extraction uses are seen as being limited to landfill at this stage.

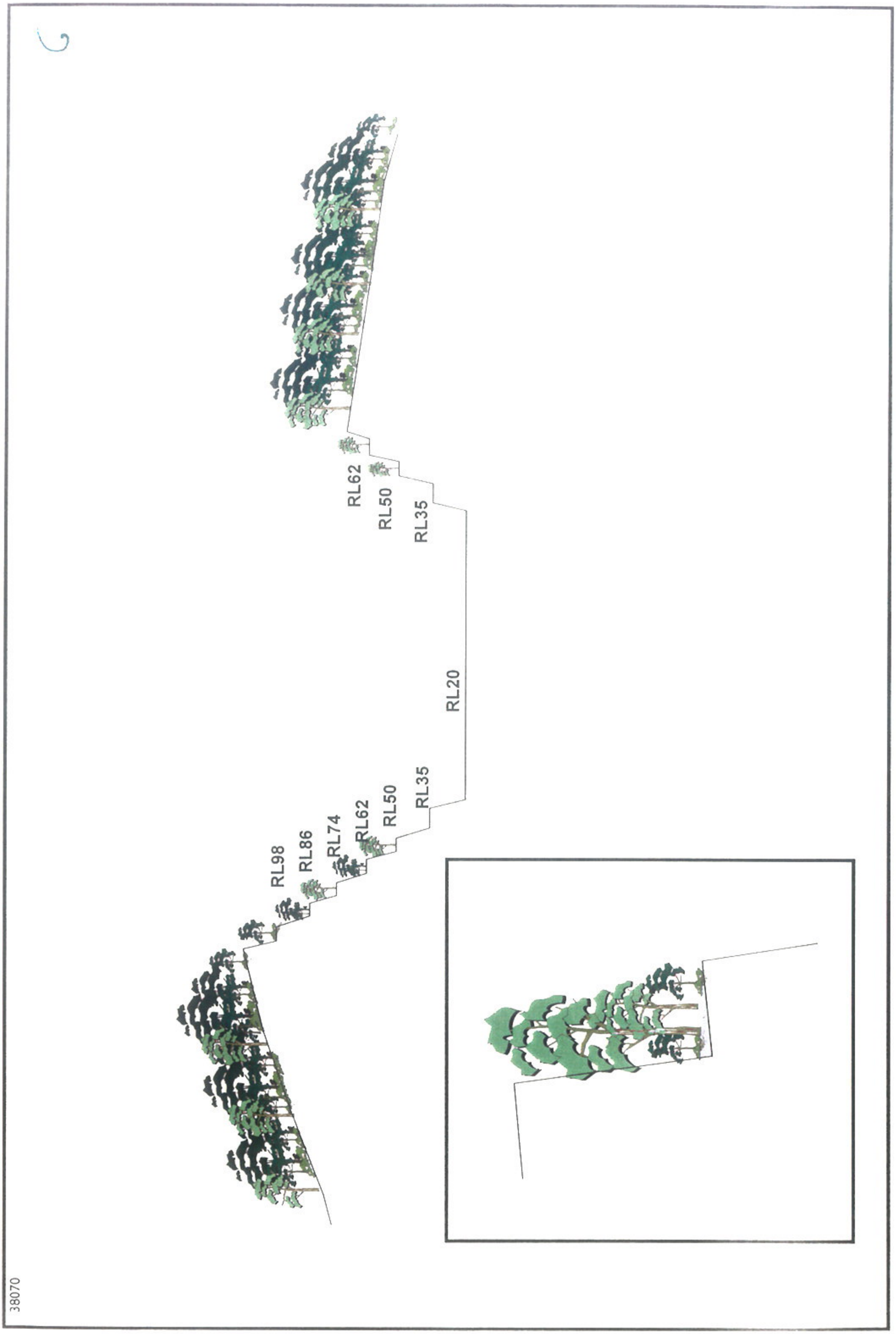

Figure 3.14 CONCEPTUAL ELEVATION VIEW OF QUARRY BENCH REHABILITATION

3.12 SAFETY AND HEALTH

3.12.1 Quarry Operations

CSR places a great emphasis on safety and has a comprehensive safety program that applies to all sites and involves risk management, measuring safety performance, safety communication, compliance audits, safety training and a shared responsibility for safety and health in the workplace for managers and CSR staff. A safety manual will be prepared for operation of the extended quarry and updated as required. This will include provisions on all aspects of CSR's operations including site induction processes, staff health and safety training, incident reporting and management procedures and drilling and blasting procedures.

The following safety factors will be continued during the operation of the quarry:

- visitors to the quarry will be required to participate in a site safety induction;
- employees will receive safety inductions, ongoing job training and work instructions;
- a safety fence will be installed along the ridge top to prevent access to the top of the quarry faces;
- safety signs will be displayed where required providing instructions to staff on safety procedures. These will also indicate the requirement for personal protective equipment in specific site areas;
- handrails and proper stairways are currently in position at the plant. These will be fully maintained for the life of the plant;
- traffic management procedures have been set out in the Safety Manual and visually displayed on site. These include marked lanes and signage where vehicles use is permitted, associated pedestrian areas and areas of restricted access;
- safety aspects of blasting will be set out in the Safety Manual. These will include requirements for notifying site personnel and neighbouring sites, and emergency response procedures; and
- rock being quarried has approximately 25 percent free silica. Testing of dust generated during crushing has shown that constant exposure to high dust levels could cause silicosis. Current dust control measures are keeping the exposure of site personnel to below the level where there is a potential for the disease to develop. Efforts to reduce the already acceptable dust exposure

levels, in the form of greater water application via fine misting sprays, dust extraction and other engineering controls are continually in progress.

3.12.2 *Neighbouring Properties*

The proposed eastern extension of the quarry excavation will finish close to the southern property boundary. The neighbouring property to the south, Lot 10 DP790056, is owned by Youth Care and Life Style Centre Incorporated (YALA).

As shown in *Figures 3.7, 3.8* and *3.9*, quarry operations will occur close to the southern boundary at various times during Stages 2, 3 and 4. The quarry excavation will be closest at RL 86 and will finish approximately 15 metres from the boundary in the area near where the boundary steps to the south. A safety fence will be erected along the top of the quarry excavation in this area.

YALA currently have development approval to commence youth care and life style programs similar to their operation at Delhuntie Park at Trafalgar East in Victoria. These activities include outdoor adventure and personal development programs which are to be conducted at various locations on the YALA property including the area close to the step in the southern boundary of the property with CSR.

The close proximity of the CSR's proposed quarry operations to the proposed YALA activities during Stages 2, 3 and 4 requires a formal agreement that will allow both operations to coexist without compromising safety.

To this effect, the formulation of a formal coexistence agreement between CSR and YALA is currently in progress. Progress to date is as follows:

- a site meeting was held at Jandra Quarry in July 1998 between CSR and YALA representative to discuss:
  - CSR's proposed quarry expansion;
  - YALA's planned development of a youth care and life style centre;
  - CSR's requirements for a 'zone of exclusion' that would ensure the safety of persons when blasting within the proposed eastern extension of the quarry in the vicinity of the step in the southern boundary;
  - YALA's requirements relating to proposed youth care and life style centre activities, particularly those within the proposed 'zone of exclusion; and

- the way forward - the process for formulating a formal coexistence agreement;

- a representative from CSR visited the existing youth care and life style centre operation in Victoria to assist in understanding YALA's requirements for consideration in the proposed agreement
- a draft of the proposed formal agreement has been completed by CSR and is currently being considered by YALA; and
- a non-binding letter of intent has been signed by both parties to indicate the intention to enter into a formal coexistence agreement. A copy of this letter is provided as *Appendix F*.

JANDRA QUARRY
EXTENSION

CSR

4 INTERACTIONS WITH THE PHYSICAL ENVIRONMENT

Chapter 4

INTERACTIONS WITH THE PHYSICAL ENVIRONMENT

4.1 CLIMATE

Meteorological data has been compiled from the nearest official meteorological station at Taree, approximately 18 kilometres from the study area. The Taree district is located in the sub-humid temperature zone where the climate is influenced by topography, latitude, the local differences in altitude, the proximity of the ocean and the effect the ocean has on temperature and precipitation patterns.

4.1.1 Rainfall and Evaporation

Mean annual rainfall of the area is 1,183.9 millimetres. Rainfall is seasonally distributed with a late summer/early autumn peak. February and March are the two wettest months, with a mean monthly rainfall of 138.4 and 149.3 millimetres respectively. Rainfall is least from July to September with the lowest mean monthly rainfall being 36.5 millimetres in August. In winter the westerly influences bring most of the rain. The annual rainfall distribution characteristics are illustrated in *Figure 4.1*.

Mean daily pan evaporation rates range from 1.8 to 2.8 millimetres per day during the winter months, increasing to between 5.3 and 6.2 millimetres in summer.

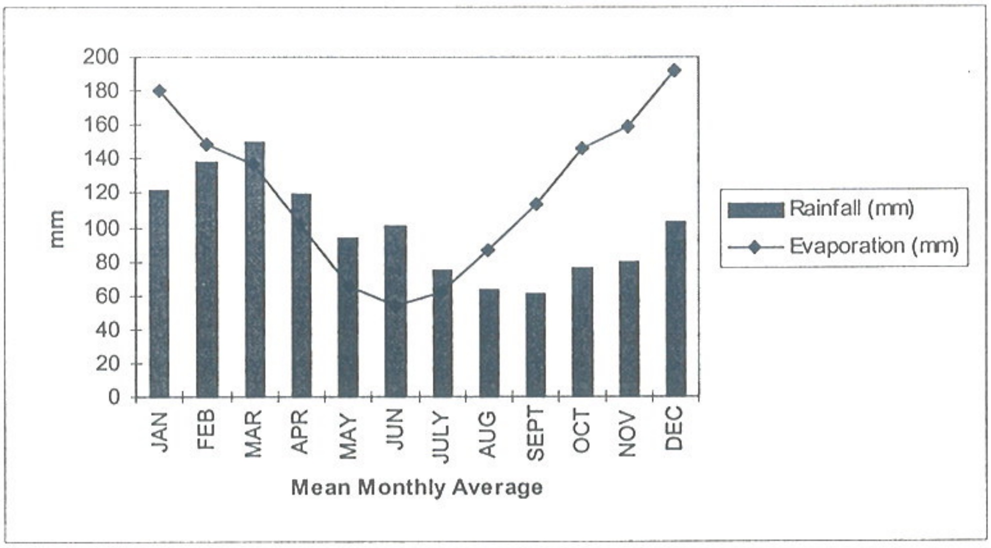

Figure 4.1 ANNUAL RAINFALL DISTRIBUTION

4.1.2 Temperature

Figure 4.2 shows the mean daily temperatures recorded at Taree. The highest temperatures are reached in December, January and February, when the mean maximum temperatures are 28.3°C, 28.8°C and 28.4°C respectively, while the mean minimum temperatures of these months is approximately 17°C. The lowest maximum temperatures are recorded during July, with the mean being 18.3°C, while the lowest mean minimum temperature is recorded in July when it reaches only 5.8°C.

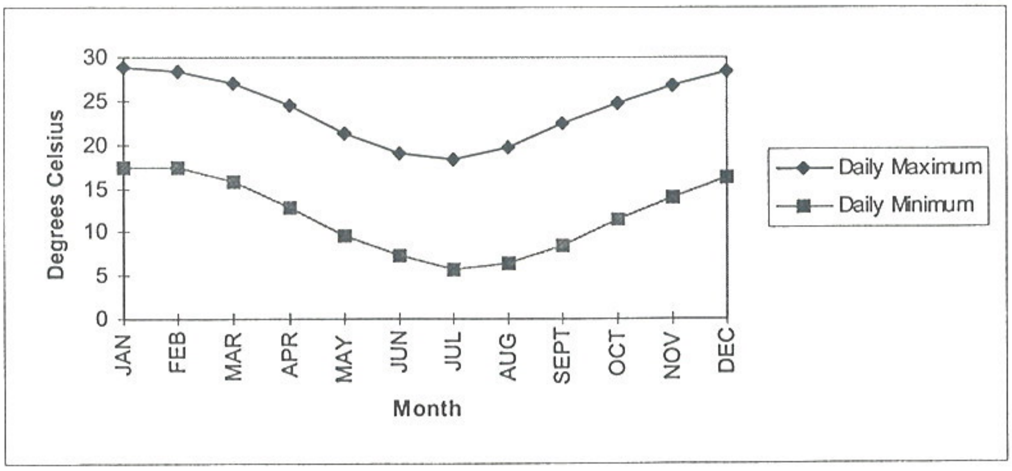

Figure 4.2 MEAN DAILY TEMPERATURE

4.1.3 *Wind*

Wind patterns vary with the time of day as well as seasonally. During summer, morning winds are erratic, however they generally originate in the west, with the wind speed typically being less than 10 metres per second, as well as sea breezes from the north-east, again being less than 10 metres per second. In the afternoon, the winds are predominantly sea breezes from the south-east and are typically less than 10 metres per second.

During autumn, morning offshore winds are typically less than 15 metres per second from the west. In the afternoon, south-westerly winds prevail and rarely exceed 15 metres per second.

In winter, offshore westerly winds predominate in the morning. Wind speed generally reaches a maximum of 18 metres per second. In the afternoon, the winds are predominantly offshore and are generally less than 18 metres per second.

In spring, morning offshore winds are typically less than 10 metres per second from the west. In the afternoon the winds are predominately sea breezes from the south-east and are typically less than 10 metres per second.

4.2 SOILS, LANDFORM AND EROSION

4.2.1 *Topography and Landform*

The study area can be divided into two main topographic units being the gently undulating and the steep hilly terrain. The slopes range from four degrees on the lower elevations to approximately 45 degrees on the upper slopes (see *Figure 4.3*).

To the north and west, the landscape displays similar topographical features as the study area. These areas are moderately to heavily timbered. To the south and east, the foothills give way to gently undulating coastal plains. These plains have been extensively cleared and are predominantly utilised for cattle grazing. Only small remnants of native forest remain.

The elevation of the study area varies from 20 metres AHD at its lowest point to 115 metres AHD at its highest. A secondary peak (100 metres AHD) occurs approximately 350 metres east of the site's highest point. Between the spurs that extend northward from these two high points lies the existing quarry pit.

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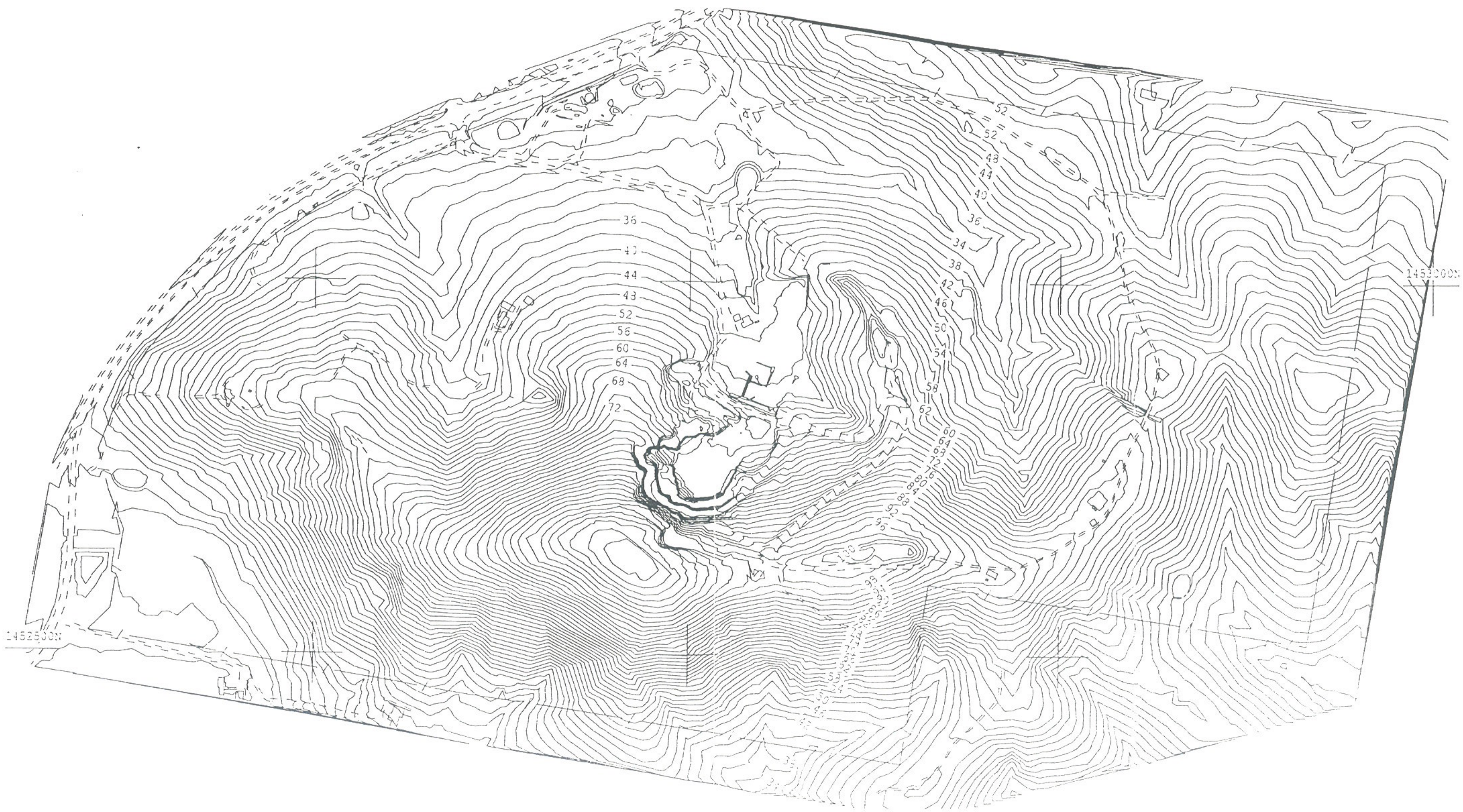

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Figure 4.3 EXISTING SITE TOPOGRAPHY

4.2.2 *Soils*

Soil parameters that are relevant to the proposal include:

- suitability for rehabilitation - not all soil material is suitable for rehabilitating disturbed areas. The suitability of the available soils for this purpose has been assessed by both field and laboratory analysis; and

- erosion potential - the implications of exposing the soil to erosive forces have been examined. This has been determined from observations in the field and following laboratory analysis.

Site assessment was undertaken during which existing cuttings were inspected and the profiles from three soil bores were examined (see *Figure 4.4*). Soil samples from two soil horizons in each bore hole were collected and taken for analysis. (total of six samples). The soil overlying the study area was found to have a moderate erosion potential, being mildly to moderately dispersive. Generally, consideration must be given to erosion control over the site. The analysis also indicates the soils have good rehabilitation potential. The results of the laboratory analysis are contained in *Appendix I*.

Generally, the topsoil layers were found to be suitable for rehabilitation. The topsoil can be used for revegetation purposes subject to the following factors:

- *depth of stripping*: generally only the surface soil to a maximum depth of 60 centimetres (and even less at certain sites) is suitable for direct transfer to rehabilitation areas. Soil below this depth is less suitable due to high rock content and may require additional treatment to increase its organic matter content and nutrient status prior to supplementing the topsoil stocks; and

- *stockpiling*: the structure of strippable topsoil material, while good in a natural state, is often dependent on the existing root mass holding the solum together. Therefore, it will be necessary for this organic matter to be retained within the soil during the stripping operation and for stockpiled materials to be sown with suitable cover crops to reduce the leaching of nutrients, and to enhance the retention of organic matter and the subsequent binding effect of the root mass.

4.2.3 *Contamination Potential*

Potential contamination sources from quarry activities include fuel, chemical and lubricant storages, fuel or oil spillage, pre-coated and asphalt raw materials and products and the asphalt plant wet scrubber water and collected particulate. All these sources will be located within contained hardstand areas.

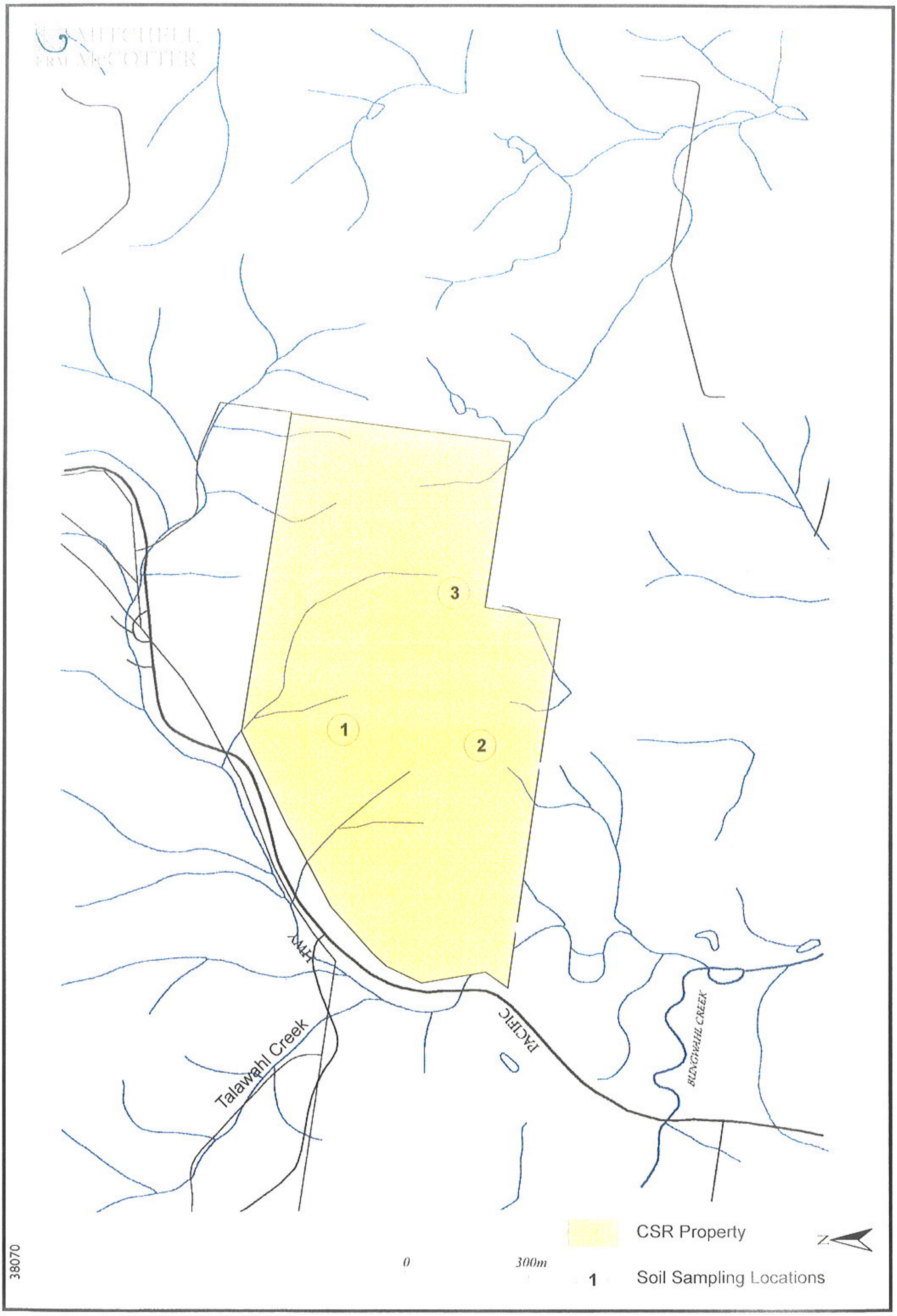

Figure 4.4 SOIL SAMPLING LOCATIONS

Many of the mitigation measures for protection of surface water quality detailed in Section 4.3.3 below are also applicable for the prevention of soil contamination. In addition, solids from the wet scrubber interceptor pit will be bioremediated on-site in a clay-lined area. Remediated solids will be tested prior to disposal to ensure they meet specific criteria for the intended disposal method. Applicable criteria include:

- disposal at solid waste landfill - Environmental Guidelines Assessment, Classification and Management of Non-Liquid Wastes (EPA, 1997); and

- incorporation into quarry overburden stockpiles - Guidelines for the NSW Site Auditor Scheme (EPA, 1998).

4.3 SURFACE AND GROUNDWATER

4.3.1 Surface Waters

i. Catchment Description

The existing quarry and site facilities area is located at the head of a minor creek line that flows northward crossing the Pacific Highway before joining a creek that flows south-west to Talawahl Creek. The catchment upstream of the confluence of the two streams has an area of approximately 48 hectares. Talahwahl Creek flows to Bungwahl Creek and thence to the Wallamba River. The existing operation includes a disturbed area of approximately 7.5 ha including the existing 3 ha quarry pit.

The proposed extension increases the disturbed areas primarily within the same creek catchment currently affected by the operation. The quarry extension will result in minor disturbances to ridgetops above minor creek lines to the west and south of the site. The upper most section of another minor creek line will be impacted during the eastern most extension of the quarry. This latter creek has two small instream dams and joins the creek line that originates in the existing quarry area prior to the Pacific Highway crossing. The proposed extension will result in a total area disturbed of approximately 23.8 ha, including the 17.3 ha quarry pit, 4.6 ha site facilities area, 0.7 ha secondary stockpile area and approximately 1.2 ha of access and haul roads etc.

The surface water drainage system is shown in *Figure 4.5*.

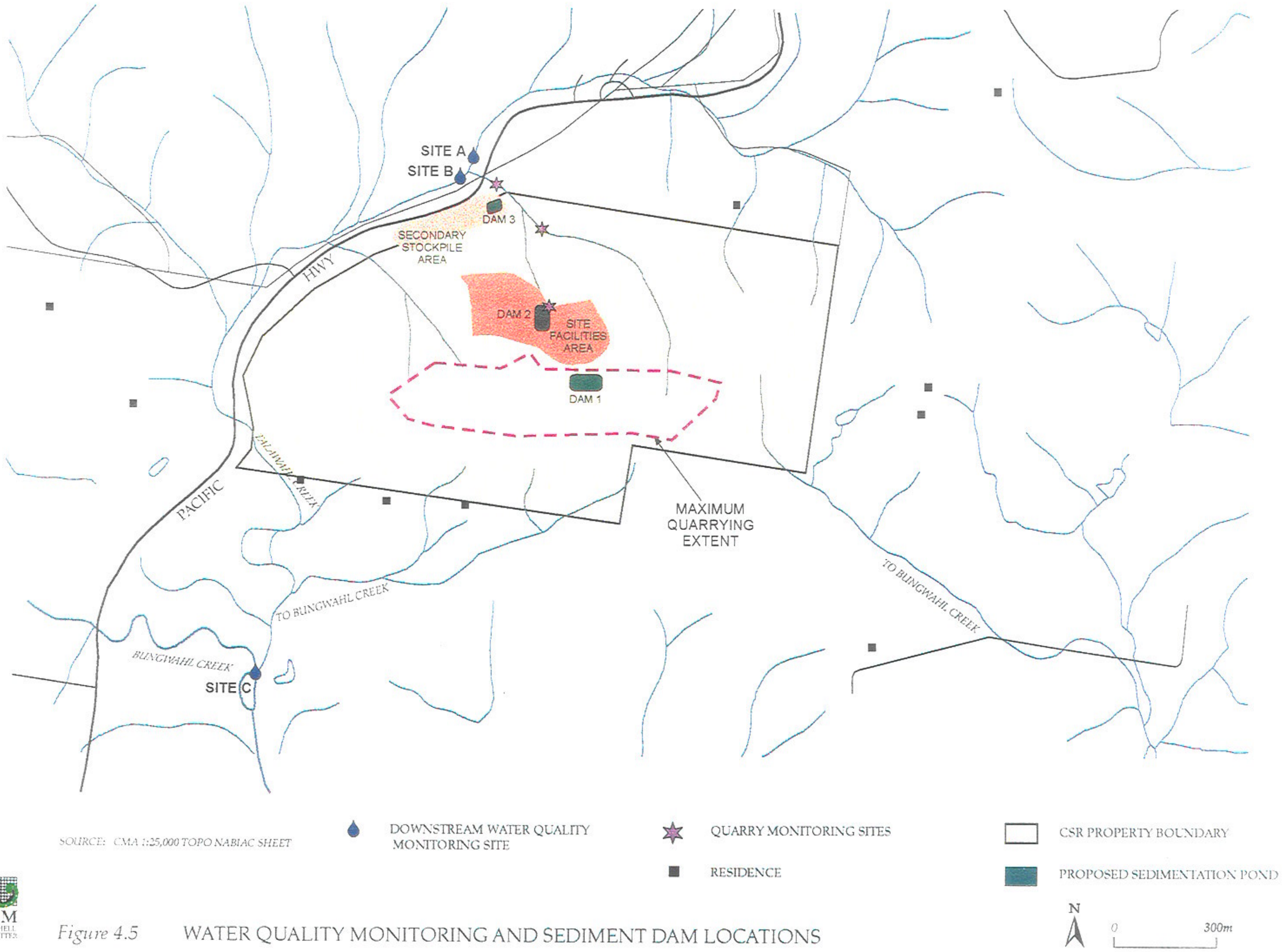

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Figure 4.5 WATER QUALITY MONITORING AND SEDIMENT DAM LOCATIONS

ii. Surface Water Quality

No detailed data is available describing water quality in the surrounding creeks of the local catchment. During the EIS investigations water samples were obtained at three locations, as shown in *Figure 4.5* and described below:

- minor creek west of the Pacific Highway, upstream of its confluence with the quarry sourced creek line (Site A);
- minor creek west of the Pacific Highway downstream of its confluence with the quarry sourced creek line (Site B); and
- at the confluence of Talawahl Creek and Bungwahl Creek (Site C).

Two sample sets were collected representing the catchment in a wet and dry state. The samples were collected in relatively high and moderate to low flow conditions respectively. The results of the water quality analysis is summarised in *Table 4.1.*

Table 4.1 RESULTS OF WATER QUALITY ANALYSIS

	Wet Catchment			Dry Catchment		
Sample	Site A	Site B	Site C	Site A	Site B	Site C
pH	6.9	6.9	6.9	6.6	6.4	6.7
Dissolved Oxygen (mg/L)	3.0	5.4	5.9	5.8	5.0	8.4
Salinity1 (uS/cm)	266	375	303	1,275	1,859	873
Suspended Solids (mg/L)	5.0	8.0	2.0	14.0	3.0	5.0
Oils/Grease (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Notes: 1. Salinity is measured as electrical conductivity in units of micro-siemens per centimetre.

The water quality results indicate the creek water sampled was of good quality. The results indicate there was no noticeable effect of the quarry on the samples collected. Low dissolved oxygen levels may be attributed to the samples being collected early in the morning when diurnal oxygen levels are at their lowest.

Water quality analysis has also been carried out at various locations around the existing quarry. Samples were collected during various catchment conditions over the period 1997 - 1998. A summary of the results are given in *Table 4.2* below.

Table 4.2 QUARRY WATER MONITORING RESULTS

Measurement Locations	pH			Non-Filterable Residue (mg/L)		
	Min	Max	Average	Min	Max	Average
Site Facilities Dam	6.6	8.2	7.2	20.8	144	81.1
Clean Water Dam	6.1	7.0	6.6	15.8	67.0	38.2
Downstream Creek at Property Boundary	6.6	7.4	7.0	19.4	59.0	37.2

The results show that pH is within the range recommended for fresh waters (6.5 to 9.0), based on the ANZECC (1992) *Water Quality Guidelines for Fresh and Marine Aquatic Ecosystems*. The non-filterable residue (NFR or suspended solids) values average between 37 and 81 mg/L, compared with the ANZECC (1992) criteria of 50 mg/L for suspended solids in fresh aquatic ecosystems. The results indicate that significant peaks in the NFR values are experienced in the site facilities sediment control dam and that specific sedimentation management measures such as hand casting of flocculent will be required. Nevertheless, the results for the creek at the property boundary downstream of the sediment dams indicate that generally the NFR levels are within the ANZECC criteria.

4.3.2 *Groundwater*

The existing quarry is not subject to groundwater inflow and no groundwater was recorded during geological investigations. Any groundwater is likely to be located in fractured material above the basement rock. This groundwater would have limited flow potential as it would originate from subsurface flows following recent rainfall events rather than from interception of the watertable. As the catchment is limited to the ridge to be quarried groundwater inflow is expected to be negligible.

4.3.3 *Impacts*

i. Surface Waters

Potential impacts of the proposed development on surface waters are degradation of water quality in downstream watercourses and/or variation to the volume of water discharged from the site.

Currently, no process wastewater is generated by the quarry. The only potential change to downstream water quality would be generated by sediments or hydrocarbons leaving the site. Without adequate control, sediments have the potential to increase turbidity in downstream waters, thereby increasing sedimentation. Hydrocarbons are located as point sources (e.g. fuel storage) and can be easily contained using appropriate mitigation measures.

Existing sediment and erosion control measures at the quarry have shown to be generally effective in controlling sediment movement. All runoff from disturbed area due to the proposed expansion will be directed to the existing and proposed additional sediment controls. Provided the capacity of the sediment controls is not exceeded, they are regularly monitored to identify if flocculation is required and they are maintained in correct operating order, the proposed extension will not have a significant effect on water quality in downstream watercourses.

The quarry is located in the upper catchment of a minor creek and as such flow volumes at the site provide only a minor contribution to the flows in Talawahl and Bungwahl creeks. The proposed extension will result in changes to the volume of runoff leaving the site as water collected in sedimentation dams will be used on-site for dust mitigation and to increase product moisture levels. However, the system of sedimentation dams has been designed such that even in dry years (an annual rainfall year with a probability of exceedance greater than 90 percent) there will be overflows into the downstream watercourses (see Section 3.10.6).

ii. Groundwater

The only potential effect on regional groundwaters would be a loss of groundwater input from rainwater infiltration. Quarry operations would not prevent such infiltration occurring although there may be a decrease in the infiltration rate due to increased runoff from working areas of the quarry.

Currently any intercepted subsurface flows are directed into the existing sedimentation ponds that overflow into the creek downstream. This will continue for the proposed expansion, however, once the quarry becomes non self draining, ie. floor level below RL 50, any excess subsurface flows above quarry demands will be collected in a sump and pumped into the downstream watercourse.

There will be no significant effects on regional groundwaters as a result of quarry operations.

iii. Asphalt Plant, Pugmill and Pre-coating Operations

The operation of an asphalt plant, pugmill and pre-coating plant has the potential to degrade surface water quality. Sources of potential contaminated runoff from the asphalt plant sites include:

- movement of processed material within the stockpile area;
- asphalt or hotmix spills;
- spill/leakage of admixture (lime, cement, flyash); and
- fuel or oil spills.

It is standard practice for these types of processes to prepare specific areas to a suitable standard to mitigate against the potential for soils and water contamination. In the case of the asphalt plant it will be situated on a specially constructed hardstand pad raised slightly above the surrounding site facilities area. The raised pad will ensure that runoff from surrounding areas is diverted around the asphalt area. A small sediment/evaporation pond lined or constructed with impervious soils will be constructed to collect and treat runoff from the pad. Secondary containment is provided by the site facilities sediment dam.

The pugmill and pre-coating plant will be located on a concrete pad also within the expanded site facilities area. Runoff around and from the pad will be managed as for the asphalt plant. In addition, runoff from the pre-coating area will be directed through a grease trap as 'pre-coat' floats on water.

Through appropriate site preparation and implementation of relevant mitigation measures detailed below the operation of the asphalt plant, pugmill and pre-coating facility will not significantly impact on downstream water courses.

4.3.4 *Mitigation Measures*

i. General Quarry Activity

A soil and water management plan incorporating the measures detailed in Section 3.10 will be included in the quarry environmental management plan. The soil and water management plan will address the following principles:

- the use of sediment control dams;
- minimisation of disturbed areas. Quarry and ancillary area boundaries will be marked and no activity permitted outside designated areas;
- diversion of clean water from undisturbed areas around working areas;
- the installation of temporary erosion and sediment controls, such as geofabric filter devices, prior to commencement of topsoil and overburden removal;