WORSLEY ALUMINA PTY LTD

BODDINGTON GOLD MINE PROJECT

EXPANSION OF FACILITIES - STAGE TWO

NOTICE OF INTENT

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SUMMARY

The Boddington Gold Mine Project, managed by Worsley Alumina Pty Ltd (WAPL) on behalf of the Worsley Joint Venturers, was commissioned in July 1987 with a design ore throughput of 3 Mt/a (8,000 t/d). In October 1987, a proposal was submitted to, and subsequently approved by, the State Government to enhance facilities to guarantee a processing rate of 3 Mt/a and permit ore throughputs of up to 4.5 Mt/a (12,000 t/d) under optimal conditions of ore hardness and water supply. This Notice of Intent outlines a proposal to expand the project to a processing rate of 6 Mt/a (16,000 t/d). The direct impacts of this expansion would be small, and confined to private land - no clearing of State Forest would be required.

Further assessment of the orebody, particularly the proposal to include marginal ore in mill feed, has resulted in the ore reserve being increased from earlier estimates by 15 Mt to 60 Mt. Thus operation at 6 Mt/a would give a project life of some ten years, the same as that projected for the 4.5 Mt/a operation with an ore reserve of 45 Mt.

Of the proposed $30 million investment, the greater part would be spent in Australia. The proponent and the Australian economy would benefit from a faster rate of revenue generation and increased revenue over the life of the project.

Expansion of the mining operations would be facilitated by the addition of mining equipment similar to that currently in use. The inclusion in mill feed of the marginal ore would effectively offset the increased ore mining rate, resulting in a rate of mine-pit development similar to that of the current operation.

To provide an adequate and secure water supply for the expanded plant, it is proposed to construct an additional water supply reservoir of 3,060 ML capacity and to increase the maximum pumping rate from the Hotham River from 2,200 kL/h to 3,300 kL/h.

The new water supply reservoir would be constructed on privately owned land on Thirty-Four Mile Brook immediately north of the Plant Site. This site was selected in preference to a number of others investigated on the basis of cost, practicability and environmental considerations. Construction would necessitate the clearing of about 58 ha of private land.

No changes to the Hotham River pump station or the delivery pipelines to the Water Supply Reservoir would be required to facilitate pumping at 3,300 kL/h. This increased extraction would be managed to ensure both maintenance of the minimum Hotham River flow required by the Water Authority of Western Australia and equitable sharing of this water resource with Alcoa of Australia Ltd's Hedges Gold Project. A strategy for the management of water extraction for the two mining operations was recently approved by the Minister for Water Resources; this strategy would apply to the 6 Mt/a operation.

Modelling of the Hotham-pumping strategies for both the Boddington Gold Mine and Hedges Gold Mine has shown that the water extracted generally constitutes only a small proportion of the total Hotham River flow. Therefore, the

environmental impact of the increased pumping on the ecology of the Hotham River and on downstream users would not be significant.

The plant facilities proposed include the installation of an additional dump hopper and crushing facility, an upgrading of the milling and classification area, three additional leach/adsorption tanks, an additional residue surge tank, a re-arrangement of tank duties, the installation of a second elution column, the upgrading of the existing dosing pumps in the reagent preparation area, and the construction of an additional administration building. All of these, except the new administration building, would be accommodated within the existing Plant Site perimeter fence and would not involve any additional clearing; construction of the new administration building may require clearing of about 0.1 ha.

Depending upon final arrangements developed during detailed design, the run-of-mine ore stockpile area may be extended by up to 30 m to the west, to provide clearance around the ore stockpile, which may be re-positioned to allow access to the new dump hopper: this may result in additional clearing of up to 0.75 ha of private land.

Based on the original design of the Boddington Gold Mine residue management system, and on performance of the system to date, the Residue Storage Area would be capable of containing the residue from at least 60 Mt of processed ore. Modelling of the residue management system has shown that the average residue level following the placement of 60 Mt of residue would be about 4 m higher than for placement of 45 Mt of residue.

The increased residue deposition rate would also necessitate early construction of the saddle embankments to the north-west, north and east of the Residue Storage Area, to take advantage of suitable borrow material which can be sourced from within the final area of residue inundation. Construction of these embankments would be brought forward to 1988-89 as part of the 6 Mt/a expansion.

The modifications to the residue disposal and reclaim return systems proposed are a duplication of the residue disposal pipeline, the relocation of the existing residue disposal pipeline along the southern section of the Residue Storage Area, the construction of an additional reclaim water pump station, and the enlargement and relocation of the reclaim water collection tank. The duplication of the residue disposal pipeline would not involve any significant clearing.

All aspects of environmental management for the Boddington Gold Mine Project are documented in WAPL's Environmental Management Programme (1987a) and the Enhancement of Facilities Notice of Intent (1987b). The policies and procedures set out in those documents would apply to the proposed expansion and this Notice of Intent acts as a supplement to those.

It is planned that construction of the proposed facilities be commenced in late 1988, with commissioning scheduled for mid 1989.

1 INTRODUCTION

1.1 BACKGROUND

The Boddington Gold Mine Project involves the mining and processing of an orebody located approximately 13 km north-west of the town of Boddington (Figure 1.1).

Approval for the project was granted by the State Government in December 1985, after the Environmental Protection Authority (EPA) reviewed and assessed an Environmental Review and Management Programme (ERMP) prepared by the Joint Venturers (Worsley Alumina Joint Venturers 1985). Environmental approval was subject to the Joint Venturers adhering to the commitments made in the ERMP and subsequent submissions, and complying with specific EPA recommendations (Department of Conservation and Environment 1985). One of these recommendations required the preparation of an Environmental Management Programme (EMP), to document all aspects of environmental management prior to the commissioning of the project (Worsley Alumina Pty Ltd 1987a).

The project was commissioned in July 1987, with initial operations designed for an ore throughput of 8,000 t/d (3 Mt/a), the actual rate varying with the hardness of the ore encountered. A Notice of Intent (NOI) was prepared for the EPA in October 1987 (Worsley Alumina Pty Ltd 1987b), outlining the environmental impacts of a proposal to enhance existing operations. The proposed enhancement was designed to guarantee an ore throughput of 8,000 t/d under all conditions of ore hardness and water supply; under optimal conditions, it could allow throughputs of up to 12,000 t/d (4.5 Mt/a). This proposal was approved by the State in February 1988, and is currently being implemented.

The Joint Venturers are now examining the feasibility of further upgrading the Boddington Gold Mine Project by expansion of facilities to allow an ore throughput of up to 16,000 t/d (6 Mt/a). This NOI outlines the possible expansion, addresses the likely impacts of the expansion on the environment and indicates how the management of these impacts could be incorporated into the existing EMP. This proposal should therefore be considered with reference to the April 1987 EMP and the October 1987 NOI (Worsley Alumina Pty Ltd 1987a, b).

1.2 THE PROPONENT

The Boddington Gold Mine Project has been developed by the Worsley Joint Venturers, a consortium comprising Reynolds Boddington Mines Ltd (40%), Billiton Australia Gold Pty Ltd (30%), BHP Gold Mines Limited (20%) and Kobe Alumina Associates (Australia) Pty Limited (10%). Worsley Alumina Pty Ltd (WAPL) is responsible for management of the project on the Joint Venturers' behalf.

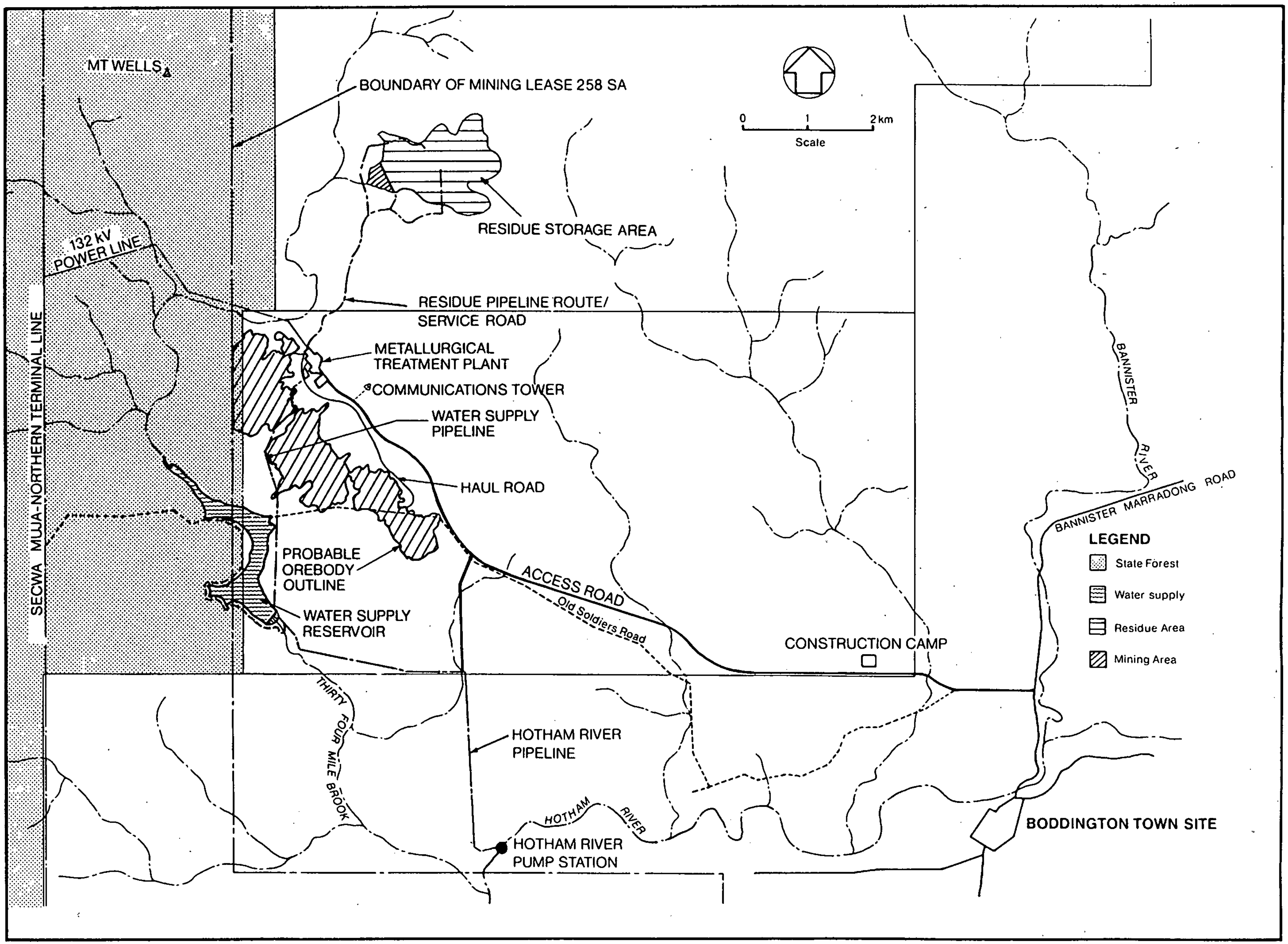

FIGURE 1.1
LOCATION PLAN – OVERVIEW

1.3 BENEFITS OF THE PROPOSED EXPANSION

The proposed expansion would involve additional investment by the proponent of around $30 million, most of which would be spent in Australia, benefiting suppliers and the engineering and construction sectors of industry. The local economy would also benefit through the requirement for regular supply of goods and services during the operational phase.

The benefit to the proponent would be increased revenue from the processing of an increased volume of material from the orebody.

Construction of the additional facilities would employ a temporary workforce of about 100, while up to 20 more employees would be required during the operational phase, primarily in mining operations.

1.4 TIMING OF THE PROPOSAL

The expansion would desirably be in operation by mid 1989, with construction commencing in late 1988 to capitalize on the favourable weather conditions of the summer/autumn period and to permit construction of water impoundment facilities prior to the 1989 winter.

2 OVERVIEW OF THE EXISTING PROJECT

A brief overview of the Boddington Gold Mine Project is presented in this section. Reference should be made to the April 1987 EMP and October 1987 NOI for a more detailed description of the overall project and the 1988 enhancement of facilities, respectively.

Ore is currently being mined by selective open cut methods. Run-of-mine (ROM) ore is delivered by rear-dump truck to a stockpile at the Metallurgical Treatment Plant, situated to the north-east of the Mining Area. (Figure 1.1 shows the location of the various elements of the project.) Gold is extracted from the ore at the Plant Site using the carbon-in-leach (CIL) process; the Plant Site comprises crushing, milling, leaching and gold-recovery circuits. Smelted bullion is transported to Perth for final refining.

Access to the Plant Site is via a 13 km sealed Access Road from the Bannister-Marradong Road. Power is supplied by a double-circuit feeder line from the State Energy Commission of Western Australia 132 kV Muja—Northern Terminal line.

Water is supplied to the Metallurgical Treatment Plant via a 4.5 km pipeline from the Water Supply Reservoir on Thirty-Four Mile Brook which has a capacity of 4,940 ML. This water supply is supplemented by pumping during winter months from a pump station on the nearby Hotham River via pipelines to the Water Supply Reservoir. Potable water for the gold-recovery circuit and human consumption is supplied by desalination of reservoir water in a reverse osmosis plant.

The waste stream from the metallurgical treatment process is a barren ore slurry, which is pumped to the Residue Storage Area. The residue is retained behind an embankment that is being progressively raised to contain the quantity of residue to be produced over the life of the project (under current operations, 45 Mt). The layered deposition technique used creates beaches to maximize drying by evaporation from the residue surface. As the residue settles, decant water, rainwater and under-drainage are removed and pumped back to the Process Water Pond at the Plant Site for reuse in the treatment process. Reclaimed water currently accounts for more than 47% of the process water requirement compared with 37% originally estimated (Appendix H of April 1987 EMP): this figure of 47% is expected to decline in future due to increased evaporation as the residue surface area increases.

3 THE EXPANSION PROPOSAL

The following sections outline the changes that would be required to various elements of the project to facilitate expansion to an ore throughput rate of 6 Mt/a. All impacts of this proposal would be confined to private land, with no requirement for clearing in State Forest.

3.1 MINING OPERATIONS

It is proposed to upgrade the existing gold mining operations by the expansion of facilities to allow processing at an ore throughput of 16,000 t/d (6 Mt/a). This proposal, which has evolved from progressive reassessment of the orebody since the commencement of operations in July 1987, would involve the processing of ore currently classified as marginal: at present, this material is either stockpiled or left in situ in the mine-pits. The total quantity processed over the life of the project would be 60 Mt, an increase of 15 Mt. At the increased processing rate, the project life would be ten years, essentially the same as that projected for the 1988 enhancement, in which the 45 Mt orebody is processed at a rate of up to 12,000 t/d (4.5 Mt/a).

Expansion of the mining operations would be facilitated by the addition of mining equipment similar to that currently in use. The inclusion in mill feed of the marginal ore would effectively offset the increased ore mining rate, resulting in a rate of mine-pit development similar to that of the current operation.

3.2 WATER SUPPLY

To ensure security of supply for a processing rate of 16,000 t/d (6 Mt/a), the requirements of the water supply system have been assessed by using the computer-based water balance model developed for earlier stages of the project. The projected water supply (net of reclaim from the Residue Storage Area) and water storage requirements for the various production rates are shown in Table 3.1.

Table 3.1 Water supply and storage requirements

Development stage	Production rate (Mt/a)	Net water requirement (kL/t)	Net reservoir offtake (ML/a)	Storage volume* (ML)
Original	3.0	1.21	3,630	4,150
1988 enhancement (in progress)	4.5	1.18	5,310	4,940
Proposed expansion	6.0	1.18	7,080	8,000

* Includes carryover capacity to cope with dry years.

In comparison with the enhancement currently in progress, processing at a rate of 16,000 t/d (6 Mt/a) would require an additional water supply of 1,770 ML/a and an additional storage capacity of about 3,000 ML to provide annual carryover capacity to ensure water supply in dry years.

The following options, addressing potential water sources within 100 km of the Boddington Gold Mine, were investigated for their suitability for providing the additional water requirement:

- Hotham River
- Great Southern Towns Water Supply Scheme
- Wellington Dam
- Worsley Alumina Refinery Freshwater Lake
- South Dandalup Dam
- Waroona, Samson, Logue Brook and Stirling Dams
- Mundaring, Canning and Serpentine Dams
- bituminized catchments
- groundwater
- local Hotham River tributaries other than Thirty-Four Mile Brook
- expansion of the existing reservoir on Thirty-Four Mile Brook.

Generally, the water source options considered are either the relatively proximate Hotham River or the relatively distant groundwater formations and man-made reservoirs or lakes to the north, south or west of the Boddington Gold Mine.

Each option was evaluated against the criteria of cost-effectiveness, guarantee of supply, and minimal environmental disturbance. It has been concluded that the most appropriate option for providing an increased water supply would be to increase the extraction of water from the Hotham River and provide additional on-site storage capacity.

To provide the additional water required, it would be necessary to increase the pumping rate from the Hotham River from a maximum of 2,200 kL/h, as currently licensed by the Water Authority of Western Australia, to 3,300 kL/h. Section 4.2.1 describes how this increased extraction would be managed to ensure both maintenance of the minimum Hotham River flow required by the Water Authority and equitable sharing of this water resource with Alcoa of Australia Ltd's Hedges Gold Project.

No changes to the Hotham River pump station or the delivery pipelines to the Water Supply Reservoir would be required to facilitate pumping at 3,300 kL/h. However, it would be necessary to operate some of the standby pumping equipment. If it were decided to maintain the existing level of standby capacity, an additional pump would be installed; provision for this already exists at the pump station.

Several options for increasing the on-site water storage capacity from 4,940 ML to 8,000 ML have been evaluated. On the basis of cost, practicability and environmental considerations, it is proposed to construct an additional reservoir on private land on Thirty-Four Mile Brook immediately north of the Plant Site (Figure 3.1). Expansion of the existing Water Supply Reservoir on Thirty-Four Mile Brook, while technically feasible, would inundate a significant area of State Forest and probably interfere with the mining and ore transport activities of the Hedges Gold Mine.

The proposed additional reservoir would have a storage capacity of 3,060 ML and at maximum storage would inundate a total area of 50 ha. The 58 ha of land

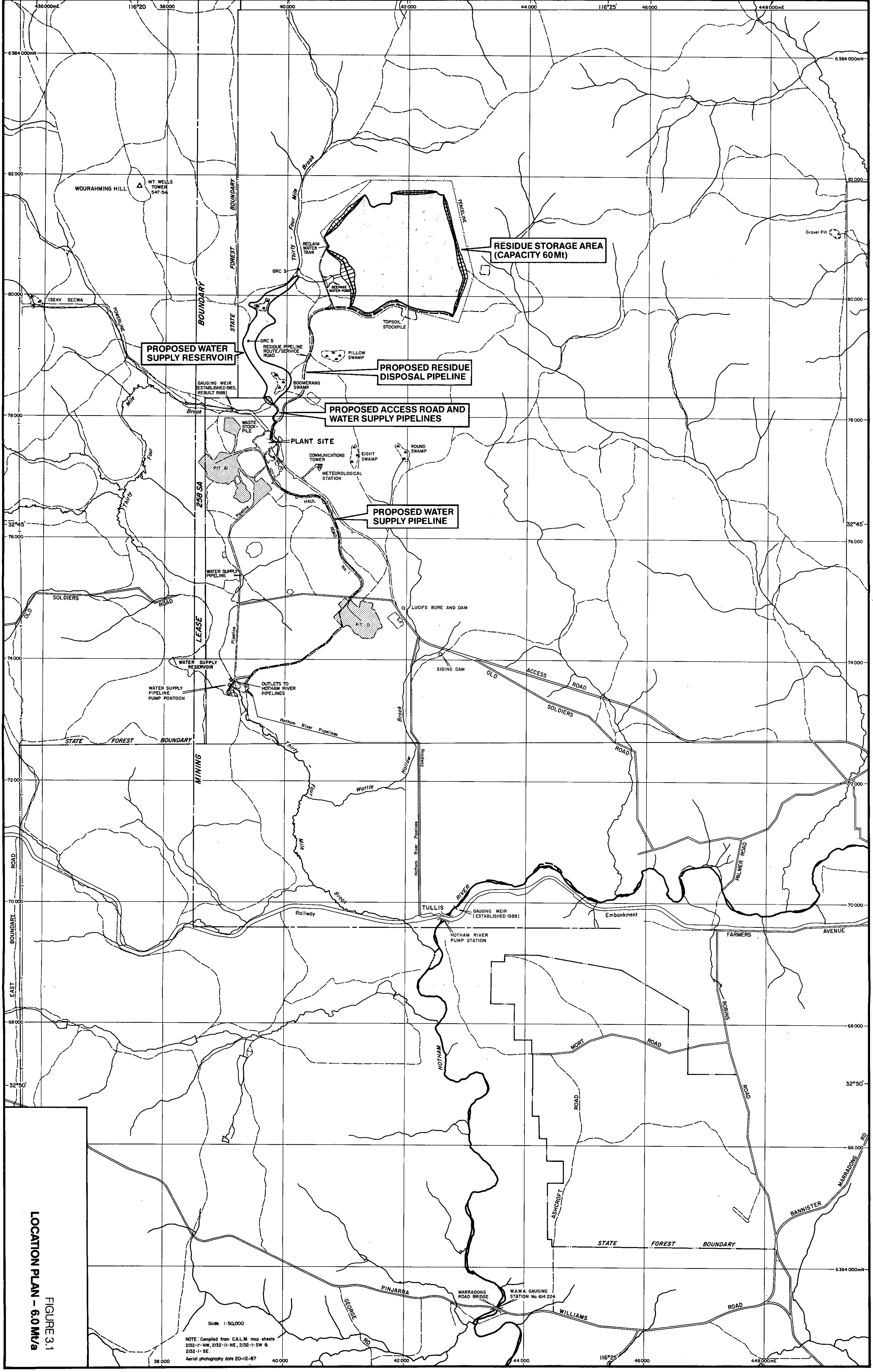

FIGURE 3.1
LOCATION PLAN - 6.0 Mt/a

required for its construction is privately owned. The reservoir dam would have a wall some 19.5 m high, including allowance for flood surcharge and freeboard. The new reservoir would require licensing by the Water Authority under the Rights in Water and Irrigation Act, 1914 (as amended).

Given the relatively small and low-yielding catchment of this reservoir, most of the water impounded would be pumped from the existing downstream Water Supply Reservoir on Thirty-Four Mile Brook: water from the Hotham River would be pumped to the downstream reservoir, mixed with natural runoff and pumped progressively to the proposed upstream reservoir. This 'second-stage' pumping would require duplication of the existing pump station and the pipeline between the Water Supply Reservoir and the Plant Site. Water would be pumped from the existing reservoir to the proposed reservoir via a ductile iron cement-lined (DICL) pipeline, following a route running along an existing forest track (formerly used for access during construction of the Water Supply Reservoir), through mining pit D and along Haul Road No. 1 to the Metallurgical Treatment Plant. From the Plant, the water pipeline would follow the route of the residue pipeline to the intersection with the access road to be constructed to the proposed reservoir, which it would then follow (Figure 3.1). A second DICL pipeline would be constructed to return water from the new reservoir to the Metallurgical Treatment Plant; this would follow the same alignment as the delivery pipeline.

The original (3 Mt/a ore throughput) potable water system consisted of a reverse osmosis plant nominally producing 7.5 kL/h. This is being upgraded for the 1988 enhancement by installation of an additional unit to produce a further 10 kL/h. For the expansion to 6 Mt/a, these upgraded facilities are considered likely to be adequate. However, should this prove not to be the case, the original unit could be modified to include a pre-treatment plant to guarantee performance of 7.5 kL/h for all likely conditions of physical water quality. Additional potable water would be obtained from Lucif's Bore as required (Figure 3.1).

The working volume of the Process Water Pond at the Plant Site was reduced to 6 ML (total volume of 9.5 ML including storm capacity and freeboard) for the 1988 enhancement to 4.5 Mt/a, after operational experience determined that the original design working volume of 15 ML (total volume of 18.4 ML including storm capacity and freeboard) was in excess of plant requirements. This reduction has not been at the expense of stormwater runoff storage capacity: Plant Site runoff from a 1 in 100 year storm event can still be contained in the volume available above the operating water level. It is not proposed to alter the volume of the pond for the expansion to 6 Mt/a, although additional pumping capacity would be installed. The Process Water Pond has been lined with clay and an impermeable membrane as part of the 4.5 Mt/a enhancement, to ensure minimal risk of seepage.

3.3 METALLURGICAL TREATMENT PLANT

Expansion of the Boddington Gold Mine Project to 6 Mt/a would require some additional facilities, as well as upgrading of existing facilities, associated with the Metallurgical Treatment Plant at the Plant Site. These would include:

- installation of an additional dump hopper and crushing plant in the ROM ore stockpile, south of the existing crushing facilities;

- possible extension of the ROM ore stockpile area by up to 30 m to the west (an area of up to 0.75 ha), to provide clearance around the ore stockpile, which may be re-positioned to allow access to the new dump hopper;

- upgrading of the milling and classification area to allow for the greater ore throughput;

- construction of an additional three leach/adsorption tanks, an additional residue surge tank and re-arrangement of duties of existing tanks so that the original 3 Mt/a facility would be duplicated;

- installation of a second elution column to the gold recovery area;

- upgrading the existing dosing pumps in the reagent preparation area to allow for greater reagent consumption. Following the 4.5 Mt/a enhancement, the reagent storage area will have sufficient capacity for a processing rate of 6 Mt/a;

- construction of an additional administration building to the west of the existing office, involving clearing of about 0.1 ha.

With the exception of the new administration building and the possible expansion of the ROM ore stockpile area, these additional facilities would be constructed inside the existing Plant Site perimeter fence and adjacent to existing facilities. The arrangement of the Metallurgical Treatment Plant following the proposed expansion to 6 Mt/a is shown in Figure 3.2.

3.4 RESIDUE DISPOSAL

Based on the original design of the Boddington Gold Mine residue management system, and on performance of that system to date, the Residue Storage Area would be capable of containing the residue from at least 60 Mt of processed ore. Modelling of the residue management system has shown that the average residue level following the placement of 60 Mt of residue would be RL 330 m, requiring an embankment level of RL 330.5 m (cf. RL 326 m for 45 Mt of residue; see Section 8, April 1987 EMP).

The increased residue deposition rate would also necessitate early construction of the saddle embankments to the north-west, north and east of the Residue Storage Area, to take advantage of suitable borrow material which can be sourced from within the final area of residue inundation. Construction of these embankments, originally proposed for the summer months of 1990-91 (see Figure 8.3, April 1987 EMP), would be brought forward to 1988-89 as part of the 6 Mt/a expansion.

The modifications to the residue disposal and reclaim return systems required to upgrade these from the 1988 enhancement (up to 4.5 Mt/a) to a processing rate of 6 Mt/a would be as follows:

- duplication of the residue disposal pipeline, involving about 5 km of 450 mm diameter steel pipeline from the Metallurgical Treatment Plant to the eastern residue embankment (Figure 3.1). Along the southern section of the residue area, this pipeline would be constructed at a higher elevation (RL 331 m) than the existing residue delivery pipeline (RL 328.5 m);

- relocation of the existing residue disposal pipeline along the southern section of the Residue Storage Area to an alignment alongside the new delivery pipeline (Figure 3.3);

- construction of an additional reclaim water pump station (Figure 3.3);

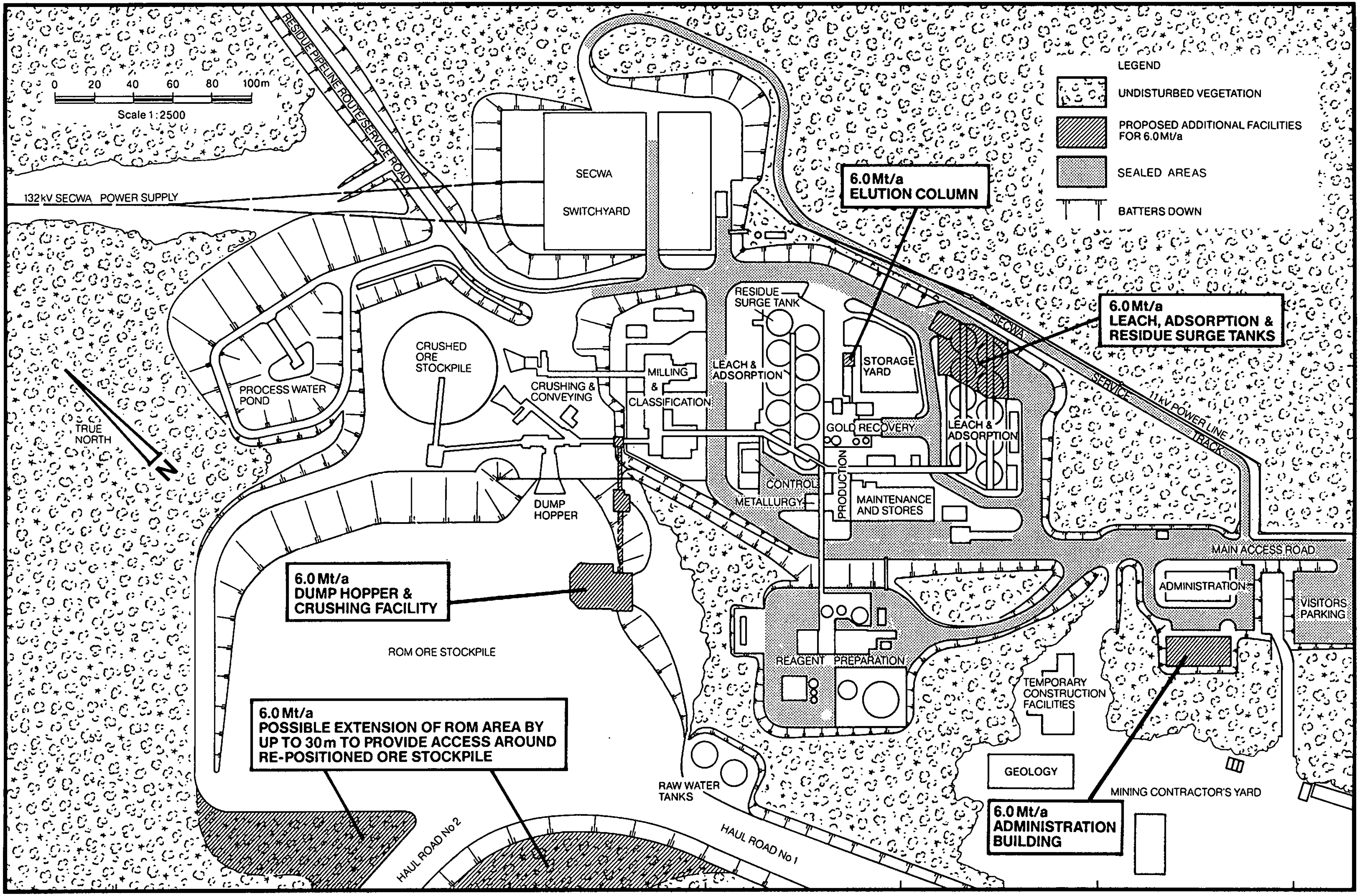

FIGURE 3.2
PLANT LAYOUT FOR 6.0Mt/a

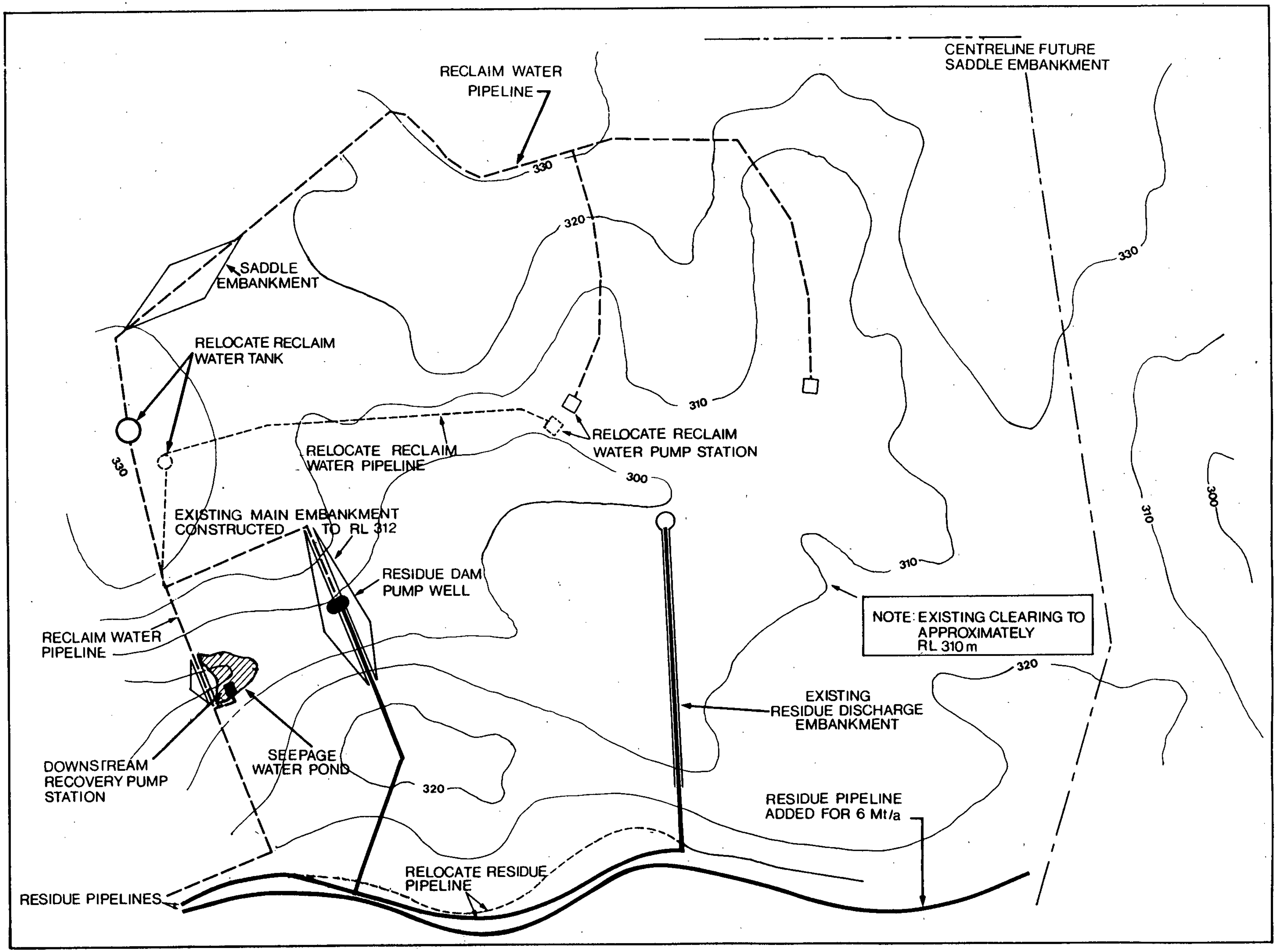

FIGURE 3.3
RESIDUE STORAGE AREA—6.0 Mt/a

- enlargement and relocation of the reclaim water collection tank and 350 m of the existing reclaim return pipeline (Figure 3.3).

The duplication of the residue disposal pipeline would not involve any significant clearing: the relocation of the existing drain to the east of the residue disposal area access road and the installation of new pipe supports to the east of the existing residue disposal pipeline (Figure 3.4) could be accomplished within the existing cleared area. The corridor drainage and containment ponds would maintain the existing capacity to retain the flow from fifteen minutes of pumping from a broken pipeline, plus any material within the pipeline that can gravitate to the pond locations.

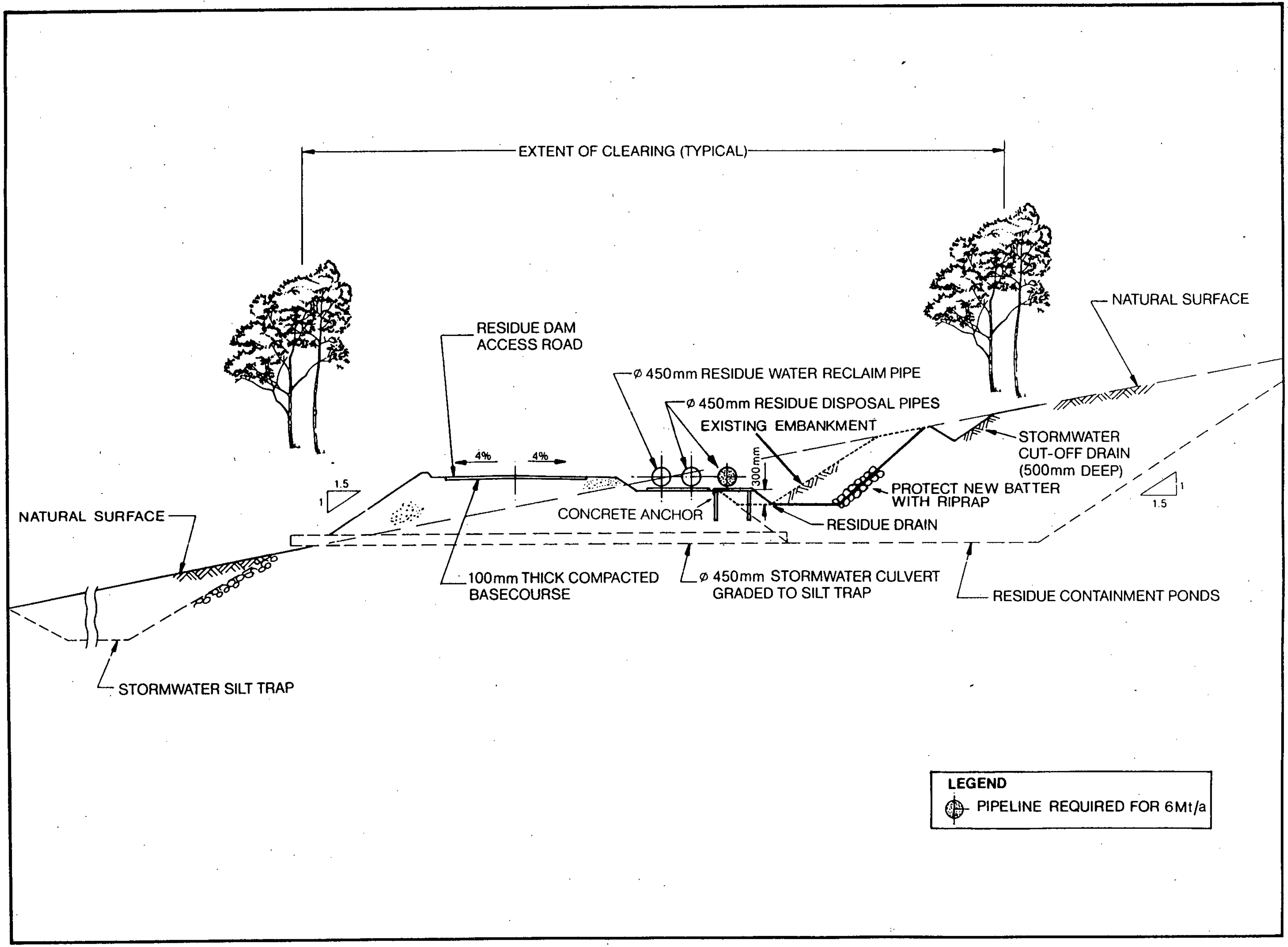

FIGURE 3.4
RESIDUE AND RECLAIM PIPELINES SYSTEM – 6.0 Mt/a

4 ENVIRONMENTAL IMPACTS

4.1 MINING OPERATIONS

By lowering the minimum head grade and increasing the rate of ore throughput, the total amount of ore processed during the life of the project could increase from 45 Mt to 60 Mt.

Mining of the 60 Mt orebody would not significantly increase areal impacts, since the additional 15 Mt of ore would come from material currently classified as marginal: in the absence of a 6 Mt/a operation, this material would be stockpiled or left in the ground. Similarly, the rate of clearing for mine-pits would be substantially unchanged from that applying to the current operation. Thus, potential impacts on stream salinity (resulting from clearing of vegetation, and detailed in Appendix B of the April 1987 EMP) are unlikely to be increased by expansion to a 6 Mt/a operation.

4.2 WATER SUPPLY

4.2.1 Hotham River flow

The impacts of increased withdrawal from the Hotham River have been reviewed using Water Authority data for Hotham River streamflow, as has been done in earlier assessments of impacts of development of the Boddington Gold Mine. This modelling uses data from the 1973-81 low-rainfall sequence, as well as median flow data from 1966-87 records; it also allows for licensed withdrawals for the Hedges Gold Mine, and for the Water Authority's requirement that no pumping take place when streamflow is less than 342 kL/h as measured at the Marradong Road Bridge Gauging Station (No. 614 224) (Figure 3.1). The model operates on a monthly water balance principle, addressing reservoir storage capacity, rainfall, evaporation and consumptions in the process, as well as the aforementioned parameters. Details of the model are presented in Appendix A.

For median flows in the Hotham River, the impacts of pumping at the proposed maximum rate of 3,300 kL/h would be as shown in Table 4.1.

Table 4.1 **Impacts of pumping rates - median Hotham River flows (median flow of Hotham River = 74,630 ML/a)**

Ore throughput rates (Mt/a)		Volume of water extracted as % of median annual Hotham flow		
Boddington Gold Mine	Hedges Gold Mine	Boddington Gold Mine	Hedges Gold Mine	Total
3	2	6	5	11
4.5	2	9	5	14
6	2	12	5	17

For the lowest rainfall/streamflow year on record (1979), the impacts of pumping at the proposed rate would be as shown in Table 4.2.

Table 4.2 **Impacts of pumping rates - low-rainfall years (1979 Hotham River flow = 16,900 ML)**

Ore throughput rates (Mt/a)		Volume of water extracted as % of total 1979 Hotham flow		
Boddington Gold Mine	Hedges Gold Mine	Boddington Gold Mine	Hedges Gold Mine	Total
3	2	18	17	35
4.5	2	31	17	48
6	2	38	17	55

The third column in Tables 4.1 and 4.2 shows extraction of Hotham River water for the Boddington Gold Mine as a percentage of total Hotham flow. For median years, extraction as a percentage of total annual Hotham flow increases linearly with ore throughput rate; for the year 1979 (the lowest recorded flow), the relationship is not linear. This different pattern reflects the fact that in median years reservoir capacity tends to limit pumping (i.e. pumping is reduced or stopped as reservoir(s) fills, even when Hotham water is available), whereas in low flow years like 1979 pumping is constrained more by the availability of Hotham water (i.e. reservoir(s) may not be filled).

This modelling assumes that no pumping occurs when the streamflow is less than the minimum level prescribed by the Water Authority Licences for both the Boddington Gold Mine and Hedges Gold Mine for extraction of water from the Hotham River. Both operators have agreed upon a strategy for sharing the water resource when streamflow is greater than the prescribed minimum (342 kL/h), but less than the prescribed minimum plus the sum of both licensed maximum rates of pumping (4,542 kL/h).

Management of extractions for a 6 Mt/a Boddington Gold Mine operation would continue to be facilitated through operation of a small crump weir jointly constructed, in consultation with the Water Authority, on the Hotham River approximately 200 m upstream of the Boddington Gold Mine pump station (Figure 3.1). The weir allows gauging of river flows below about 13,000 kL/h, and thus quick changes in pumping rates in response to varying flow. Data from the weir are currently obtained by manual observation, but it is planned to install telemetering equipment to allow real-time access to flow data from both the Boddington Gold Mine and Hedges Gold Mine sites. This strategy for management of water extraction for the two mining operations was recently approved by the Minister for Water Resources, as required by the State as a condition of the approval for the 1988 expansion of the Boddington Gold Mine and the development of the Hedges Gold Mine.

Both Boddington Gold Mine and Hedges Gold Mine have Hotham-pumping strategies based on withdrawal of most of the annual requirements during the high-streamflow months of June, July and August. During this period, which generally accounts for more than 50% of the total annual streamflow in the Hotham River, the amounts of water extracted constitute only a small proportion of the total Hotham flow.

Thus, the environmental impact of the increased pumping on the ecology of the Hotham River and on downstream users would not be significant. The impacts of increased pumping on the biological values of the Hotham River were addressed in WAPL's 1987 application to the Water Authority, which resulted in the existing licence to pump to 2,200 kL/h.

4.2.2 Additional Water Supply Reservoir

The proposed additional Water Supply Reservoir and access road would be totally contained within private land. Construction of this reservoir and access road would require the clearing of about 58 ha of vegetation, comprising primarily Wandoo Woodland (*Eucalyptus wandoo*), with small pockets of Yarri (*E. patens*) and Flooded Gum (*E. rudis*) vegetation in, and adjacent to, the gully system, fringed by open Jarrah-Marri (*E. marginata-E. calophylla*) forest on the slopes. Two seasonally inundated swamps supporting tall shrublands of *Melaleuca* species also occur within the proposed clearing zone, one fringed on the slopes by a tall shrubland to open scrub of the mallee Eucalypt species *Eucalyptus hypochlamydea* Brooker subsp. *ecdysiastes* Johnson et. Hill (m.s.) and stands of *E. aspersa* Brooker and Hopper (m.s.): the former mallee species is scattered in similar locations throughout the Jarrah Forest, and the latter is found in small pockets through the region (e.g. on Mt. Saddleback). It is proposed that seed from these mallee species be collected prior to clearing operations and used in post-construction and mine area rehabilitation programmes where appropriate.

It is expected that sufficient borrow for the construction of the dam would be sourced from within the impoundment area. The borrow may be supplemented with mine waste if required.

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m.s. - denotes manuscript name, which should not be used in any scientific publication without first checking with Mr I. Brooker of CSIRO and Dr S. Hopper of the Department of Conservation and Land Management.

Pipelines between the Water Supply Reservoir and the proposed additional reservoir would follow existing cleared corridors and the new reservoir access road. Therefore, the construction of these pipelines would not result in any significant additional clearing beyond that required for other works.

The impoundment area of the new reservoir would inundate an existing groundwater monitoring bore (GRC 5). A new bore would be established upstream of the reservoir, in consultation with the EPA and the Water Authority.

The Joint Venturers have not as yet formulated any firm plans to decommission the new Water Supply Reservoir after it is no longer required for the operation of the Boddington Gold Mine. At the appropriate time, discussions would be held with the State and Bunning Bros Pty Ltd to determine a mutually acceptable decommissioning strategy. In accordance with one of the conditions of the EPA Report and Recommendations (Department of Conservation and Environment 1985) for the original (3 Mt/a) operation, topsoil would be salvaged from the area of inundation, for use in rehabilitation programmes following project decommissioning.

4.3 METALLURGICAL TREATMENT PLANT

The environmental impact of the additional facilities and upgrading of existing facilities for the possible expansion proposal would not be significant: all components except the possible extension of the ROM stockpile area would be contained inside the perimeter fence of the existing Plant Site; the ROM extension and the new administration building would involve clearing of up to 0.85 ha.

4.4 RESIDUE DISPOSAL

As discussed in Section 3.4, the performance of the residue management system to date indicates that the Residue Storage Area would be capable of containing the residue from at least 60 Mt of processed ore. There would be an increase in residue level of approximately 4.0 m above that for 45 Mt of processed ore.

The rate at which residue would be pumped to the Residue Storage Area would be increased, resulting in a slightly lower density of the deposited residue because of the reduced time allowed for drying, underdrainage and evaporation from residue beaches.

Application of a monthly water balance model, average rainfall and evaporation data and the known settling characteristics of the residue indicates that a 6 Mt/a operation would result in a final average solids content of 60.9%. This compares with 61.3% solids estimated for the 4.5 Mt/a operation and 61.7 for the original 3 Mt/a operation. This reduction in average density of the deposited residue would not significantly affect the stability of the Residue Storage Area, particularly in relation to access for rehabilitation. Figure 4.1 shows the predicted residue density for ore processing rates of 3.0 Mt/a, 4.5 Mt/a and 6.0 Mt/a during the life of the project.

The lower average residue density would result in negligibly small changes in the potential for salt and water seepage from the Residue Storage Area (cf. Section 8.3.3 and Appendix H of the April 1987 EMP). The modelling used in assessing potential salt and water seepage does not take account of the better than expected performance to date in residue beaching and separation of reclaim water, and therefore tends to overestimate the residual moisture content of residue.

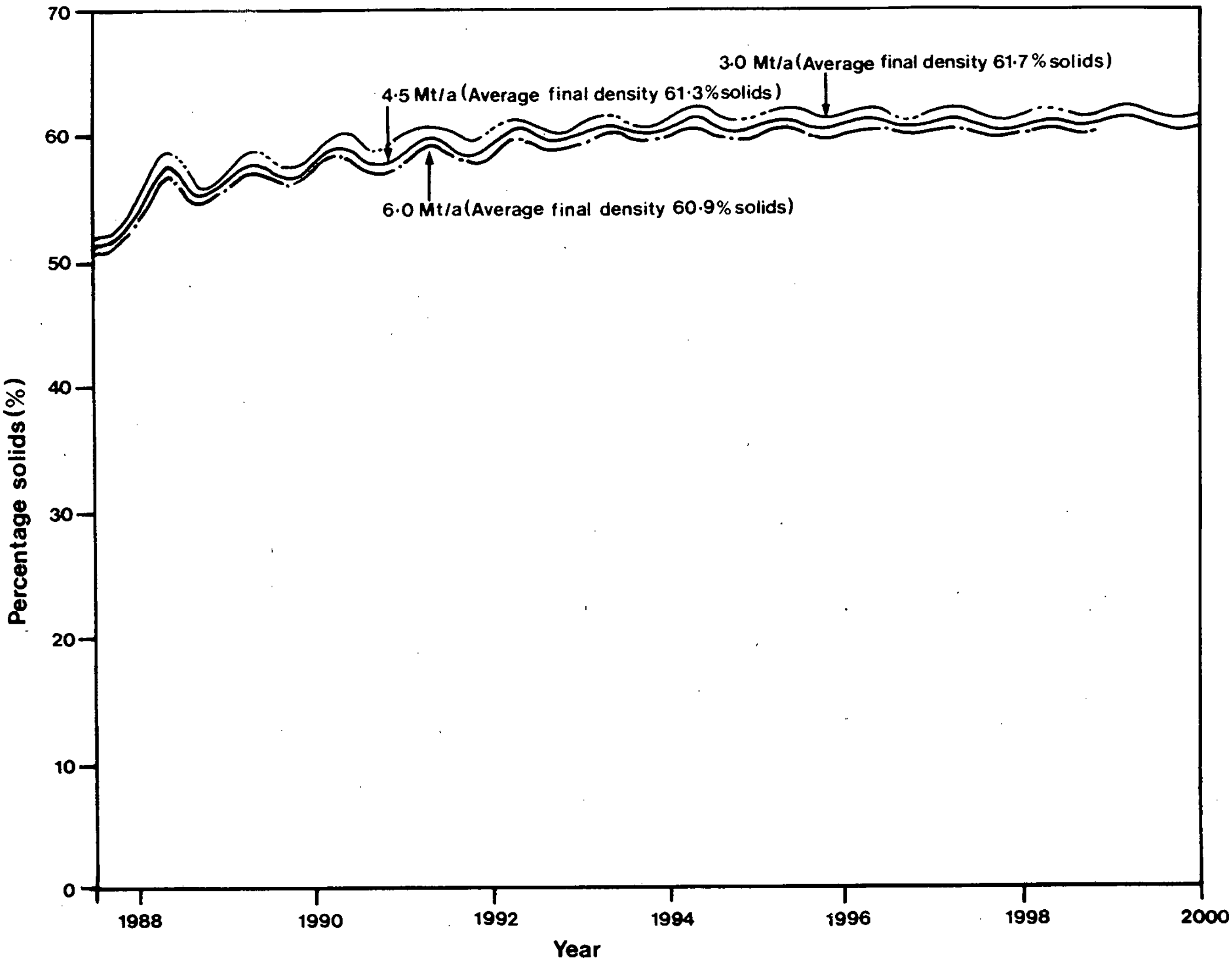

FIGURE 4.1

PREDICTED RESIDUE DENSITY

5 ENVIRONMENTAL MANAGEMENT

An extensive programme of environmental management for the Boddington Gold Mine has been documented in detail in the April 1987 EMP, which was approved by the State Government in June 1987; that programme was subsequently supplemented by the conditions of the State's approval in February 1988 of the enhancement (4.5 Mt/a) that is currently in progress. The policies, procedures and commitments of the April 1987 EMP would apply to the proposed expansion (6 Mt/a).

Monitoring of the terrestrial and aquatic ecosystems would continue to assess the impact of operations on flora and fauna. Results of this biological monitoring programme would continue to be regularly reviewed, enabling the early development of changes to management and procedures, to minimize the impact of project activities on the environment.

The existing ground and surface water monitoring programmes, detailed in the April 1987 EMP and in the conditions of the Licence issued under the terms of Section 57 of the Environmental Protection Act, 1986, are considered to be adequate for the proposed expansion of facilities.

To prevent the release of residue and reclaim water from the Residue Disposal and Reclaim Water Pipelines into the environment, containment ponds have been constructed at low points along the corridor. These containment ponds have sufficient capacity to store the quantity of residue and reclaim water produced by fifteen minutes' flow of one pipeline at the design residue discharge rate or reclaim water pumping rate, plus any material within the pipeline that can gravitate to those points.

Rehabilitation of the project area would be carried out in accordance with the Joint Venturers' agreements with Bunning Bros Pty Ltd and in consultation with the State where privately-owned land is involved, and as agreed with the Department of Conservation and Land Management in State Forest areas.

The EMP (Worsley Alumina Pty Ltd 1987a) documented a comprehensive set of environmental management commitments (Section 9) which have been adhered to in the design, construction and operation of the Boddington Gold Mine. None of the aspects of the proposed expansion to 6 Mt/a would affect the integrity of these commitments. The Joint Venturers restate their commitment to environmental management, in accordance with the April 1987 EMP, for the proposed 6 Mt/a operation.

REFERENCES

Department of Conservation and Environment. 1985. Worsley Alumina Joint Venturers - Boddington Gold Mine proposal - Report and recommendations by the Environmental Protection Authority. Bulletin No. 219. Perth: Department of Conservation and Environment.

Worsley Alumina Joint Venturers. 1985. Boddington Gold Mine - Environmental Review and Management Programme. Perth: Worsley Alumina Joint Venturers.

Worsley Alumina Pty Ltd. 1987a. Boddington Gold Mine - Environmental Management Programme. Prepared by Kinhill Stearns/BHP Engineering, April 1987. Perth: Worsley Alumina Pty Ltd.

Worsley Alumina Pty Ltd. 1987b. Boddington Gold Mine Project - Enhancement of facilities - Notice of Intent. October 1987. Perth: Worsley Alumina Pty Ltd.

ABBREVIATIONS

CIL	carbon-in-leach
CSIRO	Commonwealth Scientific and Industrial Research Organization
DICL	ductile iron cement-lined
EMP	Environmental Management Programme
EPA	Environmental Protection Authority
ERMP	Environmental Review and Management Programme
NOI	Notice of Intent
ROM	run-of-mine
WAPL	Worsley Alumina Pty Ltd

Prepared by:

Kinhill Engineers Pty Ltd
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APPENDIX A
MODEL OF THE WATER SUPPLY SYSTEM

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MODEL OF THE WATER SUPPLY SYSTEM

A1 DESIGN CRITERIA

The design of the original water supply system for Worsley Alumina Pty Ltd 's (WAPL's) Boddington Gold Mine Project was based upon results from a simple computer-based water balance model for 3 Mt/a. This model allowed the estimation of both the size of the major components of the water supply system and the effects of the Boddington Gold Mine Project on the Hotham River system, but did not take into account any other major users of Hotham River water. The model used actual and simulated data from the sequence of low-rainfall years 1973 to 1981, as well as estimates of plant production and reclaim rate at the proposed production rate of 3 Mt/a.

Since this initial work, Alcoa of Australia Ltd (Alcoa) has commenced development of the Hedges Gold Mine, with planned production of a nominal 2 Mt/a, which will also rely on water supply from the Hotham River. Accordingly, the water balance model has been refined to incorporate the effects of the Hedges Gold Project on the existing water supply for the Boddington Gold Mine and on possible upgrade options. Both projects are expected to be fairly similar except for the size of their operation, and hence the estimated water requirements of the Hedges Gold Mine have been based on it being a scaled-down version of the Boddington Gold Mine, assuming that:

- the height/area/volume curves are the same for each reservoir, although the capacities are different;
- the plant process water requirements, reclaim and potable water requirements are in similar proportions.

The model balances the water supply inputs and outputs for each mine, incorporating:

- direct reservoir rainfall
- estimated catchment yield
- Hotham River pumping
- evaporation
- pumped withdrawal to plant
- spillway overflow
- dam seepage.

The objective of the modelling is to determine, using a particular rainfall scenario, the reservoir volume and Hotham River pumping rate that ensure a continuous supply of water for production.

A2 HOTHAM RIVER FLOWS

One of the main sections of the model takes into account the actual flow in the Hotham River during each month of the modelled period, and proportions the allowable pumping between the projects when necessary.

Proportioning the available flows in the Hotham River requires the definition of a number of river 'flow levels':

- the unrestricted pumping level
- the proportional pumping level
- the minimum allowable level.

When the Hotham River is flowing above the unrestricted pumping level, the two mines can pump at their licensed maximum rates (at present, WAPL: 2,200 kL/h; Alcoa: 2,000 kL/h), unless either (or both) of their reservoirs is full. However, when the river flows fall below this unrestricted level, the available water must be proportioned by some method.

The model uses 'throughput rate' to proportion pumping below the unrestricted level (i.e. 4.5 Mt/a : 2 Mt/a). Gauging of Hotham River flows at the crump weir, upstream of the Boddington Gold Mine pump station (see Section 4.2.1 of main text), will facilitate regular adjustment of pumping rates by Boddington Gold Mine and Hedges Gold Mine to maintain the minimum flow prescribed by the Water Authority of Western Australia. When river flow falls below the minimum allowable level, no pumping from the river is allowed by either mine.

The model firstly determines whether the water available in the Hotham River in a particular month is:

- more than the unrestricted pumping level
- more than the proportional pumping level
- more than the minimum allowable level.

Depending on this flow level, the model then removes water from the river, based upon:

- availability of river water
- proportions allocated to the mines
- volume already in the reservoirs.

In practice, if any of the available flow is not required by a particular mine, it could go to the other; however, to be conservative, this has not been assumed in the model.

To determine water supply requirements, the model has been run with actual Water Authority streamflow (Hotham River) records for the period 1966 to 1987, inclusive. Within this time-frame, the period 1973-81 represents the worst 'drought' sequence, and has therefore been used as a 'worst case' of limiting water supply.