Summary of Changes to Proposal

Since the publication of the s46 Environmental Review, RNO have continued to pursue various project configuration options with the view to minimising the potential for harm to employees, impact on the environment and disturbance to the community, while maximising the economic benefits.

The most significant change to the project scope has been possible after securing a binding option to purchase two farms to the east and immediately adjacent to the previously reported project boundaries. This, coupled with the purchase of the adjacent mining tenements, has allowed for further optimisation of the project layout, which has lead to significant benefits specifically in the areas of clearing of vegetation and transportation.

Relocation of Process Facilities

With the purchase of the two farms immediately to the east of the Halleys and Hale-Bopp mining areas, investigations were conducted into the feasibility of moving the process plant to this new eastern location. These investigations concluded that the alternate site was no less geo-technically suitable for plant construction. After taking into account the other advantages of this location the decision was taken to move the process facility.

Halleys West Waste Dump

As a direct result of the movement of the process plant, a further round of mine scheduling was conducted to support the new location. This resulted in the removal of the waste dump to the west of Halleys, along with other associated ore handling equipment such as conveyors and ROM pads, to the eastern side of the pits. Significantly, this constrains waste dumps to the eastern side of Halleys and not both the east and west.

Road Access

Road access to the site for raw materials and product transported to and from Esperance was previously from Jerdacuttup Rd, which necessitated the movement of material down this road, and significantly for the local community, past the Jerdacuttup primary school. Access to the new process plant location is now directly from the South Coast Highway, with no requirement for any project related heavy vehicle traffic to pass the Jerdacuttup school.

Tailings and Evaporation Ponds

The purchase of additional land and mining leases has allowed RNO to re think the strategy for tailings and evaporation pond construction, now that the project is not critically land constrained. This has resulted in the development of a second option, in addition to the option discussed within the s46 Environmental Review document. The key differences between the two options are staged development of tailings storage areas, coupled with multiple smaller evaporation cells, which could also be developed in stages.

Production Capacity

To strengthen the financial viability of the project, modifications have been made to the production profile, specifically in the early years. These modifications have been possible following improvements in the efficiency of utilisation of the resource; importantly increases in production do not require any additional clearing than what was proposed in the s46 Environmental Review. The production during the initial years will now peak at approximately 50 000 tpa of contained nickel, rather than 45 000 tpa of contained nickel as detailed in the review document. Reductions resulting from improved efficiencies in key reagent usage, mean that transportation rates are not affected by this increase in production.

In all cases RNO believes that modifications made to the project since the publication of the s46 Environmental Review have resulted in a positive benefit to the community and the environment.

Specific responses to submissions received during the consultation process are addressed below.

KEY CHARACTERISTIC	APPROVED PROJECT	REVISED PROJECT	POTENTIAL ENVIRONMENTAL IMPLICATIONS OF REVISED PROJECT
Project Life	~ 20 years	~20 years	No additional impacts. However, it should be noted that not all the numbers from the 1998 Consultative Environmental Review (CER) and subsequent Schedule 1of the Ministerial Statement Number 509 reflect a 20 year Project life.
Size of Deposit (at cut off grade of 0.5% Ni)	60 Mt	See Below	No new environmental factors introduced. The resource to support the full Project life of approximately 20 years is now defined.
Nominal size of Resource (at cut off grade of 0.5% Ni)		183.3 Mt	
Halleys	NA	66.9 Mt	
Hale-Bopp	NA	25.2 Mt	
Shoemaker-Levy	NA	91.2 Mt	
Mining Rate – maximum *Mining Rate (ore) - average*	4.0 Mtpa	18.8 Mtpa 10.0 Mtpa	Faster mining rates are required to maintain production rates in Project life when ore grade has declined and stripping ratio has increased. This means there is a faster growth of waste stockpiles, potential for more noise associated with mining activities and traffic on haul roads within the Project area. Because of the faster mining rate progressive rehabilitation of the backfilled pits and waste stockpiles can commence sooner. Other key characteristics highlight the environmental implications of the above changes.
Beneficiated concentrate production (average) *Beneficiated ore production (average)*	1.8 Mtpa	3.8 Mtpa	No new environmental factors are introduced and no new commitments are required. There is an increase in the rate of utilities consumption, and consumption of reagents.
Acid leach throughput	1.8 Mtpa	3.8 Mtpa	No new environmental factors are introduced and no new commitments are required. There is an increase in the rate of utilities consumption, and consumption of reagents.
Maximum depth of mining	50 m (from edge of pit)	60 m (from edge of pit)	No new environmental aspects introduced. All pits will be above groundwater level so no dewatering will be required. The depth of mining is the maximum depth to the base of the pit from the edge of the pit. Rehabilitation and landform management will be the same as previously outlined.
Tailings Storage area – ground level footprint	144 ha	460 ha	The impacts and management section on tailings disposal covers the potential environmental impacts. The footprint of Tailings Storage Area approved in EPA

KEY CHARACTERISTIC	APPROVED PROJECT	REVISED PROJECT	POTENTIAL ENVIRONMENTAL IMPLICATIONS OF REVISED PROJECT
Tailings Storage Areas – final surface area	115 ha	460 ha	Bulletin 930 was based on the Halleys deposit only. The indicative figures for ground level footprint of the Tailings Storage Area are for a 20 year mine life using a stacked Tailings Storage Facility, taking into account mining of Shoemaker-Levy and Hale-Bopp deposits. Although the area of direct impact has increased, the facilities will be built on cleared farmland, have a lower vertical profile and water content than a dam and be designed to meet DMPR Guidelines as a minimum.
Evaporation Pond – maximum likely area	144 ha	250 ha	
Water Supply Source	Seawater		There are no new environmental aspects associated with increased seawater uptake. The management commitments for detailed investigation into the potential impacts on seawater abstraction and brine return are still applicable. A qualitative marine survey undertaken in February 2000 noted that construction impacts of the intake/outfall would be temporary. A Marine Study (SKM 2000c) indicated dispersion of brine would occur within 4 m of the outfall. To reduce environmental impacts the intake and outfall locations are to be located together on the western part of Mason Bay ~ 700 m east of Mason Point. Design of intake pipeline is under review to further minimise the potential for environmental impacts.
Operations Water Supply Source		Seawater	
Construction Water Supply Source		Groundwater	
Operations Water Supply – raw water (average) (35,000 mg/L Total Dissolved Solids)	13,000kL/d	~30,000 kL/day	
Operations Water Supply – process/ potable water (210mg/L Total Dissolved Solids) The process/potable water is included in the total "***Operations*** water supply – raw water"	6,000 kL/d	NA – included in above	
Water Supply – groundwater extraction (maximum)		2,500 kL/d (~ 20,000TDS)	Groundwater has been nominated for use during construction, with the bores to be kept open during operations and potentially used as recovery bores for the evaporation pond. In the 1998 CER, groundwater was flagged as a potential source of water for the entire Project. By opting for the seawater option, the Project impacts from groundwater extraction have been reduced. The commitments in the previous environmental approval relate to the higher groundwater use as depicted in the 1998 CER. RNO will comply with these commitments in relation to groundwater use and management.
Energy generation – installed capacity *Current configuration is 2 x 2 MW diesel engines and 3 x 18 MW steam turbines (two in use, one standby)*	60MW	58 MW	No implications to environmental management or impact. As per a commitment from Ministerial Statement 509. RNO have undertaken air dispersion modelling based on adopted process design criteria using one year of meteorological data from the on-site automatic weather station (installed since 22 September 1999). Increased sulphur is required due to the increase in plant capacity, however this has a positive effect because it enables more steam (no greenhouse gas
Energy generation – normal (power	40MW		

KEY CHARACTERISTIC	APPROVED PROJECT	REVISED PROJECT	POTENTIAL ENVIRONMENTAL IMPLICATIONS OF REVISED PROJECT
station) *Energy generation – from diesel engines*		4 MW	has a positive effect because it enables more steam (no greenhouse gas emissions) to be generated from waste heat recovery from the acid plant and hence a lower requirement for energy generation from fossil fuel burning.
Energy generation – from steam turbines (acid plant)	12 MW	32 -45 MW	
Energy consumption – (combination of diesel power station and recovered steam power from acid plant)	Not defined	36 MW	
Limestone	300,000 tpa	200, 000 tpa	The limestone is now to be sourced locally, within 25 km of Project site, as compared to the approved source, described in 1998 CER as Rawlinna. Limestone haulage is now limited to local shire roads within 25 km radius of the Project rather than the South Coast Highway. Pilot scale testwork has demonstrated that lower limestone quantities are required to meet the neutralisation targets.
Sulphur	220,000 tpa <1.8kg SO_2/t acid produced	500, 000 (max) <1.8kg SO_2/t acid produced	Increased sulphur use will have a direct impact on road transport to site. Total SO_2 emissions from the acid plant will increase; however the rate of SO_2 produced per tonne acid will remain at <1.8kg SO_2/t acid. No new commitments are required to cover the management of gaseous emissions.
Diesel (includes mining)	59,000 tpa	15,000 tpa	The anticipated quantities of diesel use are significantly lower due to a more efficient power station configuration developed for the revised Project. No new commitments are required.
Workforce construction (including mining)	900 people	1,200 people	A social impact assessment has been undertaken to assess the implications for the community and community infrastructure caused by the construction and operational workforce. DMPR is also working with the community to assess the multi-user community infrastructure and services needs of the Shire of Ravensthorpe given the potential for the population to increase significantly with the Project going ahead.
Workforce operations (including mining)	250 people	300 people	
Pit Area (combined total)	199 ha	1068 ha	The definition of reserves at Shoemaker-Levy and Hale-Bopp means that the total area of disturbance defined for the Project has increased from that previously approved. The potential impacts on vegetation, priority flora and fauna within the other two deposits are discussed elsewhere in this document.
Pit Area -Halleys	199 ha	205 ha	

KEY CHARACTERISTIC	APPROVED PROJECT	REVISED PROJECT	POTENTIAL ENVIRONMENTAL IMPLICATIONS OF REVISED PROJECT
Pit Area - Hale-Bopp	Not Defined	197 ha	Maximum potential area disturbed for Shoemaker-Levy South resource is 220 ha.
Pit Area - Shoemaker-Levy	Not Defined	666 ha	
Limestone Quarry Area- Tamarine	Not Defined	67 ha	The limestone deposit will require clearing of a small area of degraded remnant vegetation on predominantly historically cleared farmland. All commitments for rehabilitation, flora conservation and dieback will be adhered to for the limestone quarry.
Plant Area *Hydrometallurgical Process Plant (including Beneficiation Plant)*	25.4 ha	53 ha	The plant site is now located on existing historically cleared farmland rather than in the Bandalup Corridor as approved in 1999 EPA Bulletin 930. The location of the process plant site relative to the nearest residents is approximately 6 km. It is proposed to locate the beneficiation plant adjacent to the process plant instead of within the Bandalup Corridor with this area included in the size of the plant area. An ore conveyor will transport ore to the beneficiation plant from Halleys Run of Mine (ROM) pad.
Conveyor	N/A	10 ha	No new environmental impacts are introduced. Clearing is required, however this has been reduced as a result of the new eastern plant location and is constrained more to the east.
Ore Stockpile Area includes ROM pads (combined total)	18 ha	35 ha	No further commitments to manage the impacts will be required. Groundwater, surface water, landform/visual amenity, rehabilitation aspects for the stockpile areas are adequately covered by existing commitments. Larger ore stockpiles may be required at Hale-Bopp and Shoemaker-Levy due to the requirement to treat limonite and saprolite ore separately), at this stage it is anticipated that extra stockpiles can be accommodated on top of waste stockpiles.
Stockpile Area – Halleys	18 ha	12 ha	
Stockpile Area – Hale-Bopp	Not Defined	12 ha	
Stockpile Area – Shoemaker-Levy	Not Defined	11 ha	
Overburden Storage Area – waste dumps (combined total)	65 ha	469 ha	The total overburden storage area will increase due to addition of the two new deposits although the existing commitments are sufficient to manage any potential impacts. Groundwater, surface water, landform/visual amenity, rehabilitation aspects have commitments that can be related to these overburden storage areas.
Overburden Storage Area – Halleys and Hale-Bopp (excluding backfilled areas)	65 ha Not Defined	231 ha	
Overburden Storage Area – Shoemaker-Levy	Not Defined	238 ha	

KEY CHARACTERISTIC	APPROVED PROJECT	REVISED PROJECT	POTENTIAL ENVIRONMENTAL IMPLICATIONS OF REVISED PROJECT
Accommodation Village	~25 ha	~25 ha	The footprint of the accommodation village creates no new environmental factors and no new commitments are required. RNO's philosophy of a residential workforce during operations is being communicated to the community and stakeholders. The accommodation village will shrink to a smaller size during operations with the majority of the workforce being located within the adjacent regional communities.
Nickel Production ***Nominal** nickel production (contained nickel in a mixed nickel cobalt hydroxide intermediate)*	30,000 tpa	Up to 50,000 tpa	The increase in production feeds into other key characteristics. The product is a nickel cobalt hydroxide intermediate rather than nickel metal. The mixed hydroxide averages 170, 000 tpa with a maximum of 220,000 tpa being produced in the early years.
Cobalt Sulphide Production	2,200 tpa	NA	Cobalt sulphide will not be produced; the cobalt will be contained within the mixed nickel / cobalt hydroxide product.
Transport Rate to site	675,000 tpa	855,000 tpa	Transport rate will increase, however no new environmental factors are introduced and no new commitments are required. The transport section of this document covers the proposed management.
Transport Rate from site (product)	32,200 tpa	Up to 220,000tpa	Transport rate will increase. No new environmental factors are introduced and no new commitments are required.

General

1. *Although some areas of concern exist, the proponent is commended for the effort that has gone into the environmental review process. The proponent has demonstrated the importance it places on community consultation and interaction. It has also produced a document that is very thorough and easy to read.*

While RNO agrees with the comment that significant effort has gone into the s46 Environmental Review process, it is also worthwhile mentioning that RNO recognises the sensitivity of the environment in which it is proposing to develop the Ravensthorpe Nickel Project (RNP). This sensitivity includes not only the traditional environmental issues, which are the subject of this approval process, but also the social issues that need to be addressed as an integral part of project development. While the effort required is significant, RNO believes that a successful outcome for both the community and RNO is dependent on this continued level of mutual effort. This interaction and involvement will not be limited by statutory requirements, but will continue through the remainder of the environmental approvals process and into operations.

Further details of these programs are included within this response.

With respect to our community liaison program, RNO has engaged a full time public liaison manager for the past two and a half years. Due to the relatively small size of the populations within the study area, he has been able to become on a first names basis with many people within the Ravensthorpe Shire. RNO has also implemented a number of important initiatives that have enabled information flow and feedback to RNO from the community. These include “one on one” meetings with our fence line neighbours and other key stakeholders, community presentations, a 1800 free telephone call service and the establishment of a Community Liaison Committee. RNO is also a member of a whole of Government Infrastructure Coordination Committee. Although we recognise the need for continual improvement we believe that our community programme to date has been proactive and positive.

The process of gaining environmental approvals is deliberately structured so as to enable a sequential process of approvals as and when more specific data becomes available for the project. As more detailed design data is available more specific standards and targets are set by the authorities. It should be noted that the approval granted at the end of the s46 review will contain broad conditions and standards that must be met, rather than specific operating conditions that would be expected to form part of the works approval.

While there is no statutory obligation for community consultation for either the Notice of Intent (*Mines Safety and Inspection Act 1994*) or Works Approval (*Environmental Protection Act 1986*), RNO will continue public consultation during this time to ensure that interested members of the community have access to this information.

2. *The current proposal represents a misuse of Section 46 provisions of the Environmental Protection Act 1986. Despite the suggested benefits outlined by the proponent, the project should now be assessed at the level of a Public Environmental Review. It is unacceptable that approval granted for small-scale mining operation can be transferred across to a project, which will have impacts at a regional level.*

The approval process for the modified proposal is something that was beyond the direct control of RNO. Having said this, RNO believes that the level of approval chosen was appropriate, with regard to all of the changes, both positive and negative, to the project as compared to what was previously approved. The other two choices other than the s46 Environmental Review was for a direct transfer of approval, which is clearly not appropriate, or for the project to be completely reassessed at the level of a PER. The quality of documentation and the level of public review of the document produced, would in the opinion of RNO, satisfy what would have been the requirements for a Public Environment Review had that been the level of assessment chosen.

Information contained within the Section 46 Environmental Review was provided in relation to all aspects of the modified proposal, not just those aspects that had been significantly changed. The review document was made freely available to any member of the community who requested a copy, to date over 100 hard copies and 20 CD copies have been distributed. In addition to the full Section 46 Environmental Review document RNO also produced and distributed over 1000 copies of a Community Summary Report of the full review document.

To say that the previously approved project was a 'small scale mining operation' is incorrect. The previous project included the mining and processing of ore into final nickel metal and cobalt products. The removal of final product processing part of the project (solvent extraction, electrowinning and hydrogen sulphide production) has significantly reduced the potential for both impacts to the natural environment as well as to human health. While it is true to state that the original approval was for the Halleys deposit only, the other two deposits were mentioned as inferred resources in the CER (page 6 Description of Proposal and Fig 2 Location Map). The CER stated that these other two deposits would be the subject of separate environmental approvals.

The RNP as detailed in the 1998 CER was unable to conduct any life of operation planning, as the resource life had not been defined. Consequently the size of key infrastructure such as the Tailings Pond was sized for the Halleys deposit only.

RNO considers that the inclusion of all three deposits and the removal of the back end refining parts of the project has reduced the potential for environmental harm. This coupled with the ability to develop and implement life of operation planning result in a more defined and sustainable use of the Ravensthorpe resource than what was previously proposed.

3. *There have been major changes to the proposal assessed by the EPA in 1999, including:*

   - *an increase from one to three ore deposits, with an increase in area from 199 ha to 1068 ha;*
   - *an increase in the size and capacity of Tailings Storage facility, evaporation pond, and waste rock dumps;*
   - *addition of a limestone quarry; and*
   - *transport of an intermediate nickel product through Esperance Port.*

   The proposed commitments are insufficient to address the impacts of this larger project and the EPA should set conditions that reflect this change to a larger proposal.

As is detailed in the response to point 2 above, the previously approved project was for the Halley's deposit only, the associated infrastructure was also only sized to process the Halley's deposit. The project presented as the subject of this review includes all three deposits, with equivalent supporting infrastructure also sized for the life of operation. The full scope of the project is now defined up front prior to commencement.

The local establishment of the limestone quarry further increases regional employment opportunities as well as removes the need for long distance haulage of this material.

RNO believes that the commitments made as part of the s46 review, and those that have been added or modified after consideration of comments on the s46 review are appropriate. A modified list of commitments to that provided in the s46 review is provided as Attachment 1.

4. *There were problems in getting access to the environmental review document during the review period and so the EPA should have advertised an extension to the review period.*

RNO have not been made aware of these problems, all requests for copies of the s46 Environmental Review were fulfilled. As detailed in the response to comment 2 above, to date over 100 copies of the hard copy document and 20 copies of the CD were freely distributed during the comment period. In addition to this, RNO generated a Community Summary Report of the s46 Environmental Review, of which over 1000 copies were distributed within the Ravensthorpe and Esperance Shire. In addition to the distribution of documentation, RNO also delivered three presentations within the region, to the Esperance Port Development Consultative Committee, to the Ravensthorpe Nickel Project Community Liaison Committee and third one to the Jerdacuttup Community Association at the Jerdacuttup Hall. All three of these presentations were given in the first week of the review period, were well attended and well received.

RNO also offered to deliver similar presentations to both the Shire of Ravensthorpe and the Shire of Esperance but these were declined.

In addition to the above the DEP continued to accept submissions on the s46 review well after the stated closing period of the review. This position is supported by RNO.

RNO believes that it has exceeded all applicable statutory requirements for provision of information; in line with it's stated community consultation philosophy.

5. *As it is expected that the mine will be worked for some twenty years, it should be a requirement for the operation to be re-assessed at least every seven years. As well as being necessary to accommodate changes in understanding and standards, it is felt the proponent would also welcome the opportunity to demonstrate the environmental compatibility of its operation on and on-going basis.*

A standard condition normally imposed on projects commits them to conducting a Performance Review every five to six years, covering the following broad topics;

- To document the progress towards achieving targets;
- To review the success of goals, and to set objectives and targets for the next reporting period; and
- To evaluate general environmental performance over the reporting period.

In addition to the above, and in keeping with best practice environmental management, RNO will also complete a number of other additional annual auditing and reporting requirements, these are;

- All BHP Billiton controlled sites must have an Environmental Management System (EMS) certified to ISO 14001, an international standard for environmental management systems. As a core requirement of certification, the EMS needs to be externally audited every six months for at least the first three years. To enable an EMS to be certified to ISO 14001, the company must be able to demonstrate to the certifying body, that it has identified all significant environmental aspects, which have the potential to cause significant environmental impact. Further, the company must also be able to demonstrate that it has systems and management plans in place to control those aspects. RNO will include the results of these certification audit reports in its annual performance report.
- In addition to the ISO 14001 certification audit reports, the Stainless Steel Materials division (where RNP would report) of BHP Billiton produces an annual public (currently in it's third year) Health, Safety, Environment and Community performance report. This report details specific performance criteria including emissions, analysis of both positive and negative events, of its operations during the previous twelve months. The report also details what targets have been set for both the coming year and also strategically for the years ahead. These reports are freely distributed to among others, the local community including and fence line neighbours that border our operations.

Transparent reporting of environmental performance is already an integral component of the proposed RNO management philosophy.

Flora and vegetation

6. *The Department of Conservation and Land Management's (DCLM) is reasonably satisfied with the outcomes in relation to conservation of floristic diversity, provided appropriate detail is included in subsequent management plans to DCLM's requirements. DCLM has worked closely with the proponent and the Environmental*

Protection Authority Service Unit in reviewing specific aspects of the amended project in relation to impacts on flora values. (DCLM)

RNO believes that the proposal as represented in the s46 Environmental Review is a realistic balance between protection of important environmental values and the social and economic benefits arising from the development of the project. As stated in the above, the proposed management strategies detailed in the review were arrived at after detailed discussion with the Department of Environment Protection (DEP) and Department of Conservation and Land Management (DCLM).

7. *All management plans relating to flora and vegetation should be to the EPA's requirements on the Department of Conservation and Land Management's (DCLM) advice. Specific consideration needs to be given to geotechnical stability and hydrological function (direct and indirect impacts) with respect to the K. Similis conservation zone. (DCLM)*

RNO agrees with this statement, the commitment in relation flora and vegetation management plans has been modified to this effect.

8. *It is unacceptable to leave the Hale-Bopp pit as an excavation. It should be refilled and contoured as close as possible to the original, so that ecosystem processes including water flows (both surface and underground) can be re-established. The long-term survival of the Kunzea similis and Eucalyptus purpurata communities will be otherwise jeopardised.*

RNO recognises the importance of protecting *Kunzea similis* and *Eucalyptus purpurata* populations that remain post mining, so that they are self sustaining. An important element in this plan is to ensure that surface and groundwater regimes are re established post completion of mining to support these important communities.

Further mine planning completed to support the relocation of the process plant to the eastern side of the pits has resulted in additional backfilling being possible, to the extent that the Halleys pit is completely backfilled and Hale-Bopp is back-filled to a large extent. RNO will continue to work towards the entire back-filling of the Hale-Bopp pit but the final amount will depend on practical mining constraints. Contouring of the backfilled pits will aim to as closely as possible resemble the pre-disturbance profile.

9. *The buffer zone between the Hale-Bopp pit and the Eucalyptus purpurata ms and Kunzea similis communities is too narrow and raises concerns for the long-term viability of these communities. The pit nodes between the Kunzea similis conservation area, and another to the east of the access road and midway along and adjacent to the community, are of particular concern. For ecosystem function to be maintained, it is imperative that these two extremely rare communities remain linked by a minimum 500 m wide corridor of original, native vegetation and that a buffer zone of at least 100 m width surround each community without any roads/tracks/pits through these zones. In addition, these communities should remain linked by (i) a minimum 1 km wide corridor from the Kunzea similis conservation area westwards to the main Bandalup Corridor, and (ii) a minimum 500 m wide*

linkage along the east side of Halleys to Mining Reserve 26290,(i.e. the HY-East waste dump must be relocated to cleared land east of Halleys).

As per comment 8 RNO recognises the importance of protecting *Kunzea similis* and *Eucalyptus purpurata* populations that remain post mining so that they are self sustaining. The establishment of appropriate buffer zones around the remaining populations is an important element in this process. Future mine planning will also include balancing the buffer zone established around these populations and the corresponding reduction in ore reserve, and consequently the viability of the project. The current minimum buffer zone around these populations will remain at 50 meters with the potential for expansion should mine planning considerations permit.

The requirement for linkage of these two populations is not clear; works completed to date indicate that this is not a requirement for successful pollination or survival of the respective species.

The requirement for unimpeded linkage from the *Kunzea similis* conservation area to the west and east may be possible after completion of future detailed mine planning and pit design. The reason for the need for this is unclear, other than potentially for general ecological function. Other than the maintenance of soil-plant-water relations, the only other significant short-term issue is pollination of *Kunzea similis*, which has been shown to be an insect pollinated species. The impact of the mining process on pollinators is likely to be minimal. Longer-term impacts are considered to minimal / negligible post completion of rehabilitation.

RNO is confident that the current management regime for *Kunzea similis* and *Eucalyptus purpurata* will be successful in protecting these populations; future activities will build on this current proposal.

10. *The siting of waste dump HY-East is unsustainable. It is unacceptable to demolish more native vegetation and further contract the Bandalup Corridor for a waste dump when there is cleared land less than 1 km away. Land should be bought/resumed from the adjacent landholders for dump HY-East. Melaleuca coronicarpa 'gorse' has been recognised as a significant species — a large proportion of the known populations will be buried under the proposed HY-East dump.*

RNO cannot, and would not be involved in the resumption of land, all land purchased to date has been after agreement of an appropriate sale price with the owner, future purchases of land would be on the same basis.

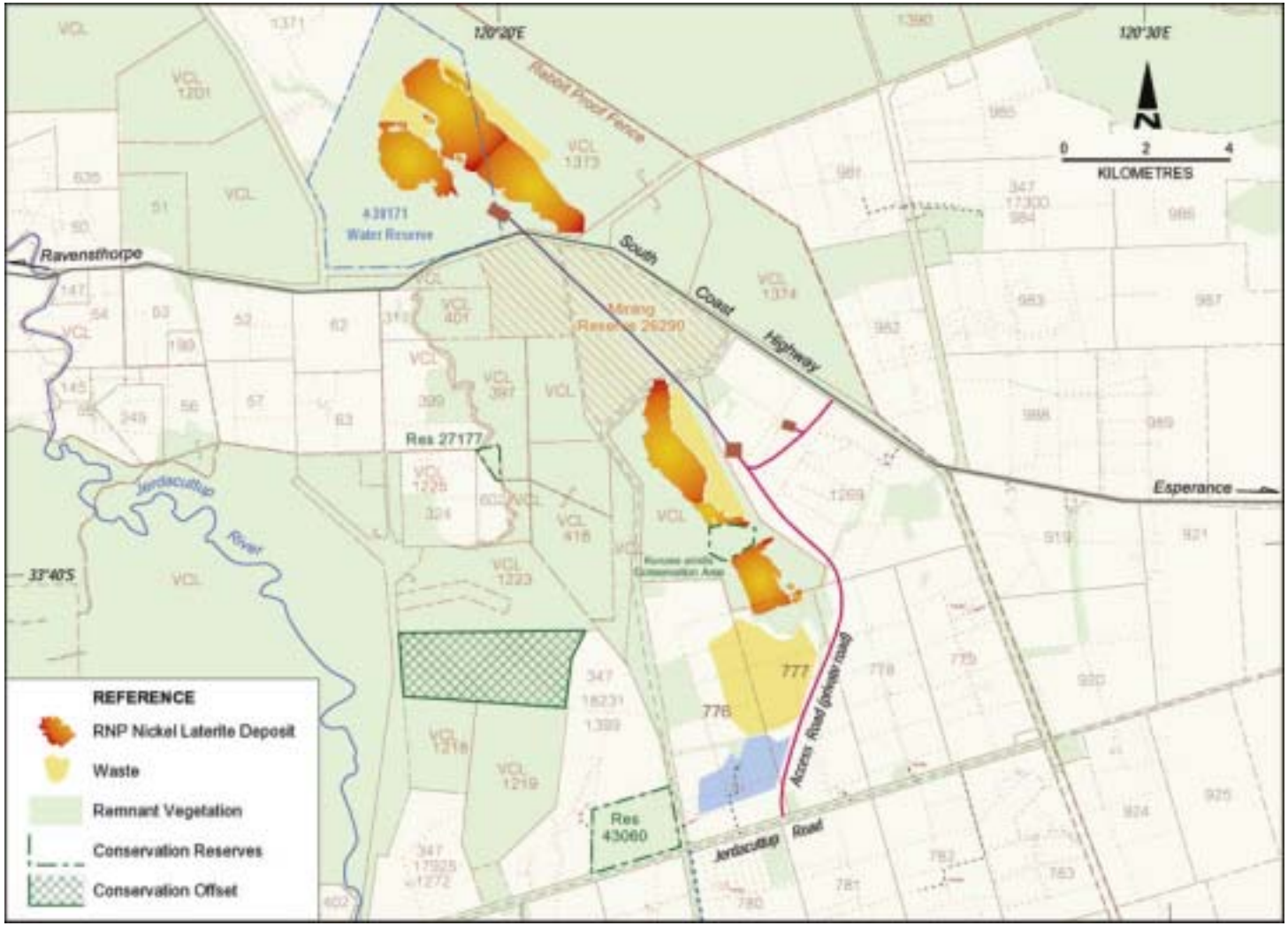
The Bandalup Corridor will already be disturbed through development of the mining areas, therefore the narrowest margin of the corridor is to the west and not the east. Siting of these waste dumps on the eastern side of the pits will not further contract the corridor.

The location of waste dumps in relation to the ore body is directly proportional to cost, the further the waste dump is away from the ore body the higher the cost. Location of the entire Halleys East waste dump on cleared land, would make the project uneconomic. As per the response to comment 8 and 9 RNO recognises the value of remnant vegetation that occurs within the project leases, future mine scheduling will aim to

minimise the area of land that is required to be cleared for mine development, this will include this Halleys East waste dump.

As shown in Fig 1, relocation of the processing facility to the eastern side of the site has allowed the removal of the Halleys West waste dump and associated ROM pads at Halleys and Hale-Bopp. This means that now all project development is focussed on the eastern side of the ore bodies and not on both the eastern and western sides.

Fig 1 Conceptual Process Plant and Mine Layout



11. *The Land Conservation District Committee is not convinced that priority species (particularly Kunzea similis and Eucalyptus purpurata) will be satisfactorily protected and ask that a meeting be held between RNO, DCLM, The Ravensthorpe Wildflower Committee, local Herbarium, members of the State Herbarium, Ravensthorpe LCDC and other interested parties to discuss this matter.*

RNO has always and will always, be receptive of comments and suggestions from interested members of the community, community groups and regulatory authorities, that improves the outcome of what RNO is proposing to implement. RNO and its advisors, in consultation with the DEP and DCLM, have given a lot of thought to the management and protection of not only *Kunzea similis* and *Eucalyptus purpurata,* but all priority species as well as general remnant vegetation.

The establishment of the *Kunzea similis* mining exclusion zone (in conjunction with other identified conservation initiatives) along with the commitment to back fill as far as practical mine voids, demonstrates that RNO is acutely aware of the importance of, in particular, these two identified priority species.

RNO would make itself available to attend a meeting organised by the Ravensthorpe Land Conservation District Committee, to discuss it's plans for the management and protection of vegetation, including *Kunzea similis* and *Eucalyptus purpurata*.

12. *Abstraction of groundwater may be detrimental to local swamps and remnant vegetation. The water table and soil moisture should be monitored. Transects in undisturbed natural vegetation and wetlands within the groundwater draw down area should be established and monitored. Agreement to depth of decrease negotiated and ongoing liaison with the Waters & Rivers Commission.*

The construction water supply borefield currently consists of five saline production bores within the Jerdacuttup palaeochannel. Groundwater abstraction during construction, which will occur for approximately two and one half years, with total abstraction from the five bores ranging from 2000 to 2500 kl/day of saline water. The proposed conservative abstraction rates proposed are those that are considered sustainable for the duration of the construction period only. Monitoring of bore performance during construction will allow for a more applicable longer term abstraction rate to be determined, should these bores be used to either supplement process water requirements, or are utilised as part of a contingency plan for seepage recovery.

Groundwater modelling completed to date, has shown that even at the proposed maximum (2000 kl/day) abstraction rate there is little chance of impact on the saline Jerdacuttup river pools. It is predicted that the cone of depression will in fact, from a local environmental perspective, have a positive benefit in that it will lower the local water table sufficiently to eliminate the seasonal saline seepage that currently occurs in the vicinity of Masons Bay Rd at the head of the Montario Creek system.

Regardless of the options chosen, groundwater will be managed to ensure that abstraction is sustainable for the life of the project, and in a manner, which protects the environment, and local pastoral needs. It will be necessary to provide the Waters & Rivers Commission (WRC) with relevant technical documentation to support this claim.

A monitoring network consisting of 22 bores has been installed and a monitoring program developed and implemented. All bores are monitored for water levels, salinity (TDS) and pH, samples of groundwater are collected on a regular basis and laboratory analysed for a comprehensive suite of parameters. Groundwater monitoring will continue throughout the construction and operation phase, as well as playing an important role in demonstrating that decommissioning criteria have been met.

While the existing groundwater monitoring network is considered sufficient to provide reliable baseline information within the immediate vicinity of the mining and processing operations, it is recognised that additional sites external to the mining leases would also be beneficial. If the Project is approved, the existing groundwater monitoring network will be expanded to augment the existing program, outside of the mining leases. The length of time between Project approval and the commencement of commissioning is approximately three years, this is considered to be sufficient to baseline these additional new locations.

As with all monitoring and management programs a continued assessment as to its effectiveness is conducted, and any applicable modifications are made. It is expected that during the life of the project a number of modifications to the management program will be required.

13. *It is recommended that the EPA and the proponent give due consideration to expanding the Rare and Priority Flora surveys to include comprehensive vegetation mapping in a regional context to provide input into flora and vegetation management decisions. This extension of the existing commitment should not require significantly higher levels of effort.*

    Prior to mining commencing it is recommended that the proposed management of significant vegetation communities be reviewed in the light of any further available knowledge from the expanded surveys.(DCLM)

RNO has been conducting regional surveys for Priority flora *Kunzea similis* and *Eucalyptus purpurata* in order to locate populations external to the mining lease.

RNO has discussed the above comment with DCLM and has agreed that if any of these populations are identified then detailed vegetation assessment, including soil profiling, will be conducted. This information will be provided to DCLM as it becomes available.

If survey work leads to gaining information that would have implications for existing management plans, then the management plans would be amended, it is expected that these management strategies may be amended many times during the life of the project.

14. *It is recommended that DCLM, DEP and DMPR collaborate to produce a detailed vegetation map of the System as the Ravensthorpe System mapped by Beard (1973) is not detailed enough to determine the degree of representation of different communities in the region.*

RNO agrees with this suggestion and would offer any applicable information that it holds to assist in this project.

15. *The statement (Page 8) that "all vegetation communities are well represented in the region" is incorrect. Craig and Chapman (1998) list four communities of special interest, and numerous surveys since then have failed to find significant areas of two of them, i.e. the Eucalyptus purpurata community and the Eucalyptus flocktoniae – Melaleuca coronicarpa 'gorse' community. The former should be listed by DCLM as a Threatened community (p.123, p.261). The latter requires further taxonomic work (p.261) to determine whether the 'gorse' form should be recognised as a separate species/subspecies, and if so, ground surveys to determine the distribution and extent of the 'gorse' form.*

RNO agrees that a typographical error was made; the statement should have read, " all **major** vegetation communities are well represented in the region".

The *Eucalyptus purpurata* ms community on the SE side of Bandalup Hill is not represented elsewhere although it's constituent significant species (*Pultenaea* sp. Bandalup P1, *Beyeria* sp. A Ravensthorpe, *Leucopogon pleurandroides* P2) are found on carbonate influenced soils adjacent to Bandalup Hill, Hatfield Rd, Mason Bay Rd and the intersection of Lee and Jerdacuttup Rd. The *Eucalyptus purpurata* community on Bandalup Hill will be protected from significant disturbance associated with project development.

Melaleuca coronicarpa 'gorse' is very common and dominant in the south eastern portion of the Ravensthorpe Ranges and on mafic hills between Ravensthorpe and Bandalup Hill (Cockerton and Craig 2000).

Although the pit areas and surrounding waste rock dumps disturb this area during the life of the mine, there is a vast area of this community that will not be disturbed by the Project. Due to its locally common nature it probably does not warrant priority status (Cockerton and Craig 2000). It has been estimated that this species at Bandalup Hill, while being locally common, would represent significantly less than 10% of the total area of distribution. This community is still recognised as important fauna habitat for the western whipbird and the heath rat and will be reincorporated in rehabilitation.

Eucalyptus flocktoniaea is a very widespread mallee of the Esperance – Malcolm areas. The co-existence of these two species in the Bandalup-Ravensthorpe region is coincidental and does not in any way constitute a specific association that would be considered of conservation significance. Neither the joint association nor the individual species forming this association are limited to the Bandalup Corridor.

The *Eucalyptus flocktoniae - Melaleuca coronicarpa* 'gorse' mallee heath community represents approximately 30% of the vegetation community area on Bandalup Hill. During mine development, a small part of the pit and majority of the waste dumps are planned to overlay parts of this community.

As detailed, it is understood by RNO consultant ecologists that the *Melaleuca coronicarpa* " gorse" is far more widespread than currently published reports indicate. While it is recognised that there is still not a clear delineation of this taxon from other closely related species, currently planned and underway annual ecological survey work in September and October of this year will collect flowering vouchers of this species to facilitate further taxonomic work as is suggested in the submission above. The results of this work will be included in the annual survey report, and if necessary, included in the vegetation management plan.

16. *It is unclear how much total vegetation will be cleared as a result of this project. Adding up the areas in the Bandalup Corridor (1 730 ha), on farmland and road reserves (890 ha) gives a total of 2 619 ha, yet this does not take into account additional clearing that may be involved in finding a landfill/remediation site nor the amount buried under overburden.*

The level of clearing was best summarised in Table 3.2 of the s46 Review, as detailed above the total level of clearing within the Bandalup corridor currently stands at 1730 ha, although all practicable means are being explored to reduce this level. The use of farmland, while included in the s46 as a disturbance, could hardly be included as clearing of vegetation, as the vegetation has long since been cleared. The placement of 'overburden', or waste rock as it was called in the s46 review, is included in the 1730 ha and will not require any additional clearing.

The location of a landfill site has yet to be chosen, RNO's current preference for the operations phase is to support the development of an appropriately located and sized engineered landfill that would also be utilized by the Shire. If an appropriate external site is not available, then RNO will develop it's own facility for it's own use on currently cleared land or on land currently identified to be cleared.

17. *The use of saline water dust suppression and its implications for vegetation health requires detailed and comprehensive review by the proponent for the EPA's consideration. (DCLM)*

The Project is faced with no practicable alternatives to the use of saline water for dust suppression, RNO believes that the use of saline water for dust suppression can be managed to prevent unnecessary disturbance to adjacent vegetation.

A brief search of literature shows that very little research has been undertaken as to the impacts on vegetation of saltwater used for dust suppression. Anecdotal evidence suggests that the primary mechanisms for impact would include:

- Over-spray of saline water from road watering operations; and
- Transport of built up salt from the road surface in water run-off during rainfall events.

In most cases it would be suspected that 'shadow effects' on vegetation from water inundation or starvation, caused by altering pre existing drainage regimes are far more significant. Specific control measures that could be applied to control impact, and which are successfully used in other mines include;

- Use of dribble – bars rather than spray bars on water trucks to prevent over-spraying;
- Appropriate awareness training for water truck drivers to prevent over watering;
- Construction of appropriate drainage channels and catchment areas along roads to minimise salt loads associated with the first flush after significant rainfall; and
- Use of a chemical dust suppressant to reduce the volume of water that needs to be applied for dust suppression.

RNO will design roads with appropriate catchment diversions that are able to capture the first flush of rainwater and entrained salt from the road surface. Operators will be trained

as part of commitment to implement an ISO 14001 certified EMS, best available techniques will be included within the training program.

Saline water is used extensively within the Goldfields region for similar applications and where appropriately managed causes no significant effects.

RNO will continue to investigate the use of chemical dust suppressants that reduce the volume of water that is required for dust suppression, and will implement any cost effective measures identified.

RNO will also investigate the use of lower salinity bore water from the construction bores as dust suppression water. This assessment will critically need to establish the sustainable yields of each bore, pumping data gathered during construction abstraction will be of great benefit for this assessment.

18. *Insufficient information has been provided on the ecology and volume of remnant native vegetation that will be removed through development of the limestone quarry. Why are there conservation covenants on some parts if the vegetation is of poor quality, as is claimed. Also, the limestone expression inland is likely to coincide with the presence of plants that may be uncommon or endemic to such deposits and further survey work is necessary to ascertain this. In addition, rehabilitation plans for the quarry should be provided.*

Remnant vegetation was surveyed during the annual surveys in spring 2000 (Cockerton and Craig 2000). A conclusion of this survey was that the small areas of remaining remnant vegetation have very little ecological value with the exception of an area on the southern extreme of the property, which is covered by a conservation covenant. Areas of remnant vegetation on the property that have conservation covenants covering them will not be disturbed as part of limestone pit development.

When an area of vegetation is covered by a conservation covenant it is fenced for protection from grazing livestock, those areas of vegetation not protected by fencing are subject to grazing and are therefore normally of poor quality. The comment in the s46 Environmental Review in relation to vegetation quality was in relation to the vegetation that would need to be cleared for quarry development.

No priority, DRF or otherwise significant taxa were recorded on the deposit, those species that were recorded are listed below.

It is recognised that prior to ground disturbance activities a further survey will need to be conducted to quantify the distribution of vegetation identified in the first survey along with the collection of seed.

Preliminary rehabilitation criteria for the quarry was included within the s46 Environmental Review, it is expected that the rehabilitation plan for the quarry will form part of the rehabilitation plan for the main project area, and therefore would be developed at the same time.

Table 1 Systematic Species List Tamarine Rd Limestone Deposit.

Family	Genus	Species
Poaceae	Austrostipa	sp
Poaceae	Neuracne	alopecuroidea
Cyperaceae	Gahnia	lanigera
Cyperaceae	Mesomelaena	stygia subsp stygia
Cyperaceae	Indet	sp
Cyperaceae	Indet	sp
Casuarinaceae	Allocasuarina	scleroclada
Proteaceae	Hakea	commutata
Proteaceae	Hakea	ruscifolia
Mimosaceae	Acacia	latipes subsp latipes
Papilionaceae	Chorizema	aciculare ssp aciculare
Papilionaceae	Chorizema	cyctoides
Rhamnaceae	Indet	sp
Rhamnaceae	Indet	sp
Rhamnaceae	Indet	sp
Dilleniaceae	Hibbertia	sp
Myrtaceae	Beaufortia	schaueri
Myrtaceae	Chamelaucium	megalopetalum
Myrtaceae	Eucalyptus	falcata (possible hybrid)
Myrtaceae	Eucalyptus	kessellii
Myrtaceae	Eucalyptus	sp
Myrtaceae	Eucalyptus	sp
Goodeniaceae	Dampiera	sacculata
Goodeniaceae	Velleia / Goodenia ?	sp
Asteraceae	Indet Genus	sp

19. *The pits and dumps of the limestone quarry should be redesigned to disturb far less vegetation (E.g. the topsoil dumps in Figure 2-5 should be located on the southern side of the access road). There is also inadequate information on the location of limestone within the site and whether it could be sourced only from cleared land.*

As is detailed in the response to comment 18, the quality of the remnant vegetation is not good, therefore little additional expense is justified to avoid clearing this vegetation. As is also detailed in the response to comment 18 and detailed in Figure 2-5 of the s46 Environmental Review a number of areas within the block of land are covered by conservation covenants, these areas will not be disturbed as a result of limestone mining.

Figure 2-5 clearly shows the known extent of limestone existing on this property, this has been determined after drilling and preliminary mine planning.

20. *Insufficient attention is paid to the risk of introduction and spread of weeds (Page 134). The Flora and Vegetation Management Plan should be drawn up in consultation with DCLM and a draft be made available to the community, consultative committee, and any other interested parties, should they desire to comment. The implementation of the plan should be a condition of operation on the mine.*

RNO appreciates the need to keep the area under it's operational control as free from weeds as is practicable. The s46 simply stated what the current baseline is, i.e. that the mining area is free from weeds but that a number of declared species exist within the region.

The highest potential for the introduction of weeds exists during construction, where the level of activity on site is at it's peak, with vehicles continually entering the site. Key management activities planned to prevent the spread of weeds will include the following;

- Obtaining local knowledge on the control of locally prevalent weeds;
- Management of access to Project areas;
- Implementing vehicle hygiene measures;
- Inspecting all disturbed and rehabilitated areas for weeds, especially after rainfall;
- Awareness training for all field and mining personnel on weed identification;
- Revegetation of RNO owned cleared land not required for infrastructure; and
- Progressive rehabilitation of disturbed areas.

Where weed infestations do occur, weed control measures such as spot spraying would be expected to be successful.

21. *The pipeline from Masons Bay to the mine-site should be buried in Masons Bay Road itself and so not require any additional disturbance of vegetation. This is particularly important since bushland that is now restricted to fragments on roadsides and paddock remnants in this area is critical to biodiversity conservation, including the south westernmost occurrences of Eucalyptus stoatei and the only known occurrences of E x stoatraptera.*

Installation of the pipeline beneath the surface of the road will make the initial construction and ongoing maintenance extremely difficult, and would constitute a

significant safety hazard for other road users during construction and subsequent maintenance activities. Installation of the pipeline will be undertaken in such a way as to minimise the impact on any remnant vegetation that exists within the road reserve, and where possible would be conducted within already cleared firebreaks.

Eucalyptus stoatei is currently listed as a P3 species and consequently not widely distributed. The reserve at the junction of Mason Bay rd and Jerdacuttup rd is the only significant population known from current survey work, although this species has not been targeted, impacts on this population will be avoided where possible.

Eucalyptus x stoataptera is currently listed as a P2 species and consequently not widely distributed. Survey work completed to date has not found any occurrences of this species, although this species has not been targeted.

Prior to the construction of the pipeline, a vegetation survey of the pipeline route will be undertaken, and the results used to develop an installation plan developed based on minimising the impact on priority flora.

22. *How often will the seawater pipeline need to be purged for maintenance, where will the water be discharge, and will this affect nearby vegetation?*

It is not expected that the seawater pipeline will require purging for maintenance any more frequently than every five years, and even then it will only be a discrete section of the pipeline. The pipeline will have isolation valves located approximately every 5 kilometres (depending on topography) this enables only the section of pipeline needing maintenance requiring purging.

The topography of the land where the section of pipeline lies, which requires maintenance, will also determine the volume of water that is required to be purged. Detailed design of the pipeline will require strategies to be developed to capture and treat this water, these have not been developed at this time.

23. *Given the large area of disturbance Best Practice management strategies for topsoil stripping and handling should be applied. An environmental operating procedure for topsoil and subsoil management should ideally include the following criteria:*

    - *Topsoil is to be stripped utilising scrapers and not bulldozers.*
    - *Plan to strip topsoil in summer (to maximise storage of germinable seed).*
    - *Strip dry and respread topsoil dry.*
    - *Double strip topsoil, remove first 5-10 cm and store/respread separately from remaining overburden.*

RNO understands the need for best practice topsoil removal and where required topsoil storage practices to be implemented.

Stripping of topsoil will be undertaken by the most appropriate means taking into account the size of the area and available equipment, it is expected that safety considerations (given the topography) will preclude the use of scrapers in most situations. It is expected that scrapers will only be able to be used when stripping relatively flat farmland for the siting of infrastructure. As part of the EMS procedures and work instructions will be developed for topsoil clearing and placement, it would be

expected to include the need to, as far as practicable, complete all stripping and respreading activities in the dry season. Topsoil would as far as practicable be kept separate to overburden material, topsoil dumps may be established on waste dumps to limit clearing required for separate dumps.

The primary aim would be to minimise the area required for topsoil dumps by direct placement of stripped topsoil on areas being prepared for rehabilitation in parallel to mine development clearance work. Direct placement also maximises the viability of the stored seed.

Fauna

24. *This Department of Conservation and Land Management requests that Commitment 16 be extended to include an ecological study of the heath rat, funded by RNO, to improve knowledge on:*

    - *basic species ecology (at what age do animals commence breeding, seasonal breeding triggers, numbers of offspring);*
    - *habitat preferences (review the current considered opinion of the animals preference for long unburnt vegetation habitats and whether this is an actual reality or a predation avoidance strategy or any other scenario currently not determined);*
    - *average individual animal movement capability (this is important information for determining the likely size of animal territories and population densities in preferred habitats, and important information to consider for the translocation of animals from the proposed mine site pre-disturbance);*
    - *population trends across its known range (this is important information in determining whether the species is fox predation sensitive and is, or is not, responding to predator control programs i.e. Western Shield and whether current low trap capture rates are a reflection of climate or otherwise, or whether the species truly occurs in low density in the field);*
    - *understanding the possible occurrence of the heath rat using results from the recent Satellite imagery and vegetation preference study (further analysis of this project and overlay into the FRNP Biosphere area may assist in predicting the extent of potential favoured habitat areas and therefore the extent of occurrence); and*
    - *predicted total population numbers in order to be able to accurately define local mine site, and therefore regional, impact implications upon the species.*

    This work could be undertaken through a combination of DCLM input and PhD study.(DCLM)

RNO supports the collection of additional information on the Heath Rat and would be prepared to support a thoroughly planned and considered PhD (or other suitable research project). To this end, RNO proposes that a committee, including any nominated supervisors, develop a detailed framework for the proposed study. As part of this work, RNO would like to see the committee examine DCLM's extension to the commitments in more detail to define those aspects that are still left unanswered by the regional review (already sponsored by RNO and currently being finalised). In particular, there is some

question over whether some of the recommendations proposed by CALM (eg points 2 and 3 in comment 24) can be answered given the low capture rates of Heath Rats and the variability in capture rates of rodents in general.

In addition, RNO will also continue it's commitment towards achieving a greater understanding of the fauna in the vicinity of it's operations through it's ongoing fauna monitoring program.

RNO support for this program has been formalised as commitment 16a.

25. *This Department of Conservation and Land Management recommends that the conveyor service road should also form the general access to the South Coast Highway. Consideration should be given to speed limits to assist in minimising road kills in this area. (DCLM)*

The current RNO design uses the same road for the service road for the conveyor and general access to the South Coast Highway. Appropriate speed limits for the service roads and employee education programmes will be implemented to minimise the number of road kills.

26. *The report indicates that there were no stygofauna species discovered in the mining area, and notes that mining activities will not venture below the groundwater table where stygofauna communities could be located. It is important that the EPA in its assessment process acknowledge that stygofauna species were not found to be present in this area to be mined. (DMPR)*

RNO agrees with this statement.

Groundwater

27. *Management of groundwater is an extremely important feature given the proximity of the Scarlet Pear Gum Nature Reserve (No 43060) to the location of the proposed tailings storage facilities. It is recommended that:*

    - *The design and monitoring program for the groundwater monitoring network requires review by the Water and Rivers Commission Hydrologists. Groundwater monitoring should commence as early as possible prior to mine commissioning.*
    - *The groundwater recovery system adjacent to the evaporation pond should be installed prior to mine commissioning unless it can be clearly demonstrated that there is no likely risk to vegetation resulting from post event installation.*
    - *Vegetation health monitoring sites should be established downstream from the tailings storage facility as part of the vegetation management plan.(DCLM)*

RNO agrees that the management of groundwater, including both quality and quantity, is very important, this would include protection of vegetation as highlighted in this comment.

- RNO has been conducting groundwater monitoring since early 2001 and includes a network of 22 bores which are monitored on a monthly basis for water levels,

salinity (TDS) and PH, samples are collected on a routine basis and analysed at a laboratory for a comprehensive suite of parameters. A copy of the s46 Environmental Review was sent to the Water and Rivers Commission and comments were received, but none were in relation to the groundwater monitoring program. The current monitoring program was developed in conjunction with experienced hydrologists, future expansions of the groundwater monitoring program would be assessed and designed on a similar basis.

- Any groundwater recovery system that would possibly be utilised in the event that the detected level of seepage warranted further action, could utilise the groundwater abstraction bores used for supply of construction water, or additional bores could be quickly established. Pump testing and groundwater monitoring during construction abstraction will provide valuable information as to the capability of the installed bores to be utilised for seepage recovery if required, expansions to this program could be installed quickly if monitoring identified the need. The pump testing and groundwater modelling that was completed in conjunction with the establishment of these bores indicates the suitability of these bore locations for this duty.
- Vegetation health monitoring sites would be installed downstream of the tailings facility and in other locations where ecological health monitoring would assist in the gathering of data to support the EMS. RNO would consult with DCLM, DEP and other interested parties as to the location of these long term health monitoring sites, these sites would be established prior to commencement of construction.

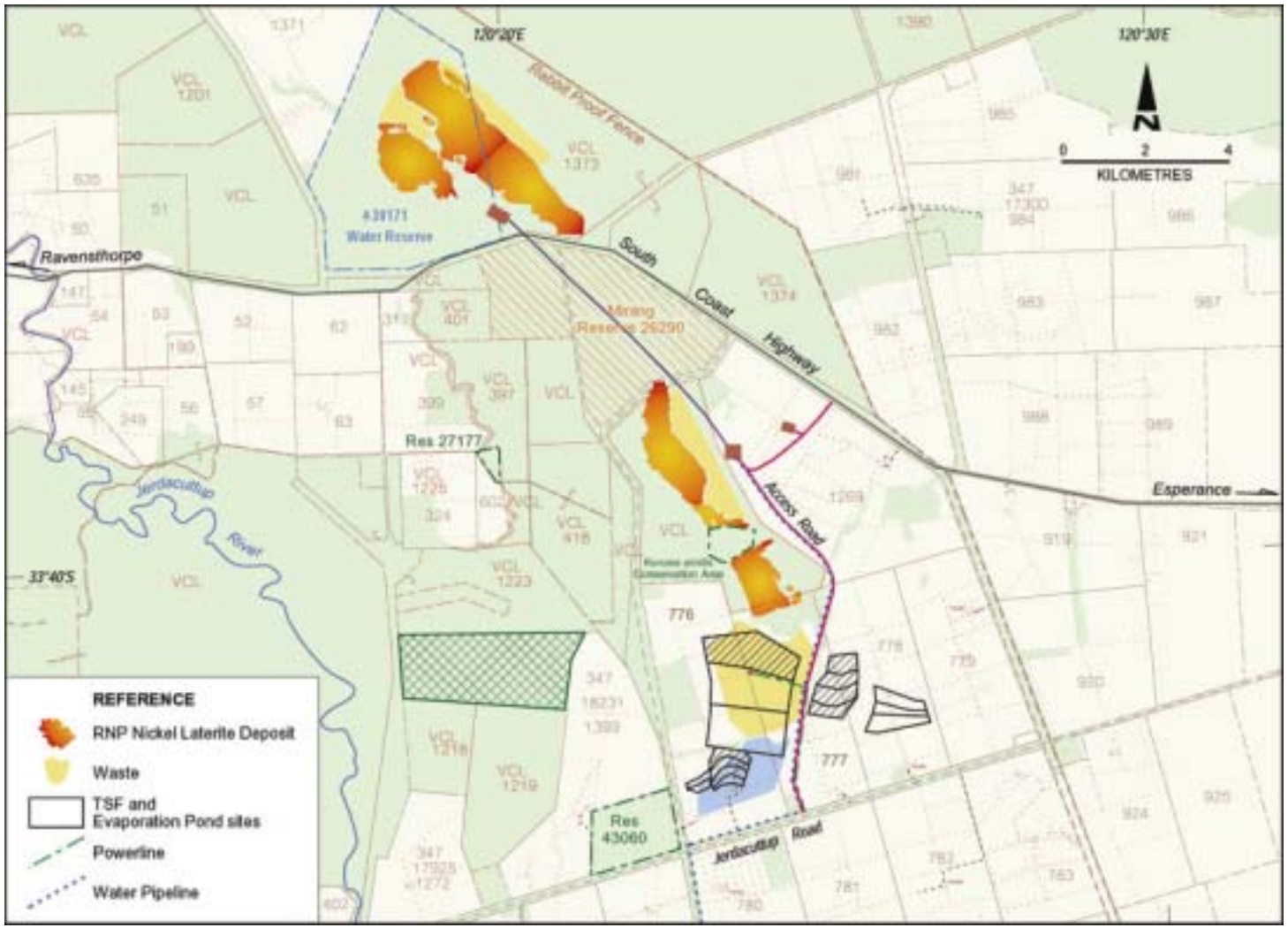
The second option for tailings and evaporation pond design and location as depicted in Fig 2 below, effectively splits the large evaporation dam into multiple smaller cells. This configuration also has the advantage of shifting the evaporation pond location away from reserve 43060. Regardless of the final option chosen the performance criteria for the two different options are the same and would include complete monitoring provisions as well as development of suitable contingency strategies.

Planned design of the tailings and evaporation pond systems would include the need to minimise seepage, criteria included within the s46 Environmental Review were as follows;

- No seepage induced rise in water table resulting in surface expression of groundwater and/or waterlogging of significant vegetation;
- No seepage induced rise in water table to within 5m of natural ground surface underlying areas of native vegetation with potential to result in deterioration of significant species;
- No seepage induced rise in water table to within 3m of natural ground surface underlying active agricultural land areas outside of the project boundary with a potential to contribute to waterlogging; and
- No detectable changes in groundwater levels in stock water supply bores as a result of seepage or groundwater mounding.

Detailed design of the tailings and evaporation pond facilities will take place towards the end of the feasibility study when all applicable testwork has been completed.

Fig 2 Conceptual Alternative Tailings and Evaporation Pond Layout



28. *Many people have concerns regarding the inadequacy of the current proposed liner design for the Tailings Storage Facility and the Evaporation Pond, particularly in respect to its ability to prevent long-term seepage. These concerns are outlined below.*

- *The preferred option (a composite geosynthetic-clay over wetted areas) does not meet RNO's seepage modelling value of 5.5 GL over the life of the mine. This value is one that RNO has determined would meet its environmental seepage criteria It is also unclear whether the seepage estimates for this option (Table 3-7) includes seepage recovery.*
- *Additional seepage to an already rising groundwater system does not protect ecosystem maintenance. The fact that adverse environmental seepage has already been caused by agricultural land clearing does not mean further preventable seepage is acceptable. The exact area where groundwater rises to within 3 m of the ground surface should be quantified in the design and monitored throughout operations.*
- *The environmental review document indicates that no liner will be used for the Tailings Storage Facility. This appears inconsistent with earlier newsletters from RNO that indicated a compacted clay or synthetic liner would be used. It is suggested that a synthetic liner over the entire Tailing Storage Facility and Evaporation Pond be used in conjunction with the composite geosynthetic-clay liner option, in order to provide maximum assurance that environmental criteria are met.*

Please refer to response 27 in regard to alternate tailings pond design and location

RNO recognises the concerns of the community, particularly in relation to tailings and evaporation pond design, and understand that it is a critical piece of project infrastructure and it must be designed and properly operated. The statutory approval process is deliberately structured so as to enable a sequential process of approvals as and when more specific information about the project is understood. Detailed design for project infrastructure has not yet commenced, which includes tailings pond design. Although a substantial amount of work has been completed to date, we will not complete the final "demonstration" pilot plant runs, which will provide the samples of tailings for detailed chemical and physical analysis, until the first quarter of 2003. It is only logical to complete the detailed design when we have all available data as to what will be coming out of the 'end of the pipe'.

The concept design that was included within the s46 was generated specifically with the view to minimise seepage. Geotechnical investigations were conducted to get an assessment of the substrate permeability, with modelling conducted to assess potential seepage impacts. The design and the seepage recovery philosophy is based on a thorough understanding of the local groundwater regime and the likely path that any seepage would take from the evaporation pond.

This proposal included the use of a synthetic liner for the evaporation pond, but seepage modelling demonstrated that there was no need for a liner for the tailings facility as it was essentially a dry facility.

The seepage estimates given in the review did not include any seepage recovery; it indicated what the predicted seepage would be without implementing further control measures.

The completion of the extensive testwork on the pilot material will ensure the most effective design is submitted for approval to the Department of Mineral and Petroleum Resources (DMPR) as part of the Notice of Intent. RNO will continue to review staging TSF construction (i.e progressive construction and rehabilitation) and liner options to ensure that the design meets of exceeds the chosen seepage criteria over the life of the operation. While there is no statutory obligation for community consultation for either the Notice of Intent (*Mines Safety and Inspection Act 1994*) or Works Approval (*Environmental Protection Act 1986*), RNO will continue community consultation during this period and ensure that this material is available to interested members of the community.

This information will include details of the testwork conducted, the proposed design and a justification for the chosen design.

29. *There is great concern that the Tailings Storage Facility and the Evaporation Pond will not be able to contain the liquor given the permeable nature of the base area, and that this will result in a chemical scald to the surrounding farmland and pollute all the surface waterways downstream of the facilities leading to the Jerdacuttup wetlands. Based on recent experience there is not much confidence that the minimum standards set by the EPA will be sufficient to prevent this occurring. The nearby RAV 8 mine has resulted in leakage of brine into surface flora and a creek system. This proposal is 10 times as large and so a much greater risk.*

Please refer to comment 28 in regards to the works completed to date in respect to tailings and evaporation pond design. Further detailed design of the tailings and evaporation pond system will not commence until the after completion of all testwork required to characterise the tailings material. This will ensure that chosen containment structure is appropriately matched to the nature of the tailings material. As was detailed in the s46 Environmental Review, planned design of the tailings and evaporation pond systems would include the need to minimise seepage, for clarification, these criteria include;

- No seepage induced rise in water table resulting in surface expression of groundwater and/or waterlogging of significant vegetation;
- No seepage induced rise in water table to within 5m of natural ground surface underlying areas of native vegetation with potential to result in deterioration of significant species;
- No seepage induced rise in water table to within 3m of natural ground surface underlying agricultural land areas with potential to contribute to waterlogging; and
- No detectable changes in groundwater levels in stock water supply bores as a result of seepage or groundwater mounding.

In order to meet the criteria detailed in the dot points above, a thorough understanding of the nature and permeability of the subsoils has already been achieved, with further works planned to support the detailed design process. When these criteria are met there is minimal possibility of the impacts occurring as detailed in this comment.

RNO is not in a position to comment on the scope of works that were completed by the RAV 8 mine prior to design, installation and operation of it's evaporation pond, nor comment on what role the regulatory authorities took in this process.

The conceptual design of the tailings and evaporation pond has been undertaken by experienced consultants on behalf of RNO, future design works would also be carried out by suitably qualified organisatios and would need as a minimum to meet the criteria defined by RNO and the regulatory authorities. It must be highlighted that it is not in RNO's interest to construct a facility that poses a risk of long term liability as this will directly affect our ability to rehabilitate and decommission the mine facilities.

RNO recognises that it will need to work with the community to alleviate any concern in relation to the construction and operation of the RNO tailings and evaporation pond system.

30. Prior to the construction and operation of the TSF the community would like the proponent to undertake further assessment of:

- *The predicted particle form and geotechnical characteristics of the tailings, including settling characteristics and settled and compacted permeabilities.*
- *A more detailed evaluation of methods to reduce tailings seepage, including the potential to install blanket drains and associated cut-offs (seepage trench) along the internal toe of the perimeter embankment; so that any liquor matter resulting from seepage or breach of the embankments may be contained and recovered.*
- *A more detailed evaluation of potential methods to remove supernatant liquor and rainfall runoff.*
- *A more detailed evaluation of potential tailings disposal options, including the option of in-pit deposition three years after the commencement of the operation.*

Also, prior to commissioning, a site specific TSF operating manual and emergency action plan should be prepared

Please refer to the response to comments 28 and 29 for the RNO general approach to designing the tailings and evaporation pond facility. Further additional responses to those items outlined in this comment are as follows;

- These are standard tests that are completed prior to commencement of design, as detailed in the response to comment 29 above, after the completion of demonstration pilot run RNO will have the appropriate samples to complete this work. The existing conceptual design takes account of such measurements completed on samples available from earlier pilot runs;

- The preference of RNO is to control the impacts associated with excessive seepage by reducing seepage at the source, the above details potential methods that can be used to capture seepage once it has occurred. The detailed design of the tailings and evaporation ponds will consider all applicable possibilities that could be used to meet the chosen seepage criteria, and implement the most applicable;

- RNO does not understand this question, and would welcome further discussion with the respondent to facilitate further understanding of the issue, and if necessary provide a response. Water that collects within the evaporation pond can be responsibly removed in one of two ways; reuse within the process or via evaporation. RNO considers that the most environmentally responsible disposal option is through evaporation as the water quality is such that re use within the process is not possible.

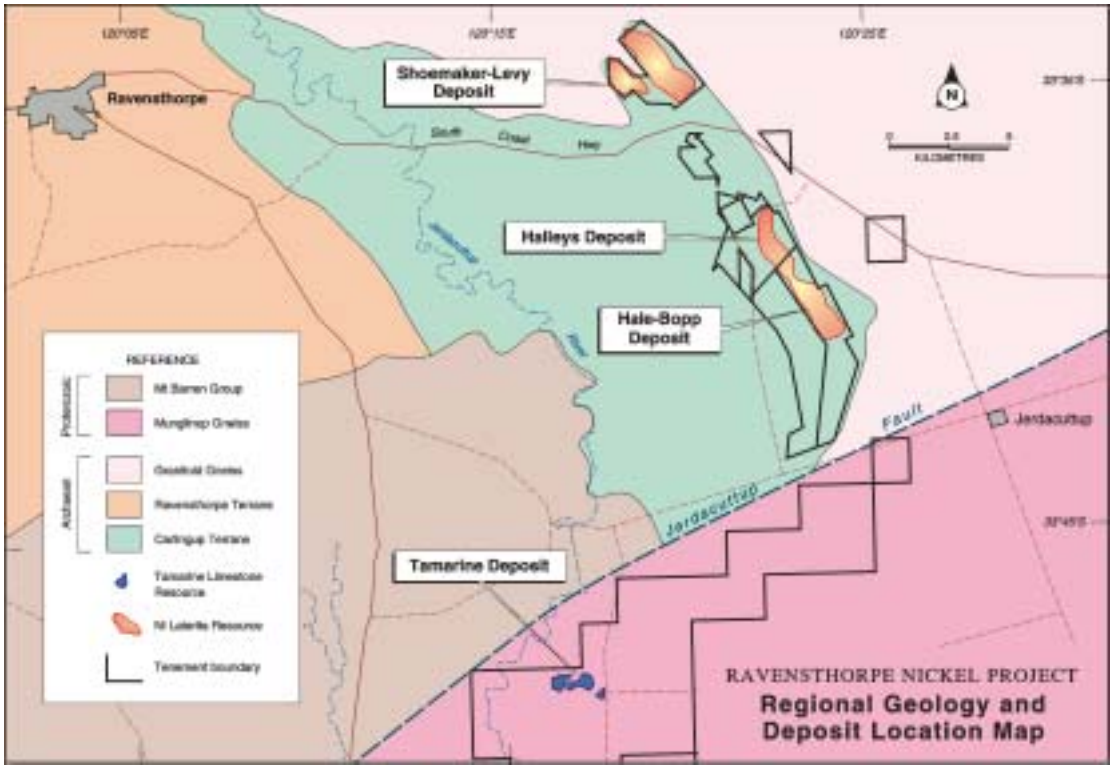
- As part of the detailed design of the tailings system, a rethink of the possible disposal options will be conducted, based on more complete characterisation of both local ground conditions and of the nature of the tailings themselves, with the most applicable taken through into detailed design prior to submission to the community for comment and to the DMPR for approval.

An operating and emergency response manual would form part of the NOI application to support the proposed design. This manual would also form part of the site EMS and would ensure that should an incident occur that a quick response to minimise the impact can be implemented. Any significant incidents of this nature would be immediately reported to the regulatory authorities.

31. *Has the design of the Evaporation Pond and Tailings Storage Facilities taken sufficient account of the existing earthquake fault line which passes through the site?*

Seismic activity is a known occurrence for the region, an analysis of the seismic data for the area will be included within the design criteria for the facility prior to the commencement of design. The actual fault line is interpreted to pass to the south of the RNP site (see Fig 3 below)

Fig 3 Ravensthorpe Nickel Project Regional Geology Map



Information received from GEOSCIENCE AUSTRALIA indicates that the earthquake experienced in Ravensthorpe in October 2001 had a focal depth of 19 km below the surface, which is uncommonly deep for Australian earthquakes. The vast majority of recorded earthquakes in the region are approximately 200-km northeast of Ravensthorpe.

The design criteria for RNP infrastructure, including tailings facilities, will include applicable seismic criteria.

32. *Has sufficient mapping of underground water systems and structural formations been conducted in view of the problems encountered with the RAV8 mine evaporation pond?*

Several groundwater studies have been conducted throughout the Ravensthorpe region by government agencies and RNO in recent years.

An extensive regional investigation was undertaken by the Waters and Rivers Commission in 1996 and included a drilling program as well as a synthesis of previous studies. The project culminated in the compilation of the Ravensthorpe 1:250 000 Hydrogeological Series Map and accompanying explanatory notes.

The Water Corporation conducted a drilling program in 1997, aimed at identifying sources of potable water to augment the Ravensthorpe town water supply. The drilling programme targeted a number of prospective sites in the vicinity of Ravensthorpe, characterised by fracture zone aquifers. The only site meeting the objectives was a bore in fractured diorite yielding about 500 kl/day of brackish groundwater (6000 mg/l TDS), located in the vicinity of the Cardingup water-supply dam.

In 1997, Dames and Moore conducted a study with the aim of reviewing the water supply options for the Project. This study identified a number of local aquifers.

A drilling program and groundwater study was conducted for RNO, carried out by AGC Woodward Clyde in 1998, confirmed the occurrence of a significant local resource of groundwater in Tertiary sediments of the Jerdacuttup and Oldfield palaeochannels.

In 2000 and then again in 2001 a construction water supply identification program was conducted by Collett for RNO. This involved groundwater exploration and installation of some monitoring bores for baseline environmental monitoring.

The sum of this information indicates that the Ravensthorpe region is characterised by an absence of major regional aquifers. Groundwater predominately occurs in the basement, tertiary-sediment as well as unconnected surficial aquifers, which would have only local significance.

Locally, groundwater at the Project site is generally contained in basement and tertiary-sediment aquifers. Minor surficial aquifers also occur in the vicinity of the Project site. The basement aquifers consist of fracture zones associated with faulting, jointing and veining mainly in basalt and quartzite. The Tertiary-sediment aquifers are composed of silt and siltstone of the Pallinup Siltstone and sands and gravels of the Werillup

Formation. The surficial aquifers comprise sandsheet, alluvial and colluvial deposits. The aquifers are not uniformly spread throughout the project site.

The Jerdacuttup and Oldfield palaeochannels, located in the vicinity of the Project site to the south and east, contain Tertiary-sediment aquifers, which are part of the regional groundwater

flow system and contain considerable resources of saline water. The Palaeochannel aquifer expresses at the surface where it underlies the Jerdacuttup River and supports river pools.

RNO appreciates that the recent experience with the RAV8 mine has left the community ill at ease with evaporation pond management. RNO is confident that the practices of BHP Billiton will far exceed the standards used at RAV 8 and ensure no material impact from RNO activities.

33. *It is believed that an underground stream flows from the Jerdacuttup area to the Oldfield river near Coxall/Springdale Roads. Monitoring bores in a circular pattern (5 or 10 km apart) are needed to determine the baseline positions and monitor any departure from this.*

It is considered highly unlikely that Jerdacuttup palaeochannel is linked in any way to the Oldfield River. The Oldfield River overlies the oldfield palaeochannel, which is also saline.

The existing groundwater monitoring network was described in section 3.5 of the s46 review, it has been designed specifically to detect any changes in baseline groundwater, either quality or quantity, once RNO operations commence. The point of installing these bores close to the possible sources of interferance, is so that prompt action can be taken should any contamination be discovered. Installation of monitoring bores 5 to 10 km away from RNO operations will have no benefit, other than potentially providing regional information in relation to general groundwater rise associated with clearing for agriculture, and associated salinity issues.

34. *In the long-term, disposal of soluble salts into the ocean may be safer than storage within the evaporation pond. There is some acknowledgement that salts could leak from the evaporation pond over the life of the mine, as there is a contingency to use recovery bores. Recovery bores are not an effective measure in the long-term once the mine is decommissioned.*

RNO considers disposal of wastewater to sea as being environmentally unacceptable.

One of the contingency measures that could be used in the advent that an unacceptable level of seepage is detected are recovery bores. These bores would recover water and return it either to the process plant or back to the evaporation pond. Evaporative modelling has shown that water within the evaporation pond will be completely removed within 3-5 years of cessation of process operations, depending on annual rainfall. Once all of the liquid has been evaporated, the remaining solid salts will be capped and the evaporation pond decommissioned. Without a liquid storage there will be very minimal seepage, so the need for recovery bores, if they were being used, would also cease not long after decommissioning.

35. *Pumping of brine into existing unsealed farm dams (refer to Page 83 of environmental review document) will cause pollution of the groundwater and salinity. Groundwater pumping should not commence until a sealed evaporation pond is established and more extensive monitoring bores install. Pre-mining monitoring is required to get base line data.*

RNO acknowledges that the statement on p83 is not as clear as it should, the current project capital estimate includes the construction of a lined dam for storage of brine generated by the desalination plant used during construction. The report acknowledges that a farm dam exists in the vicinity which could also be used for storage of brine, if the farm dam was used it would also be lined.

In regards to the installation of monitoring bores, section 3.5 of the review discusses the current baseline groundwater monitoring program, which has been operational for over three years, with figure 3.3 showing the location of installed production bores and also installed monitoring bores. All of these bores are monitored on a monthly basis, with complete chemical characterisations completed on a regular basis.

36. *What procedures will be put in place along the saltwater pipeline to detect leaks and to rectify any problem before water affects nearby paddocks or seeps into the table water affecting both the level and the salinity? For some section of the pipeline, it is actually higher than the nearby paddocks.*

The first thing to highlight is that the probability of a leak from the pipeline is extremely low and that consequent risk of it causing a significant impact as detailed in comment 36 is even lower. The pipeline will be equipped with multiple flow and pressure meters, located at least at either end of the pipeline, which will be interlocked with the pumps at Mason Bay. Any measured discrepancy, as would happen with a leak, between the flow meters would trip the Mason Bay pumps and therefore cease pumping. The leak would then be repaired prior to recommencing pumping; any consequent damage to the environment would also be rectified.

37. *The Commission has some concerns regarding the intention to use raw water for dust suppression and the potential for salinity accumulation in the soil profile from this practice. Stringent groundwater monitoring must occur via the monitoring network mentioned in the Proposed Management Commitment No. 8 (page 222). (WRC)*

Please refer to the response for comment number 17.

In addition to what is included in 17, decommissioning criteria are also detailed in Table 4.8 of the review, which describes preliminary rehabilitation and decommissioning criteria for the RNP, these criteria include an allowance for the removal of the road subsurface to facilitate rehabilitation.

38. *Will the use of groundwater for dust suppression at the limestone quarry affect the water levels or quality of nearby agricultural bores?*

All crushing of limestone will be conducted at the process site, as such limited activities other than the physical extraction of limestone will take place at the quarry. It is not expected that any significant quantities of water will be required for dust suppression, consequently it is not expected that neighbouring bores will be adversely affected. It

would be expected that in the order 0.3 Kl per day would be required for dust suppression.

39. *Detailed design of the plant processing facilities the proponent will need to ensure that appropriate bunding of vessels and recovery mechanisms to prevent contamination of groundwaters. The bunded area surrounding the autoclaves and CCD vessels will need to be sufficient to adequately contain the entire contents of the two autoclaves and vessels.*

Bunding around storage tanks will be designed in accordance with the provisions of the Water Quality Protection Guidelines No 10 for Mining and Mineral Processing, Above Ground Fuel and Chemical Storage (2000), issued jointly by the Water and Rivers Commission (WRC), the DMPR and the DEP, which provides the following recommendations.

The bunded compound should have sufficient capacity to contain leakage from storage tanks and not be overtopped during extreme storm events. The capacity should:

- Be not less than 110% of the capacity of the largest tank;
- Be not less than 25% of the total capacity of all tanks in the same compound;
- Take into account the volume of any additional objects stored inside the bund; and
- Accommodate the incident rainfall from a 72-hour, 1 in 20 year storm event; Bureau of Meteorology data for the project site estimates the 72 hour rainfall to be approximately 116mm.

It is proposed that the above provisions would apply to the sulphuric acid storage tanks, diesel storage tanks and hazardous reagent storage tanks.

Ground slabs and bunding around process liquor tanks shall be localised and limited to regions with a reasonable risk of experiencing spillage, for example around pumps, valves, tank inlets and outlets, etc. The capacity of the bunding will be determined on a case by case basis and would consider the nature of the process slurry / liquor, the safety implications, the risk of spillage, the expected source and extent of unplanned overflows or discharges, the cleanup requirements and secondary containment provisions.

In relation to the autoclaves and CCD vessels there is no requirement for the bunded capacity to hold the entire contents of all vessels, capacity will be determined based on the criteria listed above.

Surface water

40. *The value of the Jerdacuttup River has been underrated and the potential of environmental damage to the river and the impacts on local residents has not been assessed. The River is forms an important vegetative corridor linking the Coastal reserves, Bandalup Corridor and the Ravensthorpe Range. The quality of the river, its significance to local residents, and impacts on local residents, needs to be monitored from the pre mining phase through to the post mining phase.*

RNO disagrees that the value of the Jerdacuttup River has been underrated; the regional significance of the river has been a key driver in a number of design criteria for

the proposed operation, specifically in relation to the seepage control and abstraction of groundwater during construction. These criteria recognise the direct link between the Jerdacuttup palaeochannel, which passes through the project site, and the Jerdacuttup River.

A review of the Water and Rivers Commission website states that the Jerdacuttup River is a saline river of approximately 65 km in length, which lies within the Phillips – West Catchment. Flow of the river is seasonal due to sparse rainfall and the absence of significant aquifers to sustain baseflow. The website lists threats to the quality of water within the river as increasing salinisation, eutrophication (agricultural fertilisers) and siltation.

The existing RNO water-monitoring program includes one location within the Jerdacuttup River, which is monitored on a monthly basis, further opportunities for increasing the number of monitoring locations within the Jerdacuttup river will be assessed on a case by case basis. RNO would welcome any information from landholders adjacent to the river in regards to applicable locations to add to the monitoring program..

41. *The High East Dump should be redesigned to prevent disruption to the creek in this area. A very pristine creek line runs east of Halleys and Hale-Bopp pits between loc 1269 and the mining pits. The waste dump may need to be spilt in two the avoid impact on this creek and its vegetation.*

Locations of waste dumps that appeared in the s46 Environmental Review were specifically located so as to minimise disturbance on the western side of the Halleys deposit. Future works will aim to takes this a step further and minimise the level of remnant vegetation that needs to be cleared to locate waste dumps, and associated infrastructure. The primary aim will be to minimise the level of clearing required on the western side of the Halleys deposit.

The existence of ephemeral creeks or other significant drainage lines will be considered in this process.

42. *Waste rock dumps, tailings storage facilities, and evaporation pond should be designed to prevent accumulation of water at the toe of the facilities. Drainage systems should divert stormwater away from these areas.*

RNO agrees that this would be a standard design criteria.

Water Use

43. *It is not clear what the water management plan will contain or what standards for meeting water quality and water recycling will be set. There is no information on the volume or source of water that will be used for dust suppression and other uses at the limestone quarry.*

Monitoring of the groundwater resources around the Project area is essential to ensure that water quality monitoring parameters set by legislation and standards, government agencies as part of approvals and internal RNO standards are strictly complied with. Documentation on the programme together with reporting of results back to appropriate

authorities will enable maintenance of the highest possible standards of water management.

The objective of the proposed water management plan is to have a water monitoring programme that provides baseline and ongoing operational data needed to identify risks and future liabilities and to ensure that RNO activities comply with all applicable licence conditions and internal standards.

Development and ongoing implementation of the programme will assist with the achievement of environmental best practice for water management. Clearly, environmental best practice is about more that just achieving compliance with legislation. It is about cost effectively and proactively developing and implementing systems to minimise or prevent environmental impact. Stakeholder expectations of the mining industry have increased enormously and environmental performance reporting is now not only expected to include the successes but also the failures. Transparent reporting of applicable parameters measured, as part of the water management plan will be reported as part the proposed public environment report.

Please refer to the response to comment 38 in relation to expected water usage at the limestone quarry.

44. Does the proponent intend to collect runoff water form the processing plant and other cleared areas for use by the project, rather than release it into the surrounding areas?

Stormwater that falls within the process areas is considered to be possibly contaminated, and would not without prior testing be deliberately discharged to the environment. Plant site water management would be undertaken so to at least meet the requirements of the Water Quality Protection Guidelines for Mining and Mineral Processing, issued jointly by the Waters and Rivers Commission (WRC), the DMPR and the DEP.

The relevant Guideline is No.6: Minesite Stormwater.

The process plant site rainfall catchment will fall into two categories:

- Concrete bunded areas around storage tanks; rainfall will collect in sumps and be pumped out either to the stormwater containment pond, evaporation pond or raw water pond according to water quality; and
- Runoff from roads, hardstands and untreated ground surfaces within process areas will be captured in stormwater drains and directed to a stormwater collection pond prior to dispatch to the evaporation pond or raw water pond depending on water quality.

The intention to collect water from the process plant was detailed in s3.4.3 of the s46 review document, which described that the water would either be captured and reused or discharged to the evaporation pond.

45. Doubts exist as to whether the run off from exceptional rainfall events falling on the plant site, Tailings Storage Facility and Evaporation Pond and creating a "road catchment" effect have been properly calculated. Local experience suggests that the official records may underestimate the severity of exceptional events.

A numerical water balance was developed as part of the conceptual design for the tailings and evaporation pond structures. This model was calibrated with rainfall data from Ravensthorpe which was available from 1 January 1907 through to present day, this is a significant data set and leads to a high level of confidence in predicted model outputs. While different volumes can be recorded for individual rainfall events annual rainfall totals are relatively similar.

Rainfall that falls within the plant site, Tailings Storage Facility and Evaporation Pond is expected to result in 100% runoff, this is included in the design calculations. Because runoff is assumed to be 100% of received rainfall it is not possible to underestimate, as it is all assumed to be captured. Rainfall records have been taken from the nearest long term recording site, which is in Ravensthorpe, while it is expected that some small differences may exist between the project site and Ravensthorpe they are not expected to be significant. RNO installed an electronic weather station in 2000, this has been collecting near continuously since that time. The installed weather station has an electronic tipping bucket, which aids in understanding the intensity of rainfall events, as apposed to a normal rain gauge, which will only give you total rainfall figures for a 24-hour period.

Design criteria for tailings and evaporation ponds are not critically dependent on individual rainfall events (although in some parts of Australia cyclonic events can bring catastrophic volumes of water over relatively short time periods) as the storage capacity is so large, individual rainfall events are of interest for the design of drains and culverts etc.

Due to low annual rainfall that is experienced in the area the size of the tailings and evaporation dams are not critically dependent of on rainfall, they are dependent on inputs from the process stream.

46. *A fresh water dam could be constructed on the upward slopes of location 777 or 776 to provide water for the lawns and gardens of the accommodation village and site buildings. The dam could then be used by the community at the end of mining as a farm water drought facility.*

RNO does not believe that this will be possible, although this will be revisited during detailed design.

Bandalup Corridor

47. *It is recommended that the proponent review the footprint of the north west Halley waste dump and adequately identify and justify the area impacted and the dump location to the EPA's satisfaction. The review should address the overall objective of minimising the project footprint within the Bandalup Corridor. (DCLM)*

RNO recognises the importance of minimising clearing within the Bandalup corridor, especially on the western side of Bandalup Hill. One of the additional benefits of moving the plant location to the eastern side of the mining area is the removal of this dump and associated ore handling infrastructure, including ROM pads and conveyor. All material project related disturbance is now confined to the eastern side of the mine areas.

48. *The Bandalup Corridor will be effectively strangled by the RNO project. The Bandalup Corridor is the most significant corridor in the South Coast region, linking*

the coastal corridor with areas to the Goldfields and beyond. All other linkages of these major Biogeographic Regions, including the Ravensthorpe/Carlingup Corridor have been severely impacted by land clearing, and have significant weaknesses in their corridors. The review fails to recognise that the combination of the Shoemaker-Levy, Halleys and Hale-Bopp pits and their concomitant infrastructure effectively cuts off the Bandalup Corridor, except for about 1 km at the northern extremity of Shoemaker-Levy. The mining reserve between Shoemaker-Levy and Halleys has been disturbed significantly by magnesite mining and cannot be considered a good corridor link. To maintain its integrity, RNO should have a 3 km wide Bandalup Corridor to the east and north of its entire project area, especially where it abuts the RAV8 project and Oldfield Loc.1200.

The impact on the integrity of the Bandalup Corridor is an important issue; the minimisation of impact within the Bandalup Corridor has been an important criterion for RNO throughout the s46 Review process. The trade off between development and conservation is a significant issue, and one, which requires an equal amount of attention during operation as it has during project development. The avoidance of impact within the Bandalup corridor is impossible, the minimisation of impact within the corridor is a priority for RNO. The size of the buffer zones between project infrastructure and adjacent remnant vegetation have been included despite the consequent loss of resource and / or increase in operating costs, further extensions of this nature could make the project uneconomic.

The ecological quality of the Bandalup Corridor at the magnesite pits has been questioned. What survey work that has been conducted to date shows that while the area has been significantly altered, the function of the ecosystem is good, with an abundant bird and insect life and a good representation of local vegetation.

RNO also plans to undertake further actions, specifically aimed at revegetating existing cleared land, with the aim of incorporating this revegetated land back into the Bandalup Corridor. RNO believes that this will facilitate a net gain to the Bandalup Corridor in this area over the project life.

RNO will continue to work during the remainder of the feasibility study to reduce the requirement to clear remnant vegetation.

Atmospheric emissions (SO_2, dust, Greenhouse gases)

49. *It is recommended that the proponent clarify the potential for vegetation impacts from SO_2 emissions for review by the EPA and, if required, develop an appropriate monitoring program including commitments for mitigation if impacts are detected. While the environmental review document compares expected concentrations to guidelines and standards relevant to human health, further discussion is necessary on how these concentrations would affect native vegetation in the surrounding area. It would also be helpful to: quantify total emissions from the project, estimate how much of this will be absorbed locally, and compare this with the assimilative capacity of the local environment. (DCLM, EPA Service Unit)*

In response to this comment RNO commissioned Sinclair Knight Merz (SKM) to conduct a literature review of available information, and based on this review, predict a possible level of impact associated with the development of the RNP. A summary of this report is provided here, with the full report included as Attachment 2.

The impact of atmospheric pollutants on vegetation varies considerably depending upon the type of vegetation being impacted, local terrestrial conditions, climatic environment, concentration of pollutants etc. Impact on vegetation can occur through wet and dry deposition via uptake through stomata and direct contact of the leaf cuticle with acidic droplets. Indirect effects may occur through soil acidification.

Observed impacts depend upon the flora species exposed to NOx and SOx. Exposure to low levels of NOx and SOx can be beneficial by having a fertilisation effect. However, toxicity can quickly occur at exposure to higher concentrations. Common adverse effects include reduced growth, biomass, yield, foliar cover, foliar damage such as necrosis, discolouring of stems etc.

The nature of impacts depends largely on the individual species and its sensitivity. Local terrestrial and meteorological conditions also play a large role in defining ground level concentrations and deposition rates. The ability of the soil to buffer any potential acidity is also important to consider.

From the very few studies that have been undertaken in Australia, most have focused on the impact of SO_2 on vegetation. On the basis of a review of the outcome of these studies, it is unlikely that adverse impacts will occur on vegetation surrounding the project area. These studies have generally shown that adverse impacts occur at exposure levels of about >170 ug/m^3 for NOx (for a 1 hour exposure) and about >130 ug/m^3 for SOx (for a >4 hour exposure, the 1 hour exposure levels would be higher). Although none of the test species have been recorded to occur within the project area. This is the best available information to date and warrants further investigation.

Emission modelling provides conservative estimates of potential emissions based on worst case meteorological conditions that are unlikely to prevail throughout the year. Modelling predicts maximum 1-hour ground level concentrations for NOx and SOx, under normal operations, of 95 and 125 ug/m^3 respectively. These are well below the concentrations, mentioned above, where adverse impacts have been observed. Important to note that in comparing the SOx concentration, the modelled maximum 4-hour exposure is expected to be much less than the modelled 1-hour exposure.

The predicted annual load from the project is estimated in Table 2 below:

Table 2 Annual Predicted Emission

Pollutant	Emission Rate (g/s)	Load (t/yr)
SOx	60.9	1921
NOx	17.6	555

Notes: Annual load based on 24 hr and 365 day operation, predicted operation will be for 343 days

Maximum annual ground level concentrations for both NO_x and SO_x, for normal operations, are well below the WHO guidelines for vegetation, being only 47% and <10% of the guideline respectively.

SO_x concentrations also meet the most stringent UN/ECE guideline for vegetation.

Start up and upset conditions will exceed these general levels, however these conditions are not expected to occur over long durations and will be infrequent during the

operational life of the project. It is unlikely that adverse impacts will occur given the short duration of start up and upset conditions.

Although it is generally concluded that adverse impacts are unlikely to occur, the potential for impacts still remains given the general absence of information, which is applicable to the project area. The following recommendations are made to ensure that RNO minimise any potential impacts:

- An ongoing biological monitoring programme developed in consultation with the Department of Environment Protection and Conservation and Land Management be developed and implemented to monitor the impacts on vegetation.
- The determination of deposition rates on-site and off-site the project area. This information will assist in the analysis of any observed changes to the condition of vegetation.
- Determination of critical loads following the outcomes of the monitoring programme and calculation of deposition rates. Critical loads may not be determined until sufficient information is collected from ongoing monitoring.
- Maintaining plant operating conditions in accordance to best practice to minimise emissions.
- Where practicable schedule maintenance and shutdowns following harvesting and well before or well after the spring season when most native flora begin to flower and reproduce.

It is believed that the combination of low emission rates and low annual rainfall significantly reduces the potential that the RNP will have any significant adverse impact on either native vegetation or commercial crops. Some evidence from other studies suggests that the low ambient levels expected to exist will actually be beneficial to growth rates, although this is not supported by any specific data applicable to the project area.

50. SO_2, NO_2, and CO_2 emissions all have the potential to form acid rain or to be deposited on the ground as oxides, which also increases soil acidity. A benchmark study needs to be undertaken / added to by the proponent, for at least twelve months before mine start up, to the satisfaction of the Shire of Ravensthorpe and the Department of Agriculture. This study should include:

- *information on critical loads for the area;*
- *information on projected acid loads that could fall on farm land; and*
- *commitment to ongoing monitoring of the fallout.*

Refer to the response to comment 49.

51. The Jerdacuttup community recommends the use of up to one location wide buffer zones be investigated by RNO during the design phase of the project. The potential impacts on the community that give rise to this recommendation are outlined below.

Number	*Issue*	*Impact*	*Solution*
1	*Blasting*	*Damage to farm infrastructure*	*Give specific,*

	associated with mining of laterite and quarrying of limestone adjacent to farm land	*(houses and concrete tanks) on adjacent properties, and safety issues relating to livestock handling (particularly cattle), from blasting.*	*quantitative, written undertakings to adjacent landholders to guarantee no infrastructure damage or safety risks.*
2	*Location of mine pits, TSF and EP, and limestone quarry adjacent to farm land*	*Potential for dust to affect residential amenity and farmland, compromising the ability to produce food for markets requiring QA.*	*Establish buffer zones around all potential dust sources.*
3	*Noise from blasting, mining, quarrying and transport*	*Loss of residential amenity*	*Give specific, quantitative written undertakings to manage noise* *Establish buffer zones*
4	*Emissions from metallurgical plant*	*Acid plant emissions high during start-up and upset (RNO Environmental Review, table 4.3, pg 182)*	*Design plant to reduce emissions* *Establish buffer zones* *Advise local residents of start-up and upset conditions*
5	*Problem Management*	*There will be unforseen negative impacts, which will have to be recognized and managed*	*Establish processes to work with adjacent landholders, to manage problems*

1. Please refer to response to comment 56.
2. Please refer to response to comments 52,53 and 55.
3. A noise modelling study has been undertaken where predicted noise emission levels from activities were estimated for individual pieces of equipment and imputed into the 'Environmental Noise Model' (ENM), which was used to predict noise levels at nearby sensitive receptors. The conclusions from this work, was that while noise from the mine may be audible under some conditions, it would not be problematic or intrusive. This assessment recommended that no further study or noise amelioration works were required. Despite this finding, RNO recognises the importance of residential amenity and is proposing to conduct a further study later in the feasibility process, when equipment selection is substantially complete to confirm these findings. RNO does not believe that nuisance noise will impact upon the residential amenity of neighbours.
4. Please refer to response to comment 49 in relation to acid plant emissions. RNO will aim to provide prior notification to fence line neighbours before commencing acid plant start-up. RNO does not believe that emissions from the acid plant, even during start-up and upset conditions, will in any way affect the health or residential amenity of surrounding neighbours.
5. During the operation life of the project there will almost certainly be instances whereby community members wish to make a complaint, or provide feedback to, RNO about its activities. A complaint reporting and investigation procedure will

be developed and implemented as part of the Environmental Management System, details of this process will be discussed with the community prior to implementation. This will also be included as part of the role of the CLC and the Jerdacuttup Working Group.

In regards to buffer zones, it is the primary focus of RNO to control its activities such that emissions from the operation do not cause adverse impacts for the surrounding communities. This causes us to focus on reducing emissions at the source, rather than increasing the dispersion of the emission through the establishment of extensive buffer zones.

52. *There is concern that dust and emissions from the project could impact on the children of the region if emissions reach the school on prevailing winds. Firstly by inhalation, and secondly by affecting the quality of drinking water which is collected from the roof of the school and homes. The Jerdacuttup School and Hall are only 6-8 km east from the proposed tailing dam and evaporation pond. Dust monitoring and water testing programmes (including baseline measurements) should be implemented to monitor any impact on the Jerdacuttup School site. Planting of a shelter belt at the site would also reduce emissions.*

The answer to this question is best thought of in three parts, the first is the probability of wind blowing in a direction that would carry emissions from the operation towards the school, the second is the level of emissions that would be expected to reach the school and the third is what, if any, possible health effects could be associated with that level of emissions.

Of the approximately 25 500 (between 1962 and 2002) wind observations (source: Bureau of Meteorology for Ravensthorpe), the majority (22%) were from the north-west and occurred mainly through the winter; the next highest number (16%) were from the south-east, mainly during summer, ie. the two worse directions are opposed. The Jerdacuttup school (as detailed in the comment above) is approximately east of the current location of the tailings and evaporation pond facilities. The winds from this direction are predominately light and are present for approximately 11% of the time. Both of these factors, wind speed and wind direction, mean that it is unlikely that dust from the operations would blow in the direction of the school.

Operational experience from within the BHP Billiton groups indicates that the planting of a shelterbelt would do little to reduce emissions; this can only be effectively done and will be done at the source.

Reducing the impact of dust is best done by reducing dust generation at the source, best practice principles that RNO intends to implement to control the generation of dust include;

- Workforce awareness and training;
- Integrating dust control measures into operations planning; including construction, topsoil stripping, blasting, progressive rehabilitation programs and controlled water application to name a few;
- Integrating dust minimisation provisions into work practices;
- Monitoring and feedback mechanisms;
- Using observational as well as quantitative assessments to guide control efforts; and

- Maintaining awareness of current methods and technology.

The combination of all of these practices means that the probability of dust generation occurring at a level such that a potential for harm to occur is remote, the probability of this occurring at a site, which is between 6-8 km away, is even more remote.

Modelling conducted to date does not extend out as far as the Jerdacuttup School, modelling is focussed on near field receptors (within 2 kms) where any potential impact is expected to occur.

Despite this RNO has installed a dust deposition gauge at the Jerdacuttup School and will monitor this on a monthly basis as part of its ongoing monitoring program. RNO strongly believes that the sealing of Jerdacuttup Rd will be a significant contributor to reduction of dust at the Jerdacuttup School.

The Jerdacuttup School is also part of the Jerdacuttup working group, which provides a further mechanism for input by the school. Results of the dust monitoring program will be provided to the Jerdacuttup School on a regular basis.

53. The proximity of mine may compromise ability to produce food for markets requiring Quality Assurance. Of particular concern are sulphur dioxide emissions, especially during start-up and upset conditions.

RNO disagrees that the proximity of the mine and presumably the processing facilities will impact on either the viability of neighbouring farms or detrimentally impact the quality of product that they produce. RNO intends to manage it's operation on a zero harm basis, the design standards have been specifically set to achieve this requirement.

A review of the 'On-farm Quality Assurance Manuals' for Graincare, Flockcare and Cattlecare highlights that sulphur dioxide is not an issue from a quality assurance perspective. The manuals highlight that the biggest risk to farm quality assurance is from organo chlorine chemicals used by the farm itself.

Please also refer to our response to comment 49 and 50 in regards to predicted impacts of sulphur dioxide along with further detail in Attachment 2.

54. With regard to the "no regrets" and "beyond no regrets" measures to reduce greenhouse gas emissions (set out in Section 4.2.3), more detail is needed to distinguish the actions included in each of these measures and make clear what will be included in the Greenhouse Gas Management Plan. (DMPR)

The Greenhouse Gas Management Plan has yet to be developed, when it has it is expected to contain an analysis of the projects greenhouse gas emissions, estimated for the life of the project. It is also expected to highlight areas where GHG emissions could be reduced, as a new project it is expected that initially these will be minimal, as all current practicable measures have been built into the current design. It would expected that as technology improves or other opportunities become available further savings could be made, these would need to be assessed on a case by case basis.

The summary of actions that was contained in the s46 review highlights the fact that project greenhouse gas emissions have reduced between the previously approved project and what is currently being proposed, this is principally as of further power

generation from the recovery of waste heat from the acid plant, thereby offsetting the need to generate power from diesel combustion.

It is a BHP Billiton corporate requirement that all operations have GHG management plans in place by July 2003, specific public reduction targets for the group have already been set.

One of the initial possible abatement measures that RNO is considering is agro forestry options for any excess land that RNO purchases that is not required for infrastructure or revegetated as part of the conservation offset program. It would be expected that these agro forestry options would significantly reduce net operation emissions through sequestration.

55. *It is suggested that the sulphur should be kept in a covered storage with a negative atmosphere to ensure containment.*

Sulphur will be in the form of a "prill" which is essentially sulphur compacted into small tablets, prills were specifically developed to minimise dusting. It is proposed that RNO sulphur would be predominately stored at the Port of Esperance, with storage on site sufficient to cope with a just few days supply disruption. Since the sulphur is in the prill form there is no justification to enclose the storage facilities, RNO is considering covering the sulphur stockpile at the process site.

Noise and blasting

56. *Clarification is needed on some points related the potential for blasting at the limestone quarry to affect the amenity and infrastructure of nearby farms. The points requiring clarification are:*

    - *How frequently will blasting be carried out?*
    - *What will be the total charge used per blast event?*
    - *Do RNO currently have an assessment of whether this blasting will cause vibration at surrounding residences?*
    - *Will there be an explosives magazine on Oldfield Location 827?*

Detailed information such as the frequency of blasting and the charge required per blast will not be determined until the detailed mine planning has been conducted later in the feasibility assessment. What can be said at this stage is that blasting is an expense for the operation, blasting will not be conducted at a more frequent or higher level than is absolutely necessary to facilitate mining and that vibration and over pressure levels will be below those levels stated in the applicable Australian Standards.

RNO has given a public undertaking, and a commitment has been added to the register, to pay for an independent structural assessment of all dwellings and buildings on properties that immediately neighbour blast sites. We would propose to repeat the process on (reasonable) request or on specified intervals and will make good any defect that has occurred as a result of blasting vibration.

In addition to the above RNO is also in the early stages of planning a trial blast at the limestone quarry, which will allow quantitative assessment of any potential impacts from blasting on nearby neighbours.

It is currently planned that all explosive materials will be stored at the main site, explosives for each blast at the quarry site will be transported on an as needs basis.

57. *Are adequate procedures in place to protect adjoining landholders' buildings from the effects of blasting at RNO mine site and the proposed quarry site?*

Please refer to the response to comment 56.

Conservation Offsets

58. *Conservation (vegetation clearing) offsets should be resolved prior to project commencement. The identification of suitable offset land with respect to location and standard will require the EPA's approval on DCLM's advice.*

RNO strongly believes in the preservation of remnant vegetation within the Ravensthorpe Region, and believes that project planning to date has demonstrated this commitment.

RNO has recently secured an option to purchase (subject to project approval) an area of approximately 660 ha (shown in Fig 1) of uncleared land within the Bandalup Corridor adjacent to the project site, which was highlighted by DCLM as an area of significant value to the integrity of the vegetation corridor. Discussions will be held with DCLM as to how this land can be best utilised to facilitate conservation within the region, RNO believes this key purchase will significantly improve protection of priority fauna.

RNO has also committed to undertake further actions, specifically aimed at revegetating existing cleared land and areas impacted by mining operations, with the aim of incorporating this revegetated land back into the Bandalup Corridor. This commitment involves the revegetation of 0.4ha of existing cleared land for every ha of land cleared as part of project development, this is in addition to rehabilitation requirements for disturbed land. RNO believes that this will facilitate a net gain to the Bandalup Corridor over the project life.

The identification and purchase any other suitable offset land is primarily dependent on availability, and on being able to reach an equitable purchase price with the seller. To be able to accomplish this strict commercial confidence must be maintained, upon any additional purchase of the land RNO will enter into discussions with DCLM as to how this land can best be utilised for conservation offset purposes.

59. *The conservation offset of 800 ha should be greater, and other factors such as the quality of the vegetation and ecological values (e.g. displaced species of fauna etc) should also be weighed into the equation. The offset should be at least be equivalent to the area impacted by the mine, namely 1 730 ha, and in addition to the revegetation of the mine.*

Refer to response to comment 58.

Since the publication of the s46 review RNO has secured an option to purchase approximately 660 ha of land, this was part of the 800 ha that was within the original commitment. As part of the RNO strategy of minimising impact on the Bandalup Corridor

RNO will modify it's commitment (see Attachment 1) in regards to conservation offsets, to now include the revegetation of 0.4 ha of existing cleared land for every 1 ha of land cleared as part of project development over the life of the project, in addition to the existing commitment for rehabilitation of project related disturbance. RNO will enter into discussions with DCLM and other interested parties in regards to the revegetation of this land. Revegetation will commence within 3 years of the completion of commissioning of the RNP.

60. *The Friends of the Fitzgerald River National Park would like the opportunity to be involved in the design and implementation of revegetation of the farmland buffer surround the proposed mine. The proponent should also liase with those involved in the Gondwana Link Project which covers some of the project area.*

RNO will ensure that the Friends of the Fitzgerald River National Park are given the opportunity to participate in the development of plans for the revegetation of farmland buffer.

61. *The proponent may wish to consider other opportunities for offsets that could provide significant environmental and social outcomes for the local area. There may be opportunities to utilise the resources and technical capability of the planned BHP Billiton RNO Nickel mine facilities to assist the community in implementing management planning and actions to reduce the environmental footprint and offsite impacts of orphan mine-sites in the area. (DCLM)*

RNO via the Community Liaison Committee and the proposed Community Development Foundation will specifically be targeting this type of project, where the community as a whole is the beneficiary. Further details on the operation of the Community Development Foundation will become available once the project is operational.

Refer to response to comment 70 for further details on the community foundation.

Coastal impacts

62. *There is concern that the pipeline pumping station and ocean side infrastructure will impact detrimentally on the ecological and visual amenity values at Masons Point near the coast.*

Short-term environmental impacts will occur as part of the construction process, these are unavoidable. All proper care and attention, including education of the workforce, will be undertaken to ensure that any impact is reduced to a practicable minimum. The impacts on visual amenity are more long term and will exist for the life of the operation, until the pumping facilities are removed. Detailed design will aim to reduce the visual effect of the pipeline and associated pumping facilities, but to some extent it will always be visible.

The existing location was also chosen on the basis of minimising visual impact.

63. *Can the proponent give some assurance that limestone extraction will not occur in new areas of the region, particularly near the coast, since it is not clear that the 67 ha Tamarine quarry will be able to provide this raw material for the entire life of the mine.*

RNO can confirm that currently all of it's life of operation limestone requirements can be met by the Tamarine Rd quarry, there is currently no requirement to extract limestone elsewhere.

64. *The ecological impact of the return of hyper-saline water the ocean should be monitored and adjustments made to dilution design if necessary.*

Only a small amount of hyper-saline water or brine will be discharged back to the ocean, as the vast majority will be consumed within the process. Continued efforts will be undertaken during the remainder of feasibility phase to reduce, or preferably eliminate, the volume of brine requiring return to the ocean.

Monitoring, if discharge occurs, during the operational phase would be specifically focussed on identification of any impacts associated with brine discharge. A brine return marine monitoring program would need to be developed and implemented as part of the Environmental Management System; this program will need to be developed prior to the commencement of operations.

65. *What sort of monitoring is proposed for the pipeline discharge? What pollutants will be measured, how frequently, at what distance from the discharge point?*

As is detailed in the response to comment 64 only a limited amount of brine is expected to be discharged. Details such as the monitoring parameters, the frequency and the monitoring locations would be key components of the proposed monitoring program.

The brine is essentially concentrated seawater so the most important parameter is expected to be salinity, this will be directly controlled by dispersion to background within approximately 6 meters of the discharge point.

66. *Have surveys of the seabed in the vicinity of the pipeline been completed?*

Surveys of the seabed have been completed, a summary of this work was included in section 3.9 of the s46 Environmental Review, and further details can be obtained from RNO upon request.

67. *The large number of workers during the construction and operation phases of the project will place a greater strain on the coastal environment and on recreational facilities and services on the coast. How will these impacts be addressed? It is anticipated that workers and their families will want to make use of the coast for recreation. However, there is currently little in the way of rubbish collection, sewerage, and life saving services, that could cope with increased usage. An increased number of visitors will also increase erosion, demand for fire wood, and recreational fishing. Workforce education and a contribution to services may be necessary.*

The construction of the RNP will be predominately conducted on a 13-day fortnight on a fly in fly out basis, with workers completing 12 hour shifts. It is expected that this roster will leave little time for local recreation activities unless the worker is employed locally.

During operations the workforce will be split predominately between Hopetoun and Esperance with some workers choosing to reside in Ravensthorpe and in the surrounding district.

The recently released Ravensthorpe / Esperance and Jerramungup Blueprint, estimates that the population in the Shire of Ravensthorpe will increase from approximately 2100 to 2650. It is expected that most of these people will wish to take advantage of the

natural assets of the area. RNO will ensure that all new employees are provided with detailed induction and education resources to assist in the understanding of the areas unique natural attributes.

As far as impacts on existing multi-user infrastructure is concerned it has been recognised from an early stage that significant improvements would need to be made, RNO has worked closely with all stakeholders to identify these needs and to ensure that adequate funding is available to address them. The blueprint document itself is evidence of this understanding and commitment from all parties.

Social

68. The establishment of a Community Liaison Committee by RNO is illustrative of the leadership and best practice RNO is showing to others in the resources industry. (DMPR)

RNO agrees with the above statement, and also believes that the Community Liaison Committee (CLC) will play an important role in facilitating successful implementation of the project. The following key operating principles have been adopted by the CLC;

1. The CLC should be vested with process control and clearly understand that although it may have influencing capacity, it does not have direct decision control over matters within its terms of reference.
2. The processes guiding the operation of the CLC will be based on clearly articulated criteria for procedural fairness, against which the practices of the CLC and other stakeholders may be evaluated.
3. The CLC will reflect the diversity of interests and stakeholders in the community.
4. The CLC will foster a culture of participation that enhances opportunities for community development by other members of the general community.

From these four key operating principles the following terms of reference for the CLC more clearly defines what it is that the CLC aims to achieve;

- To provide advice on effective mechanisms for communication and consultation with interested groups including residential, non residential, business, government and special interest groups;
- To identify and engage with individuals and groups effected by the RNP and to ensure that they have adequate opportunities to contribute to the liaison process;
- To contribute to the development of RNP management plans;
- To identify potential positive and negative social, economic and environmental impacts of the RNP and comment on the implementation of monitoring and mitigation management strategies implemented by RNP;
- To provide regular feedback to the community;
- To provide regular feedback to RNP;
- To contribute through its activities to the development of resilient, capable and vital communities that are able to meet the challenges of a rapidly changing social, economic and environmental circumstances; and
- To consider other matters of interest as determined by the committee.

RNO intends to support the CLC throughout the remainder of the study period, and into construction and operations if the project receives approval to proceed.

69. *The Shire of Ravensthorpe would like to see greater liaison with Ravensthorpe Agcare — maybe on the committee — to assess the social impacts on the community on a continuing basis.*

The CLC already contains six farmers on the committee; this is by far the majority of the committee. The Jerdacuttup Working Group is a further way in which RNO is integrating the views of the farming community into Project development.

RNO has discussed this request with the CLC and the CLC does not believe that the CLC needs to increase its representation beyond the current number of 11, it would be proposed that continued direct consultation between RNO and Ravensthorpe Agcare would be better suited.

70. *A group should be empowered to assess and facilitate alternative sustainable economic options to address the anticipated negative economic effects of the eventual decommissioning of the mine. Seed funding for the group should be provided by RNO.*

RNO has discussed with the Shire of Ravensthorpe and the CLC its proposal to form an RNP Community Development Foundation that would have the following features;

- The CLC would eventually become responsible for managing the Development Foundation thereby displaying a partnering relationship between RNO and the community that is characterised by openness, sharing, trust, teamwork and involvement.
- RNO would provide annual, discretionary funding to be based on business profitability.
- The annual funding would be split into two amounts;
    - One amount to be used for new and ongoing community projects administered by the Foundation; and
    - A second amount to be allocated for use to fund Foundation Projects after Project Closure.

The Community Foundation would be yet another way in which RNO will assist the community, during and beyond the closure of the RNP, in achieving goals that would otherwise be unachievable without the RNP, principally through lack of funds.

71. *There needs to be more focus on contingency planning and amelioration of impacts from the infrastructure (including evaporation ponds, limestone quarry, waste dumps) that in some cases is very close to boundaries of adjacent farms, towns, residences. Not enough has been done to meet with farmers to discuss issues such as the economic and social impacts of the mine on the operations of the farms. Are there any protocols in place for ensuring that issues can be addressed?*

A primary focus of RNO to date has been to design the Ravensthorpe Nickel Project such that it can be operated on a zero harm basis. In other words the focus has been on the prevention of impact. Once a design has been chosen, based on the principle of

minimising impact, then specific contingency plans can be developed, to be enacted in the rare case that they are required.

RNO understands that both best practice design and contingency plans are required, and that consultation and input from the community and fenceline neighbours in particular, is integral to the success of this process.

With respect to our community liaison program, RNO has engaged a full time Public Liaison Manager for the past two and a half years. Because of the small size of the area he is on a first name basis with most people within the community and has implemented a number of important initiatives to enhance information flow and feedback to RNO from the community. These include “one on one” meetings with our fence line neighbours and other key stakeholders, community presentations, a 1800 free telephone call service, support of local enterprises and community projects and the Community Liaison Committee. Although RNO recognises there is always room for improvement we believe our community programme has been proactive and positive, especially given the lengthy study phase of the project.

The publication of the Section 46 document has provided a focal point for the community to consider the proposed mine development in its entirety and we recognise there is a level of concern regarding the possible impacts it could have on the community lifestyle. We are committed to continuing with our communication, consultation and participation with the community to manage those concerns.

While there is no statutory obligation for community consultation for either the Notice of Intent or Works Approval process, RNO will make these applications and the supporting documentation, available for community comment.

The points that RNO wish to emphasise here are;

- The Section 46 process does not mark the end of the community input process. RNO will continue to involve the community in aspects of the project throughout the study, implementation and operation of the project. This is part of the role of the existing Community Liaison Committee Jerdacuttup RNO Working Group.

- RNO will keep the community informed of progress on the project and provide opportunities for review and the provision of feedback.

There are a number of other issues that will require collaboration to achieve an optimum outcome and we recognise the limited technical and financial resources available to the community and are prepared to provide funding for one or more independent experts to provide advice to the community on various matters related to the project. We are compiling a list of candidates for selection by the community as adviser(s). RNO is prepared to provide the advisor(s) with access, subject to normal confidentiality conditions, to all relevant data on the project and will involve them in the development of forward programmes and the analysis of baseline and operational data.

72. *The impact of the Company’s preference for a locally based workforce on the local workforce and the Shire of Ravensthorpe was recognised early and planning initiated in 1999 to address this. The State Government (through the DMPR’s Office of Major Projects) in conjunction with RNO and the Shire has identified the infrastructure needed to cater for the increased population and has begun to*

anticipate and plan the management of the local effects. Part of this process has been the identification of the $55 million infrastructure package that would need contributions from the State Government, the Company, and the Commonwealth Government. (DMPR)

RNO agrees with this statement.

73. Given that the project will bring a large number of people into a sensitive and important environment, the proponent will need to ensure that people are educated about the significance of the area and made aware of the company culture that reflects this. Points to be considered are:

- *The area in which the project will operate is internationally famous as one of the top 25 biodiversity hotspots in earth and as a World Biosphere area.*
- *Training and awareness programmes for staff and the community should be designed and implemented to increase knowledge and skills regarding working and living with high biological diversity and fragility.*

As part of the EMS RNO will conduct a detailed environmental induction process which recognises the unique location and surround ecological values. In addition RNO will work with established conservation groups within the region to improve the overall knowledge and management of the unique conservation areas within the region, including the improvement in the practice of users through education.

74. Involvement in planning to address the expected social impacts of the proposal exceed the resources of the shire and local community. It would be helpful if suitably qualified consultants were made available to support Shire staff.

The Shires of Ravensthorpe, Esperance and Jerramungup, in association with the Goldfields Esperance Development Commission, successfully applied for funding from the Commonwealth Government under the Regional Solutions Program to instigate a review of the impact upon, and the opportunities associated with, the Ravensthorpe Nickel Project (RNP).

Collectively referred to as the South-East Coastal Region of Western Australia, these municipalities have come together via the Blueprint project (SMEC 2002) to chart their future, taking into consideration the major generators of social and economic activity in the area.

In addition to participating in the above planning strategy RNO has also supported, particularly the Shire of Ravensthorpe through;

- Appointment of a full time Public Liaison Manager since mid 2000;
- Assisted funding Shire of Ravensthorpe Development Officer 2000;
- Part funding of the Ravensthorpe Planning Strategy in 2001;
- Secondment of the RNO Public Liaison Manager to Shire of Ravensthorpe for 3 months during 2001;
- Arranging and leading a visit to Port Hedland with local government and Ravensthorpe Regional Chamber of Commerce, 2001;

- Organised and led a visit to Worsley Refinery and Boddington Bauxite Mine by the Community Liaison Committee to view BHP Billiton HSEC performance.

While RNO has contributed greatly to the planning and understanding, of particularly the Shire of Ravensthorpe, of the implications of the proposed RNP, it also understands that a successful outcome will require a continued close working relationship between RNO, Shire of Ravensthorpe and the Community.

75. A realistic summary of job descriptions and related skill requirements throughout the construction and operations phases should be tabled. This will better inform the local community and prevent the generation of unrealistic expectations.

As the Project draws closer to an approval date it would be expected that more details will become available on the number and types of positions that will be available during the construction and operations phase of the project.

RNO has already compiled a list of service providers that exist within the Shire, and aim to use local service providers whenever possible.

As one of only a handful of new billion-dollar residential based mining projects in the last 25 years, the RNP will provide a rare opportunity for economic development in rural and remote Australia. During it's 20 year life the RNP will not only provide opportunities, both directly and indirectly, for today's adult populations but also opportunities for children within the region over the next twenty years.

76. Given the perception that mine activities and offsite impacts will affect the amenity, viability, and value of nearby farms, some would prefer that nearby properties are purchased and used as a buffer zone.

There is no automatic correlation between the presence of a mine and declining farm productivity or amenity. RNO intends to manage it's operation on a zero harm basis. This is a cornerstone of the BHP Billiton HSEC Policy and embedded into the culture of the company. The emissions standards used within the project design are such that the likelihood of a loss of productive capacity or reduction in residential amenity is remote. Further RNO believes that an improvement in regional infrastructure will have the converse effect and may actually increase farm values.

RNO agrees that farm values may decline if the productive capacity or quality of farm products declines, but also firmly believes that this decline will not happen.

Transport

77. RNO has had extensive discussions with the Shire of Ravensthorpe, Main Roads WA, and other stakeholders on the transport issues associated with materials and personnel. Funding for the upgrade of the local roads in the Shire of Ravensthorpe directly associated with the project, and specific sections of State Roads, is part of the $55 million infrastructure package noted in Section 3.10. (DMPR)

RNO agrees with this statement.

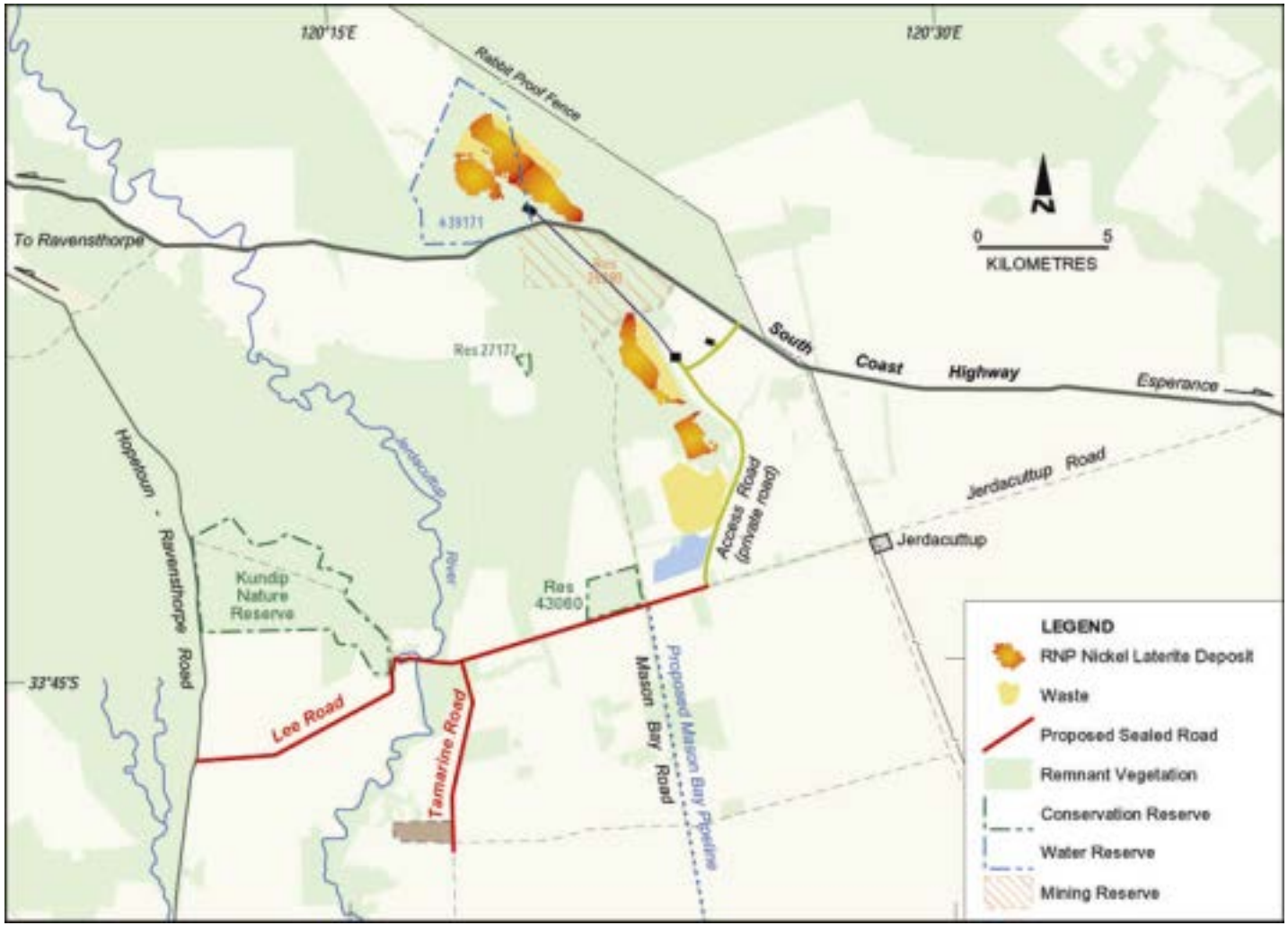
78. Jerdacuttup community's primary concern is that the roads that will carry both mine and existing community traffic (RNO Environmental Review, figure 2.6, pg 90) are

designed and constructed so that the road can be used safely by RNO and the community for the whole of the life of the mine. The present proposal will have a far more significant impact on local roads than the project detailed in the original Consultative Environmental Review. This will require consideration of pavement specifications (due to greatly increased wear of the pavement by heavy vehicles), turning and overtaking lanes, and a suitable alternative access to Jerdacuttup Primary School.

RNO agrees that the sealing of existing unsealed roads to be utilised by project related traffic will need to be to a standard that will be able to safely and efficiently carry all project and community traffic for the life of the operation and beyond. RNO has engaged in extensive consultation with the Shire of Ravensthorpe and Main Roads WA as to RNO operational requirements. Main Roads WA are principally responsible for the design of the road upgrade.

With the change in process plant and accommodation village location to the eastern side (see Fig 4) access to the site for heavy vehicles, and the vast majority of traffic in general, will be directly from the South Coast Highway. This new access route means that project related vehicle traffic passing the Jerdacuttup School has been reduced to almost zero (minimal light vehicle traffic only).

Fig 4 Conceptual Transportation Route



79. *It is suggested that the transport route be changed so that all mine traffic will travel north along Mason Bay Rd north of Jerdacuttup Rd and enter the South Coast Hwy at a safe location. This would eliminate the traffic hazards for the Jerdacuttup Primary School and students and reduce noise and traffic for all residents on Jerdacuttup Rd It now appears (contrary to past discussions with RNO) that the proposed heavy haulage route, that is only 100 m from the school buildings, will be straightened to allow vehicles to travel at 100 km/hr past the school. This is obviously a hazardous situation. The new section of Mason Bay Road could also be sealed to reduce dust, die-back and improve safety.*

See response to comment 78 above.

RNO believes that the new process plant location and access route fully answers the concerns raised in this response.

80. *The proposal raises some critical issues in relation to impacts on the Jerdacuttup School that need to be resolved through rigorous consultation with the Jerdacuttup School, Jerdacuttup community, Esperance District Education Office, RNO, and facilitated by a neutral agent. Issues include:*

    - *the effects of emissions on the health of students and the drinking water supply; and*
    - *health and safety concerns over the proximity of the transport route.*

The s46 Review essentially demonstrates that there are no critical issues for the Jerdacuttup School as a result of the Ravensthorpe Nickel Project. All monitoring and modelling completed to date indicates that ground level concentrations of atmospheric emissions will not exceed levels where impacts on health could potentially occur.

As detailed in response 78 the new access route means that no project related heavy vehicle traffic is required to pass the Jerdacuttup School, as access is now provided directly from the South Coast Highway.

RNO, as part of recent public consultation with the Jerdacuttup community has committed to the formation of a Jerdacuttup - RNO working group, which includes representatives from the Jerdacuttup community, Jerdacuttup School and RNO. This working group will work through issues that are specific to our immediate neighbours.

81. *The proposal will result in an increased number of trucks using the South Coast Highway and Harbour Rd to cart product to and from RNO and Esperance Port. Given the recent history of truck/train collisions in the region, and the existence of three rail crossings between RNO and the Port, it is recommended that:*

    - *a Management Plan for accidents (i.e. sulphur truck/train collision) be formulated in consultation with FESA, Esperance Fire Brigade and the three urban rural volunteer fire brigades in the Esperance area;*

- *an overpass, or as a minimum, boom gates be installed on the South Coast Highway rail crossing; and*
- *a Code of Practise be devised, in consultation with residents, for truck movements on Harbour Road (particularly in residential areas between the hours of 7pm and 7am).*

RNO agrees that a transport management plan including a Code of Practice needs to be developed, it would be expected that this would be developed towards the end of next year, when transport volumes become essentially fixed.

RNO agrees that some form of traffic control or warning is required at the rail intersection with the South Coast Highway. It is the intention of RNO to discuss this with the appropriate government bodies responsible for both the rail line and road to convince them of the need for these facilities prior to the commencement of RNO operations.

82. *Will road trains carrying sulphur be fully enclosed to prevent spillage of this material and potential contamination of the marine and terrestrial environment?*

    If enclosed, will road trains be custom-built to reduce the risk of explosion of the enclosed sulphur?

Sulphur that is utilised for the project will be in a 'prill' form, this form of sulphur was specifically designed to reduce the potential for dusting. It is expected that sulphur will unloaded at the Port of Esperance using grabs and ships gear, depositing directly into wharf mounted hoppers. The wharf hoppers will discharge directly onto a conveyor belt into a covered storage facility.

From the storage facility road trains will be loaded to transport the sulphur to the project site, these road trains will be similar in nature to that currently utilised for grain haulage, which means that they will be covered.

It is not expected that any significant levels of sulphur will be lost during either unloading at the wharf, transport to site or unloading at the process plant.

The potential for fire from the transport of sulphur is related to the generation of dust, the 'prill' form of sulphur essentially eliminates the risk of fire or explosion. An example of this is in relation to dangerous goods coding, sulphur is listed as a dangerous good under the Australian Dangerous Goods Code (ADG Code), with the exception of sulphur that is formed into a specific shape, including prills. Sulphur when formed as a prill is not a dangerous good.

83. *There are a number of additional concerns related to the shipment of sulphur through Esperance Port. It is assumed that these will be addressed in a separate environmental approval.*

The shipment of sulphur through the Port of Esperance will be the subject of a separate environmental, including public consultation, process.

Other

84. *The proximity of the project creates the potential for damage to the State Barrier Fence, which could increase the impact of wild dogs and large numbers of emus on*

agricultural industries. All employees to have an awareness of the state barrier fence.

It is not expected that RNO employees will in any way interact with the State Barrier Fence. Inductions for new employees will also include information on the region, and could easily include the existence of, and the importance of the State Barrier Fence to the agricultural community.

85. *The limestone quarry is an essential and integrated component of mining operations and will comprise a substantial operation in its own right. The EPA should therefore recommend that the quarrying be regulated under the Mining Act and not allow the proponent to operate the quarry under an extractive industries licence. The quarrying should be undertaken with DMPR oversight and the full range of tenement conditions applied.*

RNO agrees that the limestone quarry is essential to the project and that operations need to be integrated into overall management plans for the project as a whole. Small scale quarry operations such as the RNP limestone works are commonly operated under extractive industries licences administered by the local Shire.

The internal standards set for the quarry operation will be the same as for the mine, for instance rehabilitation will be included as part of overall site planning works and done to the same high level. Environmental management of all RNO controlled sites will be integrated under a single externally certified EMS, this will include the quarry.

86. *The environmental review is unclear about where the landfill site will be located for waste disposal of municipal and industrial waste from the proposed mine, nor does it say whether native vegetation will be cleared for this purpose. Will there be opportunity for the local community to comment on any proposals for landfill or waste disposal prior to the location of a site by either the Shire or the proponent? It may be better for RNO to develop it own facility, perhaps burying waste in the pits and backfilling during the mining process.*

At the time of publication of the s46 Environmental Review, the Shire of Ravensthorpe are undertaking a review of waste disposal within the Shire, including the establishment of a new landfill. RNO's current preference for the operations phase is to support the development of an appropriately located and sized engineered landfill that would also be utilized by the Shire. If an appropriate external site is not available, then RNO will develop it's own facility for it's own use on currently cleared land or on land currently identified to be cleared.

87. *Opportunities to maximise waste recycling should be investigated. RNO should work with the Shire of Esperance to ensure that all recyclable municipal waste is transported to, and processed by, the Shire of Esperance. RNO should also work with other mining companies recycling solid waste i.e. batteries, drums, scrap metal for community benefit, for example the Granny Smith Ruggies Recycling program.*

RNO has completed preliminary waste management investigations detailing the nature and quantity of waste likely to be generated during construction and into operation.

RNO philosophy in regards to waste follows a standard hierarchy, which is applied across many BHP Billiton sites;

- AVOID the use of certain materials and replace them with more environmentally acceptable ones, where possible;
- REDUCE the amount of waste generated;
- REUSE waste without any reprocessing, where feasible;
- RECYCLE wastes by reprocessing; and
- DISPOSE wastes in an environmentally responsible manner, where no other options are available.

While it can be seen that the aim of waste management at the site will be principally to avoid the generation of waste, some level of waste generation is unavoidable. Examples of materials that RNO will produce which can be recycled are;

- Metals (copper and stainless steel could be stockpiled separately);
- Oils;
- Batteries;
- Concrete materials;
- Paving materials;
- Timber and pallets;
- Electrical cables;
- Drums;
- Handrails; and
- Paper / cardboard / plastics / aluminium cans and glass.

The ease at which these materials can be collected and transported to a handling facility is variable, and in the case of general recyclables, will be critically dependent on participation of the general population within both shires. RNO will work with the Shire of Esperance the Shire of Ravensthorpe and any other commercial bodies within the region to develop the most practical waste collection and disposal plan that suits the volumes of waste generated and the distance to applicable processing facilities. RNO with it's small workforce, will not be a critical driver for this program, but will certainly participate if a collection strategy can be developed.

88. *The Department of Indigenous Affairs considers that at this stage the proponent has adequately addressed Aboriginal heritage issues. In addition, the proponent is encouraged to continue liaising with the local Aboriginal people regarding the project. (Department of Indigenous Affairs)*

RNO agrees with this comment.

89. *The Council (Shire of Ravensthorpe) considers that an Annual Environmental Audit should be carried out for the life of the mine, with the published findings being compared to baseline and benchmark standards (as documented in the environmental review document) for community analysis.*

Please refer to response to comment 5 in regards to RNO's proposed environmental auditing and reporting.

90. *The proponent should commit to construct a dual conveyor system to enable cost effective return of the waste rock to the mine void.*

RNO is committed to returning waste rock to fill the open voids whenever it is economically feasible, or where it is required to support a sensitive vegetation community. The most cost effective method will always be used, this may or may not include a dual conveyor. Further detailed mine planning is required prior to the decision on the most cost effective mode for returning mine rejects.

ATTACHMENT 1

PROPONENT COMMITMENTS

No.	Topic	Commitment	Objective	Compliance Criteria	Timing	Advice
1	Conservation Offsets	The proponent will purchase approximately 660 ha of uncleared land (part of Location 1399) and preserve for conservation purposes.	Facilitate Western Shield fox baiting program to expand into the Bandalup Corridor. Maintain ecosystem function protection.	Land Purchased	Within twelve months following the commencement of construction of the project as described within the s46 Environmental Review.	DCLM
2	Conservation Offsets	The proponent will, in addition to the purchase of 660 ha of uncleared land referred to in commitment 1, rehabilitate 0.4ha of uncleared land for every 1ha of land cleared as part of the project. This rehabilitation will aim to, as close as practicable, match the vegetation communities that would have existed prior to initial clearing. This rehabilitation is in addition to the revegetation of land disturbed by mine development.	Offset clearing associated with project development within the Bandalup Corridor.	Land Rehabilitated	To be completed prior to the completion of closure activities.	DCLM
3	Conservation Offsets	The proponent will avoid clearing remnant vegetation on land purchased by the proponent, except where specifically required for Project facilities and related infrastructure.	Reduce as much as practicable the area of land required to be cleared.	Annual Environmental Report	Overall	DCLM
4	Rehabilitation	The proponent will develop a Reabilitation Plan designed to rehabilitate disturbed areas to re-establish as close as reasonably practicable, similar vegetation communities as existed pre-mining, consistent with defined	Rehabilitate impacted areas to an acceptable standard, which will integrate the post-mining vegetation communities with the surrounding environment.	Rehabilitation Management Plan Annual Environmental Report	Pre-disturbance associated with pit development.	DCLM

No.	Topic	Commitment	Objective	Compliance Criteria	Timing	Advice
		post-mining landuse objectives. The program will specifically: • include detailed completion criteria to be met as the mining area progresses (completion criteria to be agreed in consultation with DCLM); and • identify suitable rehabilitation techniques by preliminary research into propagation of species during the initial years of mining.				
5	Rehabilitation	The proponent will implement the Rehabilitation Plan.	Demonstrate compliance with commitment 4.	Annual Environmental Report	Overall	
6	Surface Hydrology	The proponent will develop a Surface Water Management and Monitoring Plan which will address; • integrity of the water supply pipeline; • diversions of the Bandalup and Burlabup creeks; • runoff and water shadow effects from project earthworks; • storm water runoff from the processing plant; and • storage and handling of chemicals and reagents.	To take all reasonable and practicable measures to minimise detrimental impacts on the hydraulic function of drainage systems. To take all reasonable and practicable measures to minimise detrimental impacts on downstream water quality.	Annual Environmental Report	Pre-commissioning	WRC
7	Surface	The proponent will implement the	Demonstrate compliance	Annual	Overall	

No.	Topic	Commitment	Objective	Compliance Criteria	Timing	Advice
	hydrology	Surface Water Management and Monitoring Plan.	with commitment 6.	Environmental Report		
8	Groundwater	The proponent will prepare a Groundwater Management and Monitoring Plan, which will include; • Installation of a groundwater monitoring network (down hydraulic gradient) around the tailings storage facility, evaporation pond and process plant. • Installation of groundwater observation monitoring bores down hydraulic gradient of any groundwater abstraction bores. • A process for annually monitoring and reporting on groundwater levels and quality that exists within the lease boundaries.	Maintain the quality of groundwater exiting the Project boundaries to ensure that existing uses, including ecosystem function, are protected.	Installation of monitoring network.	Pre-commissioning Pre-construction Overall	WRC
9	Groundwater	The proponent will implement the Groundwater Management and Monitoring Plan.	Demonstrate compliance with commitment 8.	Annual Environmental Report	Overall	
10	Flora and Vegetation	The proponent will prepare a Flora and Vegetation Management Plan, that addresses: • the management and monitoring of impacts on	Protect Declared Rare and Priority Flora, consistent with the provisions of the Wildlife Conservation Act 1950. To ensure conservation	Flora and Vegetation Management Plan	Pre-disturbance associated with pit development.	DCLM

No.	Topic	Commitment	Objective	Compliance Criteria	Timing	Advice
		priority flora species within the Project area; • regional surveys to confirm the conservation status of priority species where required; • investigating the regeneration and seed ecology of specific species to determine appropriate regeneration methodologies; and • management and monitoring of impacts on significant vegetation communities within the Project area. (Note: This plan will supplement the requirements of condition 6 for a number of priority species flora.)	of priority flora and significant vegetation communities which occur in the Project area.			
11	Flora and Vegetation	The proponent will implement the approved Flora and Vegetation Management Plan.	Demonstrate compliance with Commitment 10.	Annual Environmental Report	Overall	
12	Dieback	The proponent will prepare a Dieback Management Plan for activities over which it has direct control or influence. This plan will include: • periodic surveys of project area to assess changes in dieback status;	Avoid the introduction or spread of disease.	Dieback Management Plan	Pre-construction	DCLM

No.	Topic	Commitment	Objective	Compliance Criteria	Timing	Advice
		• restrictions on vehicle movement; and • hygiene measures for earthmoving vehicles.				
13	Dieback	The proponent will implement the Dieback Management Plan.	Demonstrate compliance with Commitment 12.	Annual Environmental Report	Overall	
14	Vegetation	The proponent will undertake measures to avoid (where reasonable and practicable) disturbance to the area of vegetation to the west of Mason Bay Road (deemed "old growth vegetation") within any of its tenements during the period of the leases.	To ensure conservation of priority flora and significant vegetation communities which occur in the Project area. Protection of native fauna within the Bandalup Corridor.	Annual Environmental Report	Overall	
15	Priority Flora – *Kunzea similis*	The proponent will conserve *in situ* populations of *Kunzea similis* on Hale-Bopp deposit (currently estimated at 40% of known population), with a buffer zone of no less than 50 m as defined by Figure 4.	Protection of *Kunzea similis in situ.*	Mine plan	Overall	DCLM
16	Priority Flora – *Kunzea similis*	The proponent will develop a Kunzea Management Plan which will as a minimum; • Facilitate and undertake research studies and rehabilitation trials aimed at re-establishing viable *Kunzea similis*	Protection of *Kunzea similis.*	Kunzea Management Plan Annual Environmental Report	Pre-disturbance associated with pit development. Overall	DCLM

No.	Topic	Commitment	Objective	Compliance Criteria	Timing	Advice
		communities on areas disturbed by mining and other alternative sites. • Monitor progress of sites rehabilitated with *Kunzea similis.* (Note: This plan will supplement the requirements of condition 6.)				
17	Priority Flora – *Kunzea similis*	The proponent will implement the Kunzea Management Plan.	Demonstrate compliance with Commitment 16.	Annual Environmental Report	Overall	
18	Fauna	The proponent will form a sponsorship agreement with DCLM aimed at further study of the Heath Rat. The study framework will be agreed between the proponent, DCLM, and any supervising research institution. Topics for consideration in the framework could include: • basic species ecology; • habitat preferences; • population trends across the species known range; • use of satellite imagery to identify extent of potential habitat; and • estimates of total population numbers.	Facilitate greater understanding of the Heath Rat.	Sponsorship agreement with DCLM	Pre-construction.	DCLM
19	Fauna	The proponent will form a	Protection of native	Sponsorship	Pre-commissioning	DCLM

No.	Topic	Commitment	Objective	Compliance Criteria	Timing	Advice
		sponsorship agreement with DCLM to extend the Fitzgerald River National Park Western Shield baiting program to include the Bandalup Corridor and Project area.	fauna within the Bandalup Corridor.	agreement with DCLM		
20	Marine Flora and Fauna	The proponent will develop a Pipeline Construction Environmental Management Plan, which will include all measures to reduce the disturbance to marine flora and fauna associated with pipeline construction.	Maintain the ecological function, abundance and species diversity of marine flora and fauna.	Construction Environmental Management Plan	Pre-construction of seawater intake and return brine pipeline.	
21	Marine Flora and Fauna	The proponent will implement the Pipeline Construction Environmental Management Plan.	Demonstrate compliance with Commitment 20.	Annual Environmental Report	Overall	
22	Social Setting and Community	The proponent will actively facilitate the continuation of the Ravensthorpe Nickel Project Community Liaison Committee during construction and ongoing operation of the Project.	To assist with managing potential community effects from the construction, operation and closure of the Project.	Community Liaison Committee	Overall	
23	Heritage and Aboriginal Sites	The proponent will prepare a Heritage Management Plan that incorporates: • Training for all employees to make them aware of the significance of indigenous and non-indigenous heritage; • Procedures to identify and report internally such	Ensure that the proposal complies with the requirements of the *Aboriginal Heritage Act 1972* and any other statutory requirements in relation to areas of cultural or historical significance.	Heritage Management Plan	Pre- construction	DIA

No.	Topic	Commitment	Objective	Compliance Criteria	Timing	Advice
		indications; and • Procedures for external notification and reporting of potential heritage sites.				
24	Heritage and Aboriginal Sites	The proponent will implement the Heritage Management Plan.	Demonstrate compliance with Commitment 23.	Annual Environmental Report	Overall	
25	Air Quality	The proponent will provide predicted ambient air quality information to any interested members of the community when applying for a Works Approval under Part V of the *Environmental Protection Act 1986*, including. This information will include. • Predictive dispersion modelling for SO_2, SO_3, NO_x and particulates using collected onsite meteorological data and final plant design information. • Demonstrated compliance with relevant standards or guidelines with results obtained from dispersion modelling	Demonstrate compliance with ambient air quality criteria.	Air Quality Report	Pre-construction.	CLC
26	Greenhouse Gas Emissions	The proponent will prepare a Greenhouse Gas Management Plan that: • includes calculation of the greenhouse gas emissions	To ensure that GHG emissions from the Project are adequately addressed and best available efficient	Greenhouse Gas Management Plan Annual	Pre- commissioning	DMPR

No.	Topic	Commitment	Objective	Compliance Criteria	Timing	Advice
		associated with the proposal (using the generally accepted methods); • indicates specific measures adopted to limit greenhouse gas emissions for the Project; • includes monitoring of greenhouse gas emissions; • estimates the comparative greenhouse gas efficiency of the Project (per unit of product and/or other agreed performance indicators) with the efficiency of other comparable projects producing a similar product; and • provides an analysis of the extent to which the proposal meets the requirements of the National Strategy using a combination of •'no regrets' measures; •'beyond no regrets' measures; •land use change or forestry offsets; and international flexibility mechanisms.	technologies, as far as practicable, are used to minimise total net GHG emissions and/or GHG emissions per unit product. To mitigate GHG emissions in accordance with the Framework Convention on Climate Change 1992, and consistent with the National Greenhouse Strategy.	Environmental Report (including GHG emissions)		
27	Dust and Particulates	The proponent will prepare and implement a Dust Management Plan in consultation with DMPR and DEP. This plan will include ambient monitoring proposals to verify that dust levels comply	To ensure that dust levels generated by the Project do not adversely impact the ecological function or health and amenity of the	Dust Management Plan Annual Environmental Report	Pre-disturbance Overall	DMPR

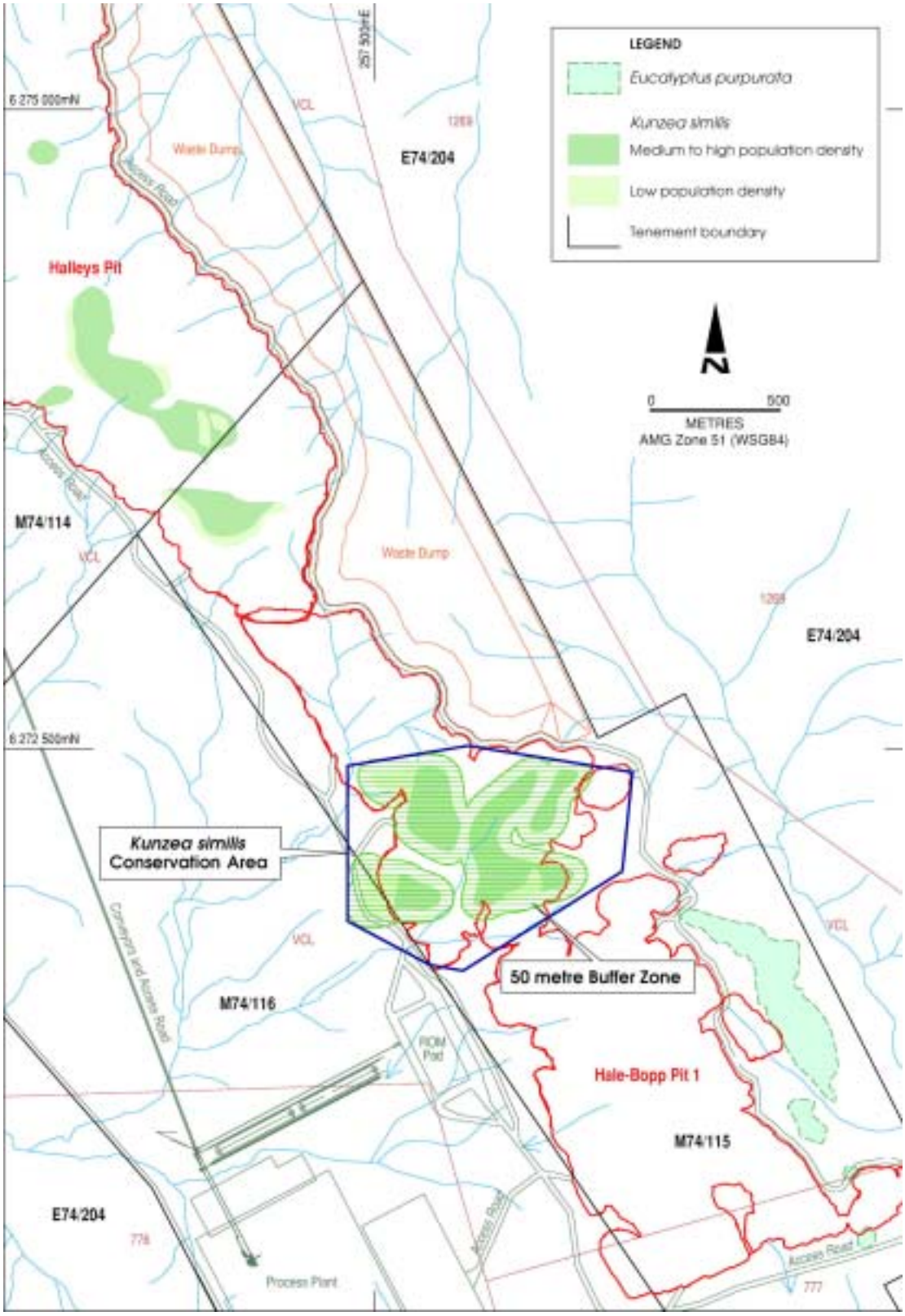
No.	Topic	Commitment	Objective	Compliance Criteria	Timing	Advice
		with the relevant standards or guidelines.	community.	Report		
28	Dust and Particulates	The proponent will implement the Dust Management Plan.	Demonstrate compliance with Commitment 27.	Annual Environmental Report	Overall	
29	Noise	The proponent will maintain a complaints register to record any nose related complaints from the public. This information will be used to revise noise management measures where investigation into the complaint identifies the need.	To maintain noise related amenity of surrounding community.	Complaints Register	Overall	
30	Blasting Vibration	The proponent will pay for independent structural integrity assessments to undertaken on all dwellings and buildings on properties that immediately neighbour blast sites. The proponent will repeat this process on (reasonable) request or on specified intervals and will make good any defect that has occurred as a result of blasting vibration.	To ensure that adjacent neighbours are not materially impacted by proponent blasting operations.	Completion of assessments.	Pre commencement of production blasting.	DMPR
31	Solid Waste	The proponent will develop a Waste Management and Waste Minimisation Plan, including; • measures to minimise waste generated by the activities on the premises; • training for all employees; • provision of adequate	Cleaner production and sustainability.	Waste Management and Minimisation Plan	Pre-commissioning	

No.	Topic	Commitment	Objective	Compliance Criteria	Timing	Advice
		waste storage containers.				
32	Solid Waste	The proponent will implement the Waste Management and Waste Minimisation Plan.	Demonstrate compliance with Commitment 31.	Annual Environmental Report	Overall	
33	Public Health and Safety	The proponent will develop a Hazardous Substances Management Plan, including; • Development of a register • Storage, handling and disposal requirements.	Ensure that risk is managed to meet the EPA's criteria for individual fatality risk off-site and the DMPR's requirements in respect of public safety.	Assessment completed.	Pre-construction	DMPR
34	Public Health and Safety	The proponent will implement the Hazardous Substances Management Plan.	Demonstrate compliance with Commitment 33.	Annual Environmental Report	Overall	
35	Closure	The proponent will prepare a Preliminary Closure Plan that provides the framework to ensure that the site is left in a stable and sustainable condition. The plan will include: • the establishment of appropriate vegetation communities; and • measures to reduce visual impact associated with mine development by designing post-mining landforms as close as practicable to resemble pre-mining landforms.	Maintain ecological integrity and long term landform stability.	Preliminary Closure Plan	Pre-construction	
36	Closure	The proponent will build on and implement the Preliminary Closure Plan within 5 years	To implement progressive closure.	Annual Environmental Report	Overall	

No.	Topic	Commitment	Objective	Compliance Criteria	Timing	Advice
		following commissioning.				
37	Environmental Management System	The proponent will demonstrate that an Environmental Management System for the Project has been implemented.	All risks are identified and management plans implemented for high risks. To meet BHP Billiton HSEC Management Standards.	HSEC Management System	Pre-construction and Overall	
38	Environmental Management Plan (Construction Phase)	The proponent will prepare and implement an Environmental Management Plan for the project construction phase. The plan will address the following; • Land disturbance • Water • Flora • Fauna • Waste • Air quality • Noise • Rehabilitation • Heritage • Incident management • Complaint management • Fire Management • Site induction • Performance reporting.	Implement and maintain an approved EMP in order to: • implement the Environmental Management System; • achieve the goals of protection of the environment, public and workforce.	Environmental Management Plan	Pre-construction	
39	Environmental Management Plan (Operations	The proponent will prepare and implement an Environmental Management Programme for the project operation phase. The	Implement and maintain an approved EMP in order to:	Environmental Management Plan	Pre-commissioning. Overall	

No.	Topic	Commitment	Objective	Compliance Criteria	Timing	Advice
	Phase)	plan will address the following: • Land disturbance • Water • Flora • Fauna • Waste • Air quality • Noise • Rehabilitation • Heritage • Incident management • Complaint management • Fire Management • Site induction • Performance reporting.	• implement the Environmental Management System; • achieve the goals of protection of the environment, public and workforce.			

Fig 1 *Kunzea similis* Mining Exclusion Zone



ATTACHMENT 2

THE EFFECTS OF ATMOSPHERIC EMISSIONS ON VEGETATION

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Document History and Status

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1. Introduction

Sinclair Knight Merz was commissioned by Ravensthorpe Nickel Operations Pty Ltd (RNO) to investigate the potential for proposed atmospheric emissions to impact on vegetation surrounding the project area.

RNO proposes to develop the Ravensthorpe Nickel Project involving the development of a mine, treatment plant and associated utilities, services and infrastructure to produce a nominal 45,000 tpa of nickel, by producing a mixed nickel cobalt hydroxide intermediate product (BHP Billiton, 2002).

The project is located approximately 35 kilometres east of the town of Ravensthorpe in the central south coast of WA (BHP Billiton, 2002).

A detailed environmental impact assessment was undertaken in the initial form of a Consultative Environmental Review and more recently under Section 46 (1) of the *Environmental Protection Act 1986* by BHP Billiton. RNO is a wholly owned subsidiary of the BHP Billiton Group.

Several detailed studies were completed including a survey of vegetation and air emissions modelling. During the Environmental Protection Authority's assessment of the project, the potential for atmospheric emissions to impact on vegetation was raised.

1.1 Purpose

The purpose of this document is four-fold:

- Summarise published research information regarding the effects of atmospheric emissions on vegetation;
- Obtain a preliminary understanding of the science and processes involved in assessing impacts on vegetation;
- Utilise this information in the context of the proposed project to predict potential impacts on vegetation; and
- Make recommendations for ongoing management to minimise the potential of impacts occurring.

This assessment is by no means a comprehensive impact assessment and is based only on published information that is available to Sinclair Knight Merz (ie desktop assessment). It is understood that a considerable amount of time, ongoing work including scientific experiments and monitoring is required to accurately determine environmental impacts from proposed atmospheric emissions.

2. Environmental Setting

2.1 Climatic Conditions

The project area is located in a region with Mediterranean climate. Prevailing wind directions are south-easterly to easterly through summer and north-westerly through winter.

Rainfall in the region is experienced throughout the year with an average annual rainfall of 423mm. The wettest months are May and July with the driest being January. Bureau of Meteorology data (for Ravensthorpe Station) indicates that rainfall is received on 110 days of the year on average.

2.2 Surrounding Land Use

The project is located within the Shire of Ravensthorpe, a wheat and sheep district. In addition to wheat, barley and lupins are grown in rotation. Sheep/lamb and cattle are stocked on many of the properties. Wool is also provided from the district. These agricultural practices surround the project area.

2.3 Characteristics of Surrounding Vegetation

BHP Billiton summarises that the native vegetation in the region generally comprises low mallee scrub (1 to 3m in height) interspersed with woodlands of small Eucalypts.

Vegetation Communities
Vegetation surveys undertaken as part of the environmental impact assessment of the project indicate that the process plant, being the source of atmospheric emissions, is surrounded (within 1 kilometre) by the following vegetation communities and flora species (refer to Figure 3-4 in Section 46):

- Woodland: Common species include *Eucalyptus platypus, E. cemua, E. indurata, E, clivicola, E. occidentalis, Melaleuca alliptica, Acacia glaucoptera, M. calycina* with *E. gardneri subsp. ravensthorpensi, Spyridium glaucum, Pultenaea sp.,* and *Beyeria sp.,* recognised as requiring special attention.
- Mallee Shrubland: Common species include *Eucalyptus pleurocarpa, E. flocktoniae, E. oleosa ssp. cornuva, E. phaenophylla ssp. interjacens, E. kessellii, E. ?mesopoda, E. annulata* and *Melaleuca coronicarpa*.
- Mallee Heath: Common species include *Agonis spathulata, Leptospermum oligandrum* with *Eucalyptus flocktoniae – Melaleuca coronicarpa* community recognised by the flora survey (Cockerton and Craig, 2000) as requiring special attention due to the presence of Priority Flora and providing habitats for Schedule 1 fauna.
- Thicket Shrubland: Dominated by *Eucalyptus lehmanii*.

Threatened Ecology Communities
A *Eucalyptus purpurata* ms community is an ecological community proposed for inclusion in the "Threatened Ecological Communities" database managed by CALM. This community is located adjacent to the Hale-Bopp deposit and is located within 2

kilometres and to the east of the process plant (refer to Figure 3-7 in Section 46 Environmental Review). *Eucalyptus purpurata* is also a Priority 1 Flora.

Declared Rare and Priority Flora

The following Priority Flora are located near to the process plant (refer to Figure 3-7 in Section 46 Environmental Review):

Within 1 kilometre:

- *Kunzea similis* - Priority 2 species community, located to the north of the process plant.
- *Boronia oxyantha ssp. brevicalyx* – Priority 3 species community, located to the east of the process plant.
- *Siegfriedia darwinioides* – Priority 4, located to the west of the process plant.
- *Eucalyptus stoatei* – Priority 4, located to the west of the process plant.

Within 2 kilometres:

- *Eucalyptus purpurata* ms – Priority 1 species community, located to the east of the process plant.
- *Astartea sp.* – Priority 1, located to the west of the process plant.
- *Stachystemon sp.* – Priority 1, located to the north west of the process plant.
- *Philotheca gardneri ssp. ?globosa* – Priority 1 located to the north west of the process plant.
- *Leucopogon pleuandroides* – Priority 2, located to the north east of the process plant.
- *Kunzea similis* - Priority 2 community, located to the north of the process plant.
- *Boronia oxyantha ssp. brevicalyx* – Priority 3 community, located to the east of the process plant.
- *Acacia ophiolithica* – Priority 3, located to the north and north east of the process plant.
- *Siegfriedia darwinioides* – Priority 4, located to the west of the process plant.
- *Eucalyptus stoatei* – Priority 4, located to the west of the process plant.
- *Eremophila densifolia ssp. densifolia* – special interest, located to the north of the process plant.

No Declared Rare Flora occurs within or near to the project area.

Agricultural Vegetation

There are seven adjacent farming properties to the project area which are typically involved on growing wheat, barley and lupin. Some of these properties also support pasture for grazing by cattle and sheep.

2.4 Proposed Atmospheric Emissions

Atmospheric emission modelling was undertaken by Sinclair Knight Merz (2000) and reported in BHP Billiton (2002). **Table 2-1** summarises the proposed emissions from the project with regard to ground level concentrations outside and within the project lease. **Table 2-2** provides details of the proposed emission loads based on data provided in Sinclair Knight Merz' air quality assessment.

- **Table 2-1 Predicted Maximum Ground Level Concentrations Outside and Within Project Leases**

Pollutant	Average Period	Maximum Ground Level Concentration (µg/m^3)	Maximum Ground Level Concentration (µg/m^3)
		Within Lease	Outside Lease
Normal Operating Conditions			
NOx	15-minute	194	-
	1-hour	-	95
	1-year	-	14
SOx	15-minute	203	-
	1-hour	-	125
	1-day	-	19
	1-year	-	2.1
Sulphuric Acid Mist	3-minute	-	3.5
	15-minute	3.5	-
PM10	1-day	-	5.5
Acid Plant Start Up			
NOx	15-minute	244	-
	1-hour	-	130
SOx	15-minute	1530	-
	1-hour	-	950
Sulphuric Acid Mist	3-minute	-	9.9
	15-minute	10.8	-
Acid Plant Start-Up			
Sulphuric Acid Mist	3-minute	-	550
	15-minute	526	-

- **Table 2-2 Proposed Emission Loads Under Normal Operations**

Pollutant	Emission Rate (g/s)	Load (t/yr)
SOx	60.9	1921
NOx	17.6 (2.56 with no boilers)	555 (81 with no boilers)
Particulate	0.16	5.05
Sulphuric Acid Mist	0.075 kg/t product	3.4

Notes: Annual load based on 24 hr and 365 day operation

Preliminary design information and air quality modelling both add a level of conservatism. As the design of the process plant and other utilities has progressed, the need for two diesel boilers has been removed. The boilers were a major source of NOx contributing about 70% to total NOx emissions (from Table 3-1 in Sinclair Knight Merz, 2000). The emissions predicted above are based upon preliminary design and include the boiler. When in operation, NOx emissions will be significantly lower.

Predicted emission estimates are conservative and based upon model outputs from ISC-PRIME. The model CALPUFF was also used for emission estimates and predicts maximum concentrations of SO_2 to be about 45% of those predicted from ISC-

PRIME. Thus the results presented above are considered conservative and worst-case. Worst case meteorological conditions are also included in modelling. Therefore, it is likely that during operation actual emissions may vary and potentially be lower than initially proposed.

The proposed emissions from normal operation are within relevant national air quality guidelines. Only during start up or upset conditions, given worst case meteorological conditions, does the plant have the potential to exceed the National Environmental Protection Measure (NEPM) standard for SOx and acid mist in the order of 1.67 and 17 times, respectively (BHP Billiton, 2002). It is estimated that the probability of the guideline being exceeded is once in every 182 and 65 years, respectively.

2.5 Proposed Ground Level Concentrations and Location of Vegetation Communities

Vegetation mapping and atmospheric contour data generated from ISC-PRIME have been combined in **Figures 2-1 to 2-5** to illustrate proposed emissions and resultant ground level concentrations in relation to the location of vegetation communities.

Atmospheric modelling was undertaken for a defined project area as illustrated by **Figure 2-1**. Therefore, atmospheric contour data only extends to the immediate vicinity of the project area and does not encompass adjacent agricultural properties and the wider region.

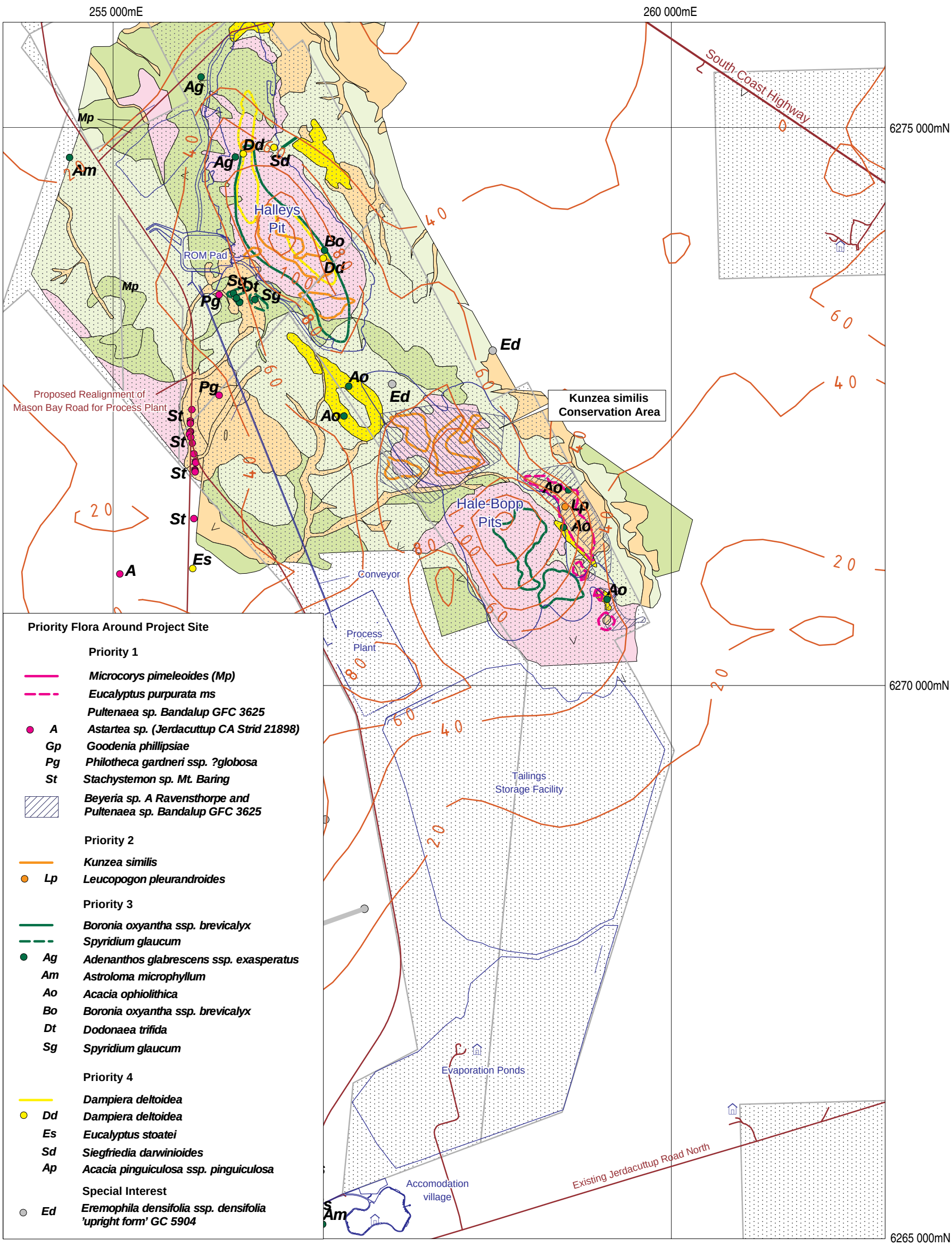
The following observations are made for each specific emission:

- NOx maximum 1–hour: highest concentrations are restricted to the immediate vicinity of the process plants. Concentrations of 150 $\mu g/m^3$ occur over two areas:
  - the western boundary of the Hale-Bopp Pit supporting Mallee Shrubland and Mallee Heath. No priority flora occurs in this area.
  - Offsite and about 2 kilometres to the south west of the process plant. No vegetation mapping occurs for this area.
- NOx maximum annual average: highest concentrations are restricted to the immediate vicinity of the process plant only. Average concentrations of 0.2 $\mu g/m^3$ extend marginally over the tailings storage facility.
- SOx maximum 1-hour: highest concentrations from 150 $\mu g/m^3$ to 250 $\mu g/m^3$ occur over the western portion of Halleys Pit where Priority 3 flora are located in Woodland and a Priority 1 flora in Mallee Shrubland. Also occurring is thicket shrubland, of which most is likely to be disturbed by mining of Halleys deposit.

  These ground level concentration also occur to the north east of Halleys Pit. No vegetation mapping occurs for this area.

- SOx maximum annual average: highest concentrations from 2 to 3 $\mu g/m^3$ also occur over the western portion of Halleys Pit affecting the same vegetation communities. The ground level concentrations are also observed within the immediate vicinity of the process plant.

- Sulphuric Acid maximum 3-minute average: highest concentrations from 6 to 12 $\mu g/m^3$ occurs directly over and within the extent of Halleys pit. Vegetation bordering Halleys pit is Mallee Shrubland and Mallee Heath.



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Vegetation and Maximum 1-hour Concentrations of Nitrogen Dioxide from ISC-PRIME

Figure 2 - 1

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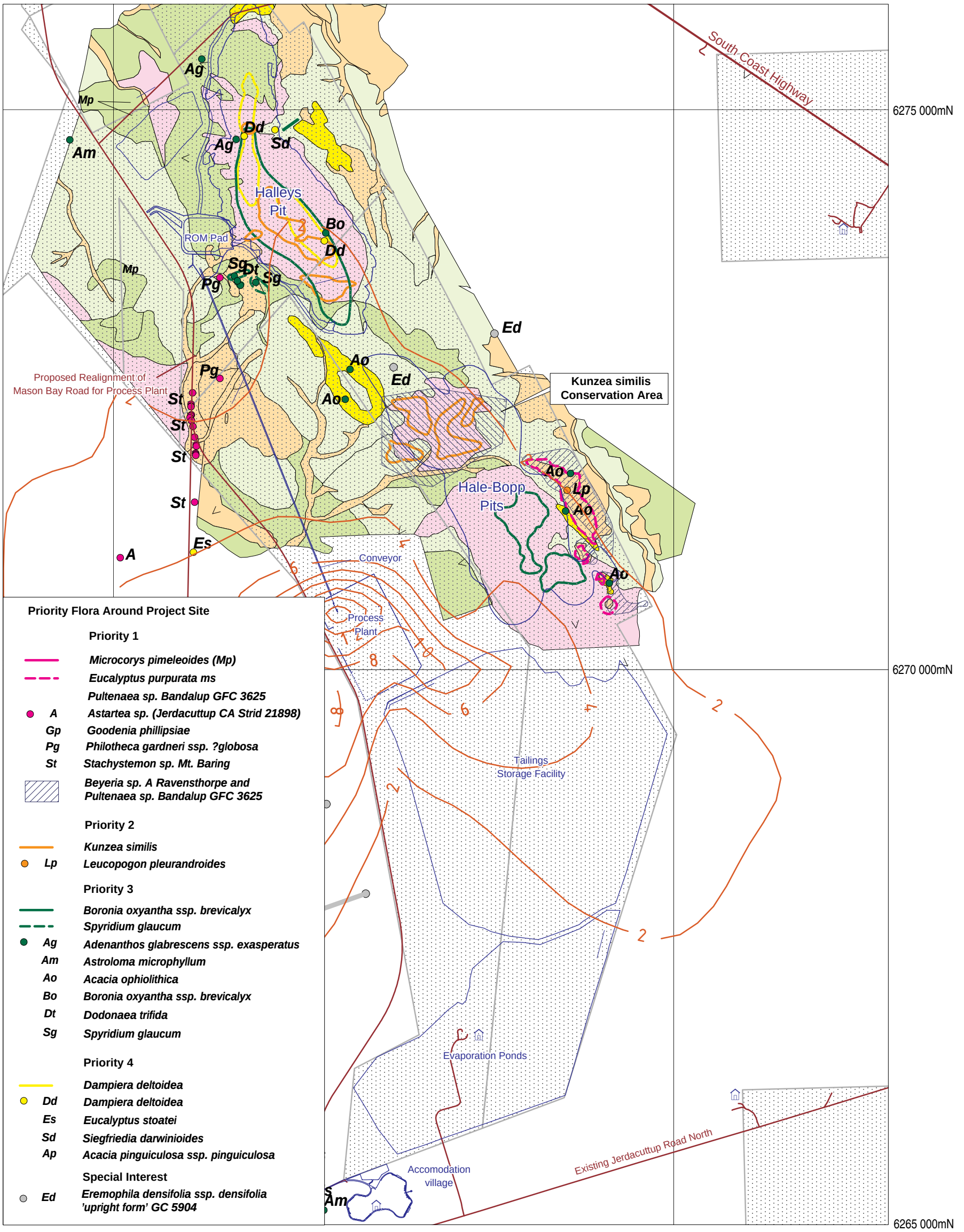

SINCLAIR KNIGHT MERZ

Vegetation and Maximum Annual Average Concentrations of Nitrogen Dioxide from ISC-PRIME

Figure 2 - 2

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255 000mE

260 000mE

6275 000mN

6270 000mN

6265 000mN

South Coast Highway

Halleys Pit

ROM Pad

Proposed Realignment of Mason Bay Road for Process Plant

Kunzea similis Conservation Area

Hale-Bopp Pits

Conveyor

Process Plant

Tailings Storage Facility

Evaporation Ponds

Accomodation village

Existing Jerdacuttup Road North

Ag Mp Am Dd Sd Bo Sg Dt Pg Ed Ao St Es A Lp

Priority Flora Around Project Site

Priority 1

- *Microcorys pimeleoides (Mp)*
- *Eucalyptus purpurata ms*
- *Pultenaea sp. Bandalup GFC 3625*
- A — *Astartea sp. (Jerdacuttup CA Strid 21898)*
- Gp — *Goodenia phillipsiae*
- Pg — *Philotheca gardneri ssp. ?globosa*
- St — *Stachystemon sp. Mt. Baring*
- *Beyeria sp. A Ravensthorpe and Pultenaea sp. Bandalup GFC 3625*

Priority 2

- *Kunzea similis*
- Lp — *Leucopogon pleurandroides*

Priority 3

- *Boronia oxyantha ssp. brevicalyx*
- *Spyridium glaucum*
- Ag — *Adenanthos glabrescens ssp. exasperatus*
- Am — *Astroloma microphyllum*
- Ao — *Acacia ophiolithica*
- Bo — *Boronia oxyantha ssp. brevicalyx*
- Dt — *Dodonaea trifida*
- Sg — *Spyridium glaucum*

Priority 4

- *Dampiera deltoidea*
- Dd — *Dampiera deltoidea*
- Es — *Eucalyptus stoatei*
- Sd — *Siegfriedia darwinioides*
- Ap — *Acacia pinguiculosa ssp. pinguiculosa*

Special Interest

- Ed — *Eremophila densifolia ssp. densifolia 'upright form' GC 5904*

Vegetation Formation

W	Woodland	S	Scrub
MS	Mallee Shrubland	H	Heath
TS	Thicket Shrubland	SH	Sedge Heath
MH	Mallee Heath		

- Residence
- Concentration Contours
- Road
- Track
- Proposed Mine Operations Layout
- RNO Tenement Boundary

0 1 2 Km

AMG Zone 51 (AGD 84)

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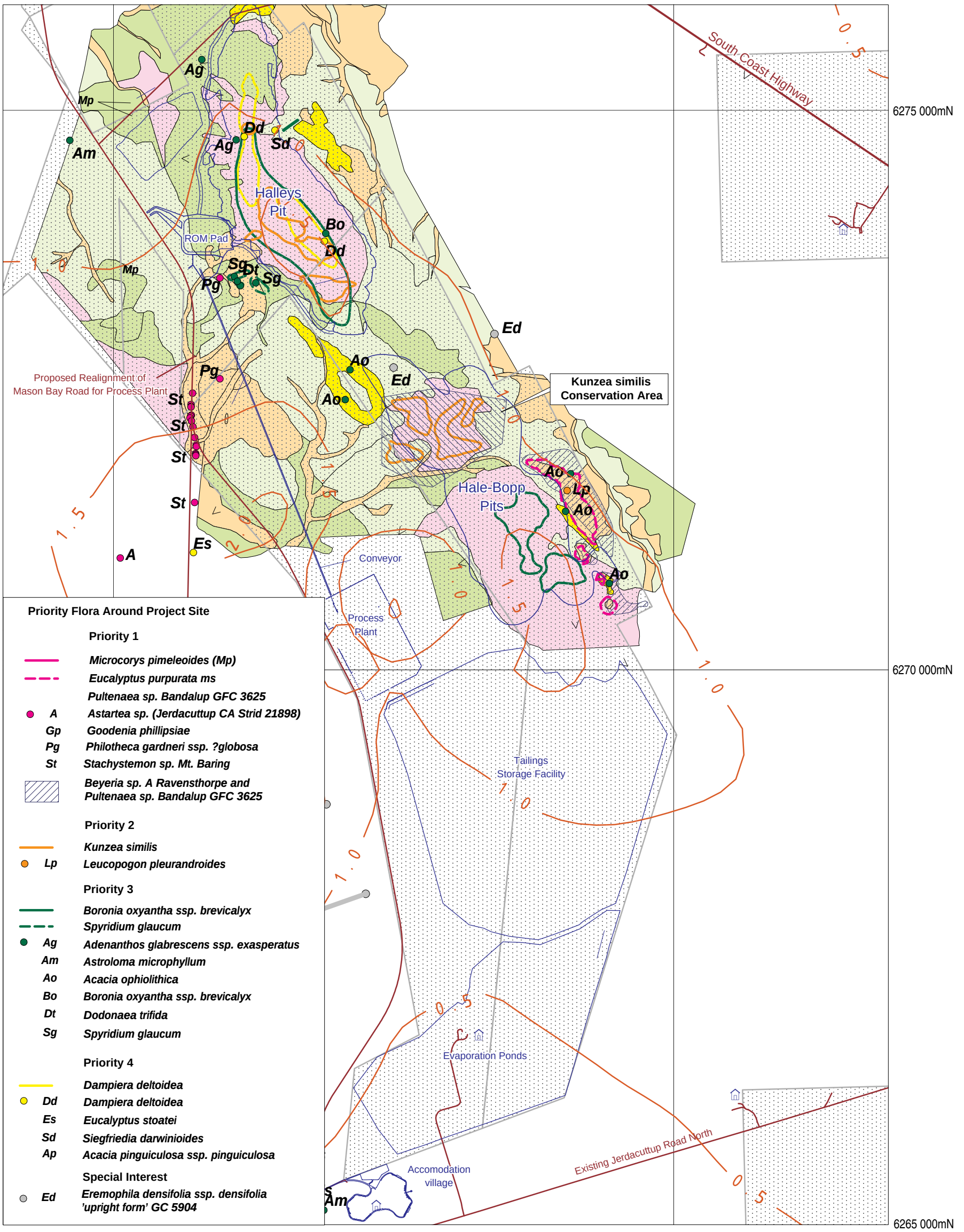
Vegetation and Maximum 1-hour Concentrations of Sulphur Dioxide from ISC-PRIME

Figure 2 - 3

\Project\de01711.001\workspace\map_priority_flora.wor



Vegetation and Maximum Annual Average Concentration of Sulphur Dioxide from ISC-PRIME

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Figure 2 - 4

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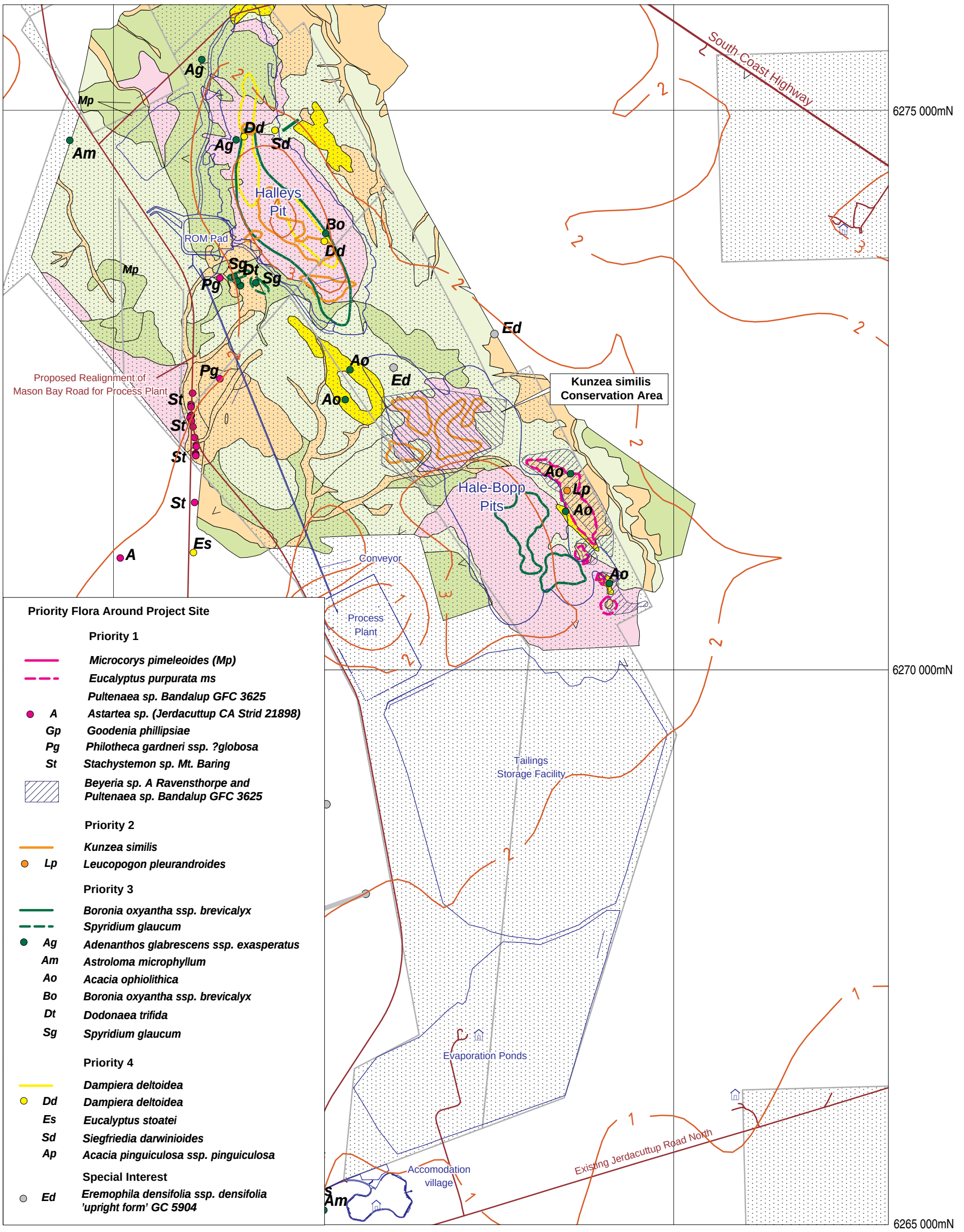

Vegetation and Maximum 3-Minute Average Concentration of Sulphuric Acid from ISC-PRIME

SINCLAIR KNIGHT MERZ

Figure 2 - 5

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3. Atmospheric Deposition

3.1 Introduction

SOx and NOx are transformed in the atmosphere to sulphuric and nitric acids through several complex reactions with atmospheric components. The gases and resultant acids can be returned to the earth's surface via two main mechanisms, these being wet and dry deposition.

The following sections provide an overview on each of these mechanisms.

3.2 Wet Deposition

Wet deposition describes the deposition of acidic pollutants through rainfall, and is commonly referred to as 'acid rain'. This form of deposition is dominant during periods of high rainfall and can cause pollutants to be distributed over a wide area. Acid rain would typically comprise carbonic acid, nitric acid and sulphuric acid and is formed through the process of removing water soluble gases, aerosols and particles from the atmosphere. It is estimated that rates of oxidation of SOx and NOx to their respective acids are in the order of 1% per hour (NZ Ministry for the Environment, 1998).

Wet deposition can occur through two main pathways, these being washout and scavenging. The two pathways are described as follows (NZ Ministry for the Environment, 1998):

- Washout refers to the process by which the gas or aerosol is absorbed by cloud droplets and eventually falls to the surface in precipitation. Washout can occur over a wide range of distances and directions from the source; and
- Scavenging involves precipitation absorbing gas or particles after it has commenced its descent from the clouds.

3.3 Dry Deposition

Dry deposition refers to the fall-out of gases and particulates on the ground surface without any interaction with water. Dry deposition tends to occur close to the source of pollution, depending upon prevailing weather conditions, and dominates in dry climates (EPA, 2001).

Both wet and dry deposition processes are likely to occur in the Ravensthorpe region as rainfall occurs all year round and there are periods of dry weather in summer.

3.4 Deposition Rates

Acids and their precursors typically have atmospheric residence times of a few days, and tend to be deposited within a distance of several kilometres of the source. Rates of deposition are dependent upon many factors including plume concentration, atmospheric stability, friction velocity, temperature and humidity (NZ Ministry for the Environment, 1998).

Previous studies undertaken in Australia have demonstrated that deposition rates can vary from 0.54% (Burrup Peninsula (URS, 2002)) to 5% (Kalgoorlie, Mt Isa (Carras *et al*, 1992)) of total emissions. No depositional studies have yet been undertaken in southwestern Australia.

Deposition rates can be estimated by modelling atmospheric emissions. The models, CALPUFF and TAPM can be queried to determine dry deposition rates of NO_x and SO_x.

In the absence of specific deposition rates, it is difficult to provide an adequate prediction of the likely fallout of NO_x, SO_x and particulates that may occur from the proposed project.

4. Effect of Atmospheric Emissions on Plants

4.1 Introduction

It has been highlighted by previous studies that it is difficult to define the impacts of NOx and SOx on vegetation as they both stimulate plant growth at very low doses, however a small incremental increase can quickly lead to toxicity (Mansfield, 1999; 2002). Studies have demonstrated that nitric acid contributes considerably less to the acidification of ecosystems compared to sulphuric acids (McLean, 1981), with an estimated ratio of 0.8 to 1 respectively (Galloway *et al*, 1982). Different plant species demonstrate various levels of tolerance. It is important to undertake site specific tests on impacts of vegetation as climate can have a two fold effect by influencing pollutant uptake and formation of secondary air pollutants (Emberson *et al*, 2001).

Currently, the information detailing the effects of air pollution on Australian vegetation is limited due to the relatively small amount of sulphur and nitrogen oxides emitted compared to the emission rates in Europe, USA and Japan. Due to the limited amount of information regarding the impact of atmospheric deposition on Australian flora, a large proportion of the following assessment discusses the impacts that have been observed and measured in other parts of the world. Where possible, reference has been made to Australian conditions.

4.2 Pollutant Gaseous Uptake and Plant Functioning

Plant response to increases in atmospheric concentrations of NOx and SOx in polluted areas varies largely on the conductance of pollutant gases through stomata. Much smaller quantities of nitrogen and sulphur can also be taken up through the cuticle (Kerstiens, 1996; NZ Ministry for the Environment, 1998). Those flora species having a waxy cuticle, a common characteristic of many Australian native flora, that covers the epidermal leaf cells show increased resistance to pollutant gases. However in some cases leaf damage has been observed when NOx and SOx deposited on cuticles react with the wax components (WHO, 1987).

Clearly, those plant species with higher rates of uptake (stomatal conductance) are more susceptible to damage (eg sunflower and radish) in contrast to those with lower conductances that demonstrate a high degree of tolerance (eg maize and sorghum) (Okano *et al*, 1988).

Under controlled conditions, the concentration, duration and pattern of exposure, light, temperature, relative humidity, soil moisture, mineral nutrition of the soil and plant age influences the response of plants to NOx and SOx emissions (World Bank Group, 1998; Murray, 1984; Lacasse and Treshow, 1978). So does a plant's natural ability to neutralise and detoxify toxic compounds. Various biochemical and physiological mechanisms react to remove toxins in the overall aim to maintain an internal ionic balance (NZ Ministry for Environment, 1998).

A plant responds to these effects by neutralising and immobilising the pollutant gases into compounds that it can sequester, for example through oxidative detoxification. Long-term resistance via oxidative detoxification will induce additional cation demand (Heber and Huve, 1998; Slovik, 1996). This requires the plant to mobilise

cations in the root system thus demanding available cations from the soil. This mechanism often requires some form of soil fertilisation to sustain the plant. Where the soil is deficient in cations (e.g K^+ and Mg^{2+}), which is typical in many soils of southwest WA (particularly farmed soils), uptake of NOx and SO_2 can lead to mineral deficiency symptoms including reduced canopy and root growth rates. Bobbink *et al* (1992) observed that losses of calcium, magnesium and potassium through the leaf canopy are stimulated at deposition rates of $9g/m^2/yr$ of nitrogen and $10.3g/m^2/yr$ of sulphur. The ability to regulate the influx of nutrients through root uptake provides a plant the ability to compensate for these losses by sourcing equivalent amounts of essential nutrients from the soil. If soil is deficient in such nutrients then mineral deficiency symptoms are likely to occur.

4.2.1 NOx

The fate of NOx (in the form of either NO or NO_2) that has diffused through stomata into the cellular components of the leaf is complex and involves various processes and mechanisms by which NOx is transformed to produce NH_4^+ as documented by Mansfield (2002). Some studies have shown that uptake of NO is much less compared to NO_2 but is about four times more inhibitory to photosynthesis than NO_2 (Stulen *et al*, 1998; Mansfield, 2002).

Various investigations have shown that NO_2 fumigation of plants cause a decrease in NO_3^- root uptake in the same order of the amount of NOx gained through stomatal conductance (Muller *et al*, 1996). These mechanisms by which plants are able to regulate root uptake of nitrogen in response to increasing atmospheric NOx are important and it is this ability of a plant that provides an indication of the plants tolerance to withstand NO_2 pollution. Although plants have the ability to regulate the root uptake of NOx, they do not show the same ability to regulate NOx uptake through stomata (Nasholm, 1998).

NOx can have a varied impact depending upon the level of exposure to plants. Mansfield (2002) summarises that rate of absorbtion of NO_2 per unit leaf area has been measured to increase linearly with increasing atmospheric concentrations from 0 to 1880 $\mu g/m^3$, and that concentrations of 565 $\mu g/m^3$ have shown to be beneficial for some nitrate-deficient plants in the short term (Okano and Tatsuka, 1986; Rowland *et al*, 1987). On the other hand, exposure to elevated and prolonged concentrations is likely to result in toxicity and injury. Early research suggested that exposure to levels of 3,000 to 4,890 $\mu g/m^3$ up to 48 hours would result in leaf injury to trees and exposure to levels as high as 37,600 $\mu g/m^3$ might result in visible injury within 1 hour (Smith, 1981).

Section 4.7 provides a summary of observed impacts on vegetation from varying levels of exposure to pollutant mixes as documented by several studies.

Specific to more local conditions, NO_x fumigation tests on Eucalyptus species and wheat have been undertaken in Western Australia. Eucalyptus species that have been investigated and their response to 2-hour exposures include (Murray *et al*, 1994a):

- *Eucalyptus microcorys* – increased growth with increasing exposure;
- *Eucalyptus marginata* – response was not found to be significant;

- *Eucalyptus globulus* – increased growth at low exposures (about >100µg/m^3), but decreased at high exposures (>170µg/m^3); and
- *Eucalyptus pilularis* – increased growth at low exposures (about 10µg/m^3), but decreased at high exposures (>50µg/m^3).

Studies on wheat have shown that NO_2 exposure (170 µg/m^3) contributes positively to vegetative growth and yield of wheat plants. An increase in mean plant dry matter of 47% was measured and an increase in mean grain yield of 118% (Murray *et al*, 1994b).

All of the above conservation indicate clearly that there is a threshold between concentrations that are non-toxic and toxic to vegetation. This threshold will vary between flora species. Given that proposed NOx emissions from the project will be well below those stated in **Table 2-1**, due to the removal of diesel boilers, the surrounding environment is likely to be exposed to very low concentrations of NOx. Given the above observed effects for Eucalyptus sp. and a reduction in the order of about 70% of initial predicted emissions, adverse impacts on vegetation are considered unlikely.

4.2.2 SOx

Plants usually uptake small quantities of sulphur from the soil via the roots where it is translocated to the leaves and transformed through various processes to organic sulphur compounds (Marschner, 1995). If the soil is sulphur deficient then plants are able to source sulphur from the atmosphere in the form of SO_2 and other sulphur compounds when present at low concentrations. When plants take up excess sulphur adverse impacts are likely to occur. SO_2 is considered to be the most phytotoxic molecule of the sulphur gases (Legge *et al*., 1998).

Several investigations have reported that SOx is more toxic to plants and ecosystems than NOx. This has included quantitative analyses of the impacts of SO_2 and NOx on Norway Spruce where the relative phytotoxicity of SO_2 was 2.0 to 2.6 times higher than NO_2 (Slovik, 1996).

Exposure to SO_2 is toxic and has the ability to bleach chlorophyll. Generally those climatic conditions which are conducive to high growth and photosynthesis rates, result in high SO_2 sensitivity.

The long term dosage of sulphur influences the plant response, with plants in regions of high sulphur concentrations tending to be more sensitive to additional SO_2 fumigations than plants in low SO_2 environments (Lacasse and Treshow, 1978). Further to this, the combination of SO_2 with other pollutants can increase plant damage by lowering plant tolerance levels. Pollutant mixes are discussed in **Section 4-7**.

Typical symptoms observed on broadleaved plants exposed to acute SO_2 concentrations include bifacial, marginal and/or interveinal necrosis and chlorosis on leaves at full stage of development (Legge and Krupa, 2002). Necrotic areas have been reported to range in colour from white to reddish-brown to black, depending upon the plant species subject to exposure.

Cereal crops in Europe exposed to SO_2 levels of 43 ug/m^3 over a prolonged period of 273 days have shown reduced growth and yields (NZ Ministry for Environment, 1998). Exposure of wheat to SO_2 concentrations of 387µg/m^3 have shown little response however at higher concentrations <681µg/m^3 growth is severely retarded (Murray *et al*, 1994b).

Specific investigations into the effects of SO_2 on Australian native species indicate that plants belonging to the *Eucalyptus* species vary in sensitivity (Wilson and Murray, 1994; O'Connor *et al*., 1974). Some species have shown no affect to SO_2 whilst others are very sensitive. *Eucalyptus regnans* and *Eucalyptus pilularis* were found to be significantly affected at SO_2 concentrations of 455 µg/m^3 for a 4-hour exposure period with decreased biomass and height. *Eucalyptus microcorys* was found to be sensitive at lower levels of SO_2 ranging from 315 µg/m^3 for a 4-hour exposure period causing a reduction in stem diameter (Wilson & Murray, 1994) Earlier studies by the authors show the long-time (5 months) exposure of *Eucalyptus calophylla* to levels of 125µg/m^3 are beneficial and have a fertilisation effect, inducing increased biomass (Murray and Wilson, 1989). However, increasing levels to 261µg/m^3 has a toxic effect, affecting foliage density. Similar effects at similar exposure levels, but for 8-hour exposure periods, (132µg/m^3 and 274µg/m^3, respectively) were found for *Eucalyptus rudis* (Clarke and Murray, 1990).

Lichens have been used in an assessment of low level SO_2 emissions from an alumina refinery in South-Western Australia (Kaeding and Kidby, 1987). Lichen species located up to 4kms from the emission source showed SO_2 sensitivity, however no mortality was recorded. Lichens are generally more sensitive to atmospheric pollutants and are well recognised for their use as indicator species in monitoring programmes (Kaeding and Kidby, 1987 ; Wadleigh and Blake; 1999; Bates; 2002).

General observations on other Australian natives that include *Casuarina*, *Acacia*, *Hakea*, *Kunzea* and *Melaleuca* indicate that these are not as sensitive as plants belonging to the *Eucalyptus* species (O'Connor *et al*., 1974) and leguminous species tend to be more sensitive than grasses (Murray, 1984).

Comprehensive laboratory testing of plants exposed to SO_2 by O'Connor *et al* (1974) reveals that:

- Acacia species show varied sensitivity (unaffected to moderately sensitive) depending upon the species when exposed to 2620 µg/m^3 to 7860 µg/m^3 for 4 to 6 hours. None of the species tested occur within the project area surveyed by Cockerton and Craig (2000);
- *Agonis flexuosa* was unaffected and extremely resistant to the above exposure level. This species does not occur in the project area but is common in southwest WA;
- Banksia species are moderately resistant (*B. ericigolia* and B. *inegrifolia*) whilst others are moderately sensitive (*B. collina* and *B. marginata*) to the above exposure level. Again none of these species have been surveyed in the project area;
- Bottlebrush species (Callistemon sp.) are generally resistant and moderately resistant to the above exposure levels. None of the species tested occur within the project area.

- Casuarina species show no affect or are considered extremely resistant to the exposure levels. None of the species occur within the project area;
- Eucalyptus species show varied sensitivity (unaffected to sensitive) depending upon the species. *Eucalyptus traptera* was found to be extremely sensitive to the exposure levels. This species was surveyed in the project area;
- Hakea species are extremely and high resistant. *Hakea laurina* was tested and also occurs within the project area was found to be extremely resistant.
- Melaleuca species show varied sensitivity (extremely resistant to moderately sensitive). *Melaleuca elliptica* was tested and found to be highly resistant. This species was surveyed in the project area by Cockerton and Craig (2000).

These exposure levels are extremely high, and are at least twenty times higher than the predicted maximum 1-hour SO_2 levels that are proposed.

4.2.3 Particulates

The New Zealand Ministry for the Environment (1998) reports that there are limited adequate investigations on the effects that particulate deposition may have on vegetation. Concerns have focussed on the effects of fire particulates (eg <10µg/m PM_{10} or <2.5µg/m) on human health.

The limited studies that have been published indicate that the impact of particulates on plants varies depending upon the size of the plant, cumulative effects, soil and particulate chemistry and the size of the particle.

Noted impacts have included the smothering of foliage, change to soil chemistry and blocking of stomata (note stomata are probably 8-10 microns in size)(Farmer, 2002).

The chemical reactivity of the particulate will determine the nature of the impact on vegetation. Particulates which are relatively inert are most likely to have a physical impact on vegetation. Particulates which a chemically reactive can lead to physiological damage. Particulates of calcareous origin (eg limestone) are known to cause extensive problems for vegetation (Farmer, 2002) by altering the pH of the soil/substrate conditions & water that may occur on leaves. Those plants protected by a thick waxy cuticle are more likely to be impacted by particulates that penetrate the surface rather than those that are deposited on the cuticle (Farmer, 2002).

The observed symptoms from particulate deposition include:

- Alteration of transpiration rates;
- Elevated temperatures in leaves and resultant affect on metabolic functions;
- Reduced photosynthesis;
- Bark peeling and dieback of branches and death of trees;
- Leaf lesions; and
- Reduced growth.

4.3 Effects of Wet Acid Deposition

Previous sections have focussed on dry deposition and the uptake of NO_x and SO_x by vegetation in a gaseous phase.

There are a limited number of experimental studies undertaken on native vegetation on an international and national level. The focus of many of these studies have been on agricultural crops due to the economic impact that occurs with adverse effects.

Dew and water droplets on leaves can become acidic through the absorption of NO_x and SO_x in the atmosphere to produce sulphuric & nitric acids. Depending upon the acidity of the water, it can cause acute foliar injury as necrotic areas with regular margins (Legge and Krupa, 2002). The potential for acidic droplets to become concentrated via evaporation is also an issue (Ashenden, 2002).

Both acute and chronic exposures may lead to long-term reductions in plant growth and productivity (Smith, 1990). In some instances, this may occur in the absence of visible chronic foliar injury symptoms (Legge and Krupa, 2002).

Generally the symptoms from acute and/or chronic exposure is highly variable at the genus, species, variety and population levels (Karnosky, 1985; Tingey and Olszyk, 1985). Factors such as leaf morphology, surface wettability, temperature, humidity and air turbulence influence the capture and retention of droplets (Ashenden, 2002). Visible leaf injury can occur in the form of leaf lesions, chlorosis, necrosis and wilting of leaf tips (Jacobsen, 1984) in the presence of acidic precipitation below pH 3.4 (Ashenden, 2002).

Exposure to acid mists with a pH of 2.5 have been shown to have no visible leaf damage to leguminous crop species (Ashenden and Bell, 1989). Lichens are likely to be more susceptible to the effects of acid deposition due to the lack of a protective cuticle (Ashenden, 2002).

4.4 Effects on Seed Yield and Regeneration

The sulphur content in plants is utilised to prevent damage by oxidising chemicals such as ozone. In this respect, the presence of low levels of sulphur in the environment may be perceived as beneficial. However chronic exposures, ie over whole growth season and entire life cycles, can lead to retarded flowering, abscission, reduced yield and seed development and possibly reduced nutritional quality in crops. These effects will be of most immediate concern for the agriculture and horticulture industries, but will also be of concern to maintaining biodiversity and long term survival of priority flora and vegetation.

Specific investigations by Murray *et al* (1994) on the effects of NO_2 on wheat grain yield indicate that 4-hour exposures per day over 108 days to NO_2 levels of 170 $\mu g/m^3$, showed an increased in the mean grain yield of 118%. Exposure to SO_2 concentrations of up to 380 $\mu g/m^3$ in the same conditions had negligible effect but at higher concentrations (>680 $\mu g/m^3$), the growth of wheat was severely affected. These exposure levels of NO_2 and SO_2 are approximately twice the predicted maximum 1-hour concentrations for the project.

Pollen distribution can be indirectly affected by floral bleaching or changes to nectar production which result from a reduction in photosynthetic activity (NZ Ministry for the Environment, 1998). Exposure to SO_2 has also demonstrated adverse effects on anther development, pollen germination, pollen growth, seed germination and seed growth in *Pinus sylvestris* (Venne *et al*, 1989). Exposure levels causing these effects were in the order of 170 to 270 $\mu g/m^3$ of SO_2 and 340 $\mu g/m^3$ of ozone and indicates that perhaps *Pinus* sp are more sensitive to SO_2 than wheat. These levels remain very much higher than predicted emissions from the project

4.5 Effects on Plant Populations

Where vegetation is exposed to chronic levels of NOx and SOx, effects on the individual plant level and also at the population level is likely to occur. These chronic levels will depend upon the sensitivity of the vegetation community exposed to air pollutants and will thus vary considerably from region to region. Where pollutants exist in high enough concentrations in the atmosphere, individual plants will try to avoid, tolerate and compensate for the pollutant effects (NZ Ministry for the Environment, 1998). Through these responses and effects on seed yield, regeneration and germination, studies have observed genetic drift, mutation and specific changes to certain genetic parameters within the population (WHO, 1987; Scholz *et al*, 1987; Degen and Scholz, 1998).

Long lived species have included forest trees which have been found to have a higher degree of genetic variation and are capable of adapting to changing environmental conditions and escaping adverse effects from pollution (Ashmore, 2002). It is this ability that maintains a stable forest ecosystem in the face of changing environmental conditions. Those species that do not possess a high degree of genetic variation are often short lived, yet may be of high conservation significance.

The effects of chronic exposure on some species is often enough to reduce the ability of the plant to compete for essential trace elements required for growth (Legge and Krupa, 2002). This is most likely to occur in heavily polluted areas having typical ground level concentrations of SO_2 varying from 524 to 5240 $\mu g/m^3$. The more resilient species within a community are then more likely to out compete and dominate in the community.

4.6 Indirect Effects

4.6.1 Soil Acidification

Generally, visible plant damage occurs at soil pH levels between 2 and 4, while significant growth reductions can occur at less acidic pH levels (Roser and Gilmour, 1995). In addition, over long periods, small excess hydrogen ion inputs through acid rain can have a significant effect on soil pH, although it can take many years for the acidification problem to become noticeable (Roser, 1995). The buffering capacity of soils can neutralise the acidity in the rainfall, however this ability depends on the soil type and location.

Long-term acidification may lead to the progressive reduction in pH. A change in one pH unit represents a ten fold increase in acidity. With increased acidity the following may occur:

- Leaching and mobilisation of cations, some cations being potentially toxic in high concentrations eg aluminium;
- Decrease in nitrification; and
- Accumulation of litter (Bobbink and Lamers, 2002).

4.7 Pollutant Mixes

Various studies have concentrated on the impacts of singular atmospheric pollutants ie NOx and SOx in isolation. Since atmospheric pollutants are likely to occur as a mixture in field conditions and undergo complex chemical changes, later studies have indicated that NO_2 can be more toxic in the presence of SO_2 resulting in overall growth reduction and visible foliar damage. Chronic, long-term and subtle effects on plant growth and productivity can prevail in the presence of phytotoxic air pollutants (Legge and Krupa, 2002). It is critical that the phytotoxicity of pollutants be considered in the context of the interactions with other pollutants in the atmosphere (Fangmeier *et al*, 2002).

Studies on the additive effects of ozone, SO_2 and NO_2 have indicated thresholds for injury as low as 28.5 $\mu g/m^3$ for NOx in the presence of SO_2 at levels of 40 $\mu g/m^3$ and ozone at levels of 60 $\mu g/m^3$ (NZ Ministry for the Environment, 1998). NO_2 can remedy nitrogen deficiency leading to increased stomatal conductance, hence an increased influx of SO_2 into the plant with a consequent increase in SO_2 toxicity (Mills, 2002).

Studies for Australian conditions (Murray *et al* 1992; 1994a; 1994b) indicate that mixtures of SO_2 and NO_2 can stimulate cereal grain yields (as discussed previously), however clover growth can be retarded at SO_2 levels of 164 $\mu g/m^3$. Conditions where levels of ozone are much lower and exist in the presence of peak NO_2 and SO_2 levels, sensitive plants are unlikely to be adversely effected if the four hour average for NOx remains below 95 $\mu g/m^3$ (WHO, 1987).

4.8 Summary of Recorded Impacts and Corresponding Pollutant Levels

Although it is difficult to determine the likely impacts on vegetation from proposed emissions **Table 4-1** provides a summary of deposition rates and observed impacts that have been recorded by numerous studies.

Comparing the predicted ground level concentrations from the project to observed impacts (in Australia), it is unlikely that proposed emissions would have an adverse impact on vegetation. From **Table 4-1**, it appears that exposure levels of NO_x generally below 170$\mu g/m^3$ (for about 2 hours) show no significant impact on Eucalyptus species. Concentrations exceeding this approximate level may potentially result in adverse effects depending upon the sensitivity of the species. It is unlikely that these levels will be reached or exceeded by the proposed project. Predicted emissions are very conservative and with the removal of the major source of NO_x from the project it would be highly unlikely that adverse impacts will occur on surrounding vegetation.

Similarly with SO_x, levels below about 130µg/m^3 (>4hrs) indicate no observable adverse effects. Higher concentrations ranging from 130-330µg/m^3 begin to show adverse effects on some species, depending upon the sensitivity of the flora species. The proposed emissions (maximum 1-hour concentrations of 95µg/m^3 of NOx and 125 µg/m^3 of SOx) are below these general ranges for both NO_x and SO_x under normal operations. On an annual average concentration, levels of SOx fall within the category of a rural environment and remains far from falling within the category of a moderately polluted environment (Krupa, 1996).

Those flora species occurring within the project area that have been previously tested under SO_2 exposure show varied sensitivity at exposure levels greater than 2,620 µg/m^3 with *Eucalyptus traptera* being extremely sensitive, *Hakea laurina* being extremely resistant and *Melaleuca elliptica* being highly resistant (**Section 4.2.1**; O'Connor *et al*, 1974). This exposure level is an order of magnitude greater than both proposed normal and upset SO_2 emissions.

■ Table 4-1 Deposition Rates and Observed Impacts in Asia and Europe

Source	Exposure Levels		Impact/ Comment
	NOx	SOx	
Australia			
Deposition rates			
Teague (1992).	-	> 0.2 g m^2/ yr	Occurs over 10,000 km^2 downwind of Mt Isa with some vegetation damage reported up to 10 km downwind of smelter
Concentrations			
Roser and Gilmour, 1995	20 µg/m^3 annual mean	-	No impacts observed – Kalgoorlie WA.
Murray *et al* (1994a)	Up to 190 µg/m^3 170 to 350 µg/m^3 94 µg/m^3	-	Increase in growth of *Eucalyptus microcorys, Eucalyptus globulus and Eucalyptus piluaris.* Reduced growth in *Eucalyptus globulus and Eucalyptus piluaris.* Reduced branch dry weight *in Eucalyptus marginata.* Tested in laboratory conditions
Murray *et al*, (1994b)	170 µg/m^3	0 - 380 µg/m^3 680 µg/m^3	Grain protein increase per plant. SOx resulted in reduced shoot weight, but no change in grain weight. Wheat growth severely affected.
Murray (1984)	-	Up to 164 µg/m^3	No impact on the weight of subterranean clover or ryegrass plants. Reduced chlorophyll concentrations in leaves of subterranean clover but not ryegrass. Reduced leaf protein in both clover and ryegrass.
Murray (1984)	-	98.8 µg/m^3	Distortion of leaves and necrosis in *Eucalyptus punctata*.
Clarke and Murray (1990)	-	Up to 132 µg/m^3 132 – 274 µg/m^3	Some stimulatory effects on *Eucalyptus rudis* Increased leaf abscission
Murray and Wilson (1989)	-	125 µg/m^3 261 µg/m^3	Fertilisation effect to *Eucalyptus calophylla* Toxic effect and reduced leaf numbers on *Eucalyptus calophylla*
Fulford and Murray (1990)	-	303 µg/m^3	Increased plant weight, but elongation effect in *Eucalytus gomphocephala*
Wilson and Murray (1994)	-	175 µg/m^3 332 µg/m^3	Reduction in biomass of *Eucalyptus* species No effect in *Pinus radiata* plants
Outside of Australia			
Deposition rates			
Bobbink *et al* (1992)	3 – 4.5 g N m^{-2} yr^{-1}	2.7 – 3.3 g S m^{-2} yr^{-1}	Includes bulk precipitation and atmospheric deposition in a heathland community in the Netherlands
Roser and Gilmour (1995)	-	1.2 – 83 g S m^{-2} yr^{-1}	Deposition rate in rainwater in southern China. Has influenced forest decline.
Roser and Gilmour, 1995	1.62 g m^{-2} yr^{-1}	3.4 g m^{-2} yr^{-1}	Deposition rate in Japan.
Bobbink *et al*, (1992).	3.0 to 4.5 g m^2/ yr	2.7 to 3.3 g m^2/ yr	Dry inland heath vegetation (dominated by *Calluna vulgaris*) shown to be deficient in K, Mg and Ca.
Concentrations			
NZ MfE (1998).	-	43 µg/m^3 for 273 days	Yield reduction in perennial rye grass
	-	55 µg/m^3 for 28 days	Yield reduction in tobacco and cucumber
	-	20 – 40 µg/m^3 long-term exposure	Folia injury in *Picea* and *Betula* spp.
	-	28.5 µg/m^3	Threshold for injury in the presence of SO_2 and ozone.
Krupa (1996)	-	<2 µg/m^3 2-60 µg/m^3 60-400 µg/m^3 400–4000µg/m^3	Classifications: 1.Remote 2.Rural 3.Moderately polluted 4.Heavily polluted

Source	Exposure Levels		Impact/ Comment
	NOx	SOx	
WHO (1987)		95 µg/m^3 4 hour mean	No impact on sensitive plants given low ozone.
World Bank Group (1998)	20 – 90 µg/m^3 annual mean in urban areas	-	
World Bank Group (1998)	-	1850 µg/m^3 for 1 hour 500 µg/m^3 for 8 hours 40 µg/m^3 long term	Visible signs of injury in sensitive plants, chronic impacts over long term periods in pine forests.
Emberson et al. (2001)	67 µg/m^3	340 µg/m^3	In Chongquin (China). Necrotic lesions, delayed sprouting and accelerated senescence.
	10 – 90 µg/m^3	75 – 135 µg/m^3	In India. Reductions in dry weight and yield reductions of up to 50% in agricultural regions.
	70 µg/m^3 (weekly mean)	-	In Lahore (Pakistan). Reduced shoots and leaves, accelerated leaf senescence, yield reductions of up to 50%
	88 µg/m^3	160 µg/m^3	In Cairo (Egypt). Visible injury on clover and berseem plants.
	-	> 1330 µg/m^3	In South Africa. Visual damage to *Eucalyptus grandis*, but not *Pinus patula*.
	-	18 µg/m^3	In Cubatao (Brazil). Increased foliar concentrations of sulphur
Guderian (1997)	-	598 – 988 µg/m^3 (Wheat and Oats) 728 – 806 µg/m^3 (Rye and Red Clover)	Observed in Germany. All indicate adverse growth and yield effects.
Marshall *et al*. (2000)	22 – 112 µg/m^3 (Moong Bean) 31 – 105 µg/m^3 (Wheat)	-	Observed in India. Resulted in reduced yields.

5. Ambient Air Guidelines and Critical Loads

The highest exposure level where no observed impacts occur is defined as the critical level. Critical levels for vegetation in Europe have been determined through numerous investigations (**Table 5-1** and **Table 5-2**). Critical loads for NOx and SOx have not yet been determined for Western Australian conditions and is a difficult task complicated by the variable response of different flora species to NOx and SOx (Murray *et al*, 1994). The varying sensitivity of species is well illustrated by O'Connor *et al* (1974).

■ **Table 5-1 Ambient Air Guidelines Adopted by National and International Organisations/ Countries**

Source	SO_2	NOx	Notes
Europe World Health Organisation (WHO)	30 µg/m^3 for crops (annual mean) 20 µg/m^3 for forests	75µg/m^3 24 hour mean 30µg/m^3 annual mean	Guidelines determined based on European vegetation and conditions
UN/ECE (Cited in Ashmore, 2002)	30 µg/m^3 20 µg/m^3 20 µg/m^3 10 µg/m^3	-	Agriculture Forests Semi-natural vegetation Lichens
New Zealand Ministry for the Environment	500 µg/m^3 10 min 350 µg/m^3 1 hour 125 µg/m^3 24 hour 50 µg/m^3 annual	300 µg/m^3 1 hour 100 µg/m^3 24 hour	Health guidelines
US EPA	365 µg/m^3 1 hour 80 µg/m^3 annual		Health guidelines
NEPM	572 µg/m^3 1 hour 228 µg/m^3 24 hour 57 µg/m^3 annual mean	246 µg/m^3 1 hour 62 µg/m^3 annual mean	Current national health guidelines in Australia
Victorian EPP	33 µg/m^3		For acid mist. Health guideline.

UN/ECE – United Nations Economic Commission for Europe.
US EPA – United States Environmental Protection Authority
NEPM – Nation Environmental Protection Measure.
EPP – Environmental Protection Policy

■ **Table 5-2 Critical Loads Adopted Outside of Australia**

Source	SO_2	NOx	Notes
WHO (1996)	-	15 – 35 kg N ha/yr	Annual average.
China (Sichuan Basin, Roser, 1995)	-	3.87 g m^2/ yr	A critical load of 4.2 g m^2/ yr has been determined for this region based upon acidification of soil types rather than vegetation impacts.
Netherlands (Bobbink *et al*, 1992)	3.0 to 4.5 g m^2/ yr	2.7 to 3.3 g m^2/ yr	Dry inland heath vegetation (dominated by *Calluna vulgaris*) shown to be deficient in K, Mg and Ca.
Europe (SO_2 - WHO, 2000) (Nitrogen – Bobbink and Roelofs, 1995).	0.5 to 3.5 g m^2/ yr 1.0 to 3.5 g m^2/ yr 0.5 to 2.2 g m^2/ yr 0.5 to 3.0 g m^2/ yr	 5 – 20 kg N ha/yr 5 – 22 kg N ha/yr 5 – 35 kg N ha/yr	Critical loads for: Wetlands Grasslands Heathlands Forests Forests Heathlands Grasslands and wetlands

Hence, critical loads are expected to differ between major vegetation types. Considerable investigations have been undertaken in Kalgoorlie in regard to

vegetation impacts from SO_x. These reports are not publicly available, however Roser (1995) indicates that discernible impacts have not been observed beyond 1.5km from emission stacks in Kalgoorlie where SOx ground level concentrations of 5µg/m^3 per year within 50km and 20µg/m^3 per year within 12km prevail. Maximum predicted annual ground level concentrations of SO_2 for the project do not exceed 2.3 µg/m^3 (Sinclair Knight Merz, 2000).

Critical levels for specific flora species or vegetation types can be estimated by in-situ monitoring, numerical modelling or through fumigation testing. This would involve careful planning of monitoring or experimental design.

Maximum annual ground level concentrations for both NO_x and SO_x, for normal operations, are well below the WHO guidelines for vegetation, being only 47% and <10% of the guideline respectively.

SO_x concentrations also meet the most stringent UN/ECE guideline for vegetation.

No comment can be made with reference to deposition rates, in the absence of appropriate site specific data for comparison.

6. Limitations and Information Gaps

For the purpose of this assessment it is noted that there is a general lack of data for Western Australian conditions and that this deficiency hinders the development of any firm scientifically based conclusions of impacts from emissions proposed by the project.

Much of the research that has been undertaken to date has occurred overseas and many European countries are well advanced in predicting environmental impacts from air pollutants. This has mainly occurred in response to observed impacts from long-term exposure to industrial and urban emissions.

Industrial development in Western Australia is much less, although it still continues to grow. For this reason, less attention has been given to the potential impacts of air emissions. Most concern has been given to health effects of emissions, with national guidelines only being relevant to human health. Currently there are no standards for the effects on vegetation.

In this assessment, fumigation studies undertaken on wheat and various Eucalyptus species (Murray *et al*, (1994); Murray (1994); Murray (1984); Clarke and Murray (1990); Murray and Wilson (1989); Fulford and Murray (1990); Wilson and Murray (1994); O'Connor *et al* (1974)) form the basis of predicting the likelihood of impacts occurring from proposed emissions. Even in this instance, this information is not entirely applicable to the project area as only O'Connor's work has tested species known to occur within the project area. However these results are considerably dated. More recent investigations have not tested any species occurring within the project area. Nonetheless, this information is still valuable and forms a basis and platform for future investigations.

Deposition rates and critical loads are also available for several localities, the majority of these being overseas. Deposition rates have not been predicted for the project, thus no comment can be made on the likely rates.

7. Conclusion

The impact of atmospheric pollutants on vegetation varies considerably depending upon the type of vegetation being impacted, local terrestrial conditions, climatic environment, concentration of pollutants etc. Impact on vegetation can occur through wet and dry deposition via uptake through stomata and direct contact of the leaf cuticle with acidic droplets. Indirect effects may occur through soil acidification.

Observed impacts depend upon the flora species exposed to NOx and SOx. Exposure to low levels of NOx and SOx can be beneficial by having a fertilisation effect. However, toxicity can quickly occur at exposure to higher concentrations. Common adverse effects include reduced growth, biomass, yield, foliar cover, foliar damage such as necrosis, discolouring of stems etc.

The nature of impacts depends largely on the individual species and its sensitivity. Local terrestrial and meteorological conditions also play a large role in defining ground level concentrations and deposition rates. The ability of the soil to buffer any potential acidity is also important to consider.

It is difficult to provide an accurate indication of whether or not impacts will occur and to what degree as there is a general lack of specification information and studies related to Australian environments and native vegetation and even less on the southwest WA environments.

From the very few studies that have been undertaken in Australia, most have focused on the impact of SO_2 on vegetation. On the basis of a review of the outcome of these studies, it is unlikely that adverse impacts will occur on vegetation surrounding the project area. These studies have generally shown that adverse impacts occur at exposure levels of about >170 $\mu g/m^3$ for NOx (for a 1 hour exposure) and about >130 $\mu g/m^3$ for SOx (for a >4 hour exposure). Although none of the test species have been recorded to occur within the project area. This is the best available information to date and warrants further investigation if a more definitive outcome on potential impacts is required.

Emission modelling provides conservative estimates of potential emissions based on worst case meteorological conditions that are unlikely to prevail throughout the year. Modelling predicts maximum 1-hour ground level concentrations for NOx and SOx, under normal operations, of 95 and 125 $\mu g/m^3$ respectively. These are well below the concentrations, mentioned above, where adverse impacts have been observed. Important to note that in comparing the SOx concentration, the predicted maximum 4-hour exposure is expected to be much less.

Maximum annual ground level concentrations for both NO_x and SO_x, for normal operations, are well below the WHO guidelines for vegetation, being only 47% and <10% of the guideline respectively.

SO_x concentrations also meet the most stringent UN/ECE guideline for vegetation.

Start up and upset conditions will exceed these general levels, however these conditions are not expected to occur over long durations and will be infrequent during

the operational life of the project. It is unlikely that adverse impacts will occur given the short duration of start up and upset conditions.

8. Recommendations

Although it is generally concluded that adverse impacts are unlikely to occur, the potential for impacts still remains given the general absence of information which is applicable to the project area. The following recommendations are made:

- An ongoing biological monitoring programme developed in consultation with the Departments of Environment, Water and Catchment Protection and Conservation and Land Management be developed and implemented to monitor the health of vegetation and any observed impacts. This monitoring programme should include a baseline survey such that valid comparisons can be made when operation commences.
- The determination of deposition rates of gaseous emissions on-site and off-site the project area utilising the atmospheric model, TAPM. This information will assist in the analysis of any observed changes to the condition of vegetation.
- Determination of critical loads following the outcomes of the monitoring programme and calculation of deposition rates. Critical loads may not be determined until sufficient information is collected from ongoing monitoring.
- Maintaining plant operating conditions in accordance to best practice to minimise emissions.
- Where practicable, schedule maintenance and shutdowns following harvesting and well before or well after the spring season when most native flora begin to flower and reproduce.

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