SPECIALITY SILICA SAND PROJECT
GNANGARA

SILICA SALES PTY LTD

Report and Recommendations
by the
Environmental Protection Authority

Environmental Protection Authority
Perth, Western Australia
Bulletin 318 January 1988

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CONTENTS

APPENDICES

TABLES

FIGURES

i SUMMARY AND RECOMMENDATIONS

Silica Sales Pty Ltd has submitted a proposal to establish a silica sand mining operation at Gnangara, approximately 20 km north-east of Perth.

Approximately 80% of the proposed project area is located over State Forest No 65 with the remaining 20% of the area covering private land.

The area of State Forest which would be affected by the proposal is zoned 'State Forest' under the Northern Forest Region-Regional Management Plan 1987-1997. This allows for multiple land use including water production.

The proposal is for the extraction of a high-purity silica sand layer which averages approximately 7 metres in thickness over a project area of about 660 hectares. Preliminary investigations have identified a reserve of an estimated 64 million tonnes of high-purity sand on the site. Additionally, some 74 million tonnes of quality concrete aggregate has been identified within the lease boundary.

Mining would be carried out using a front end loader to excavate the material prior to benefication and transport from the site.

It is proposed that a layer of topsoil would be stripped and stockpiled from mining areas prior to excavation of sand material. Rehabilitation would be carried out in a progressive manner as waste materials are returned to the mined out pits prior to return of overburden. Following the recontouring of the returned overburden the stockpiled topsoil would be respread and revegetated using native plant species.

The primary objective of the rehabilitation would be to create a stable land form and establish a diverse, effective and permanent vegetation cover capable of plant succession and regeneration to suit the present priority land use of water production.

Benefication of silica sand material would involve wet slurry screening and wet heavy media separation techniques to purify the silica sand product. This process does not require the addition of any toxic chemicals, therefore eliminating the risk of groundwater contamination.

As the project area is located above an important groundwater resource for public water supply, issues relating to water management were carefully considered during the assessment of the proposal.

Other issues considered by the Authority during the assessment were generally with respect to access, potential for the spread of Jarrah dieback, dust and erosion, final land use and effects on flora and fauna.

Upon consideration of the Public Environmental Report that was submitted for the project the Environmental Protection Authority has concluded that the proposal would be environmentally acceptable subject to the following recommendations:

RECOMMENDATION 1

The Environmental Protection Authority concludes that the proposal described in the Public Environmental Report is environmentally acceptable and recommends that it could proceed subject to the Environmental Protection Authority's recommendations in this Assessment Report and the commitments made by the proponent for environmental management including:

. rehabilitation of disturbed areas;

. monitoring of ground water levels;

. application of appropriate measures for the control of dieback disease in State Forest according to "Working Arrangements" to be developed in conjunction with the Department of Conservation and Land Management, and

. undertake vegetation surveys prior to clearing of new areas for mining.

RECOMMENDATION 2

The Environmental Protection Authority recommends that all waste oils and vehicle washdown water is collected and treated, or disposed offsite, to the satisfaction of the Water Authority of Western Australia.

RECOMMENDATION 3

The Environmental Protection Authority recommends that fuel storage facilities are constructed and operated in accordance with the requirements of the Water Authority of Western Australia.

RECOMMENDATION 4

The Environmental Protection Authority recommends that the proponent submits brief annual reports to the Department of Mines describing rehabilitation programmes and summarising monitoring results with respect to environmental management programmes adopted for the project.

RECOMMENDATION 5

The Environmental Protection Authority recommends that rehabilitation on private land be to an end land use agreed with the land owner provided that disturbed areas are left in an environmentally acceptable condition to the Environmental Protection Authority's satisfaction.

RECOMMENDATION 6

The Environmental Protection Authority recommends that prior to commissioning, a dust management programme be developed to control dust migration from unstabilised operations areas to the satisfaction of the Department of Mines. This programme should include a proposal to install an appropriate dust suppression system such as a mobile water cannon to control dust during adverse weather conditions.

RECOMMENDATION 7

The Environmental Protection Authority recommends that no mining activities are carried out within 500 metres of the Gnangara Magnetic Observatory for such a period that the Magnetic Observatory is in operation.

RECOMMENDATION 8

The Environmental Protection Authority recommends that in order to reduce the effects of vibration and magnetic disturbances on the Gnangara Magnetic Observatory, heavy vehicle access to and from the project area be diverted from Gaskell Avenue to maintain a distance of at least 500 metres from the Gnangara Magnetic Observatory.

1. BACKGROUND

Silica Sales Pty Ltd has submitted a proposal to establish a silica sand mining operation at Gnangara, approximately 20 km north-east of Perth (Figure 1).

Approximately 80% of the proposed project area is located over State Forest No.65 with the remaining 20% of the area covering private land. The area of State Forest which would be affected by the proposal is zoned 'State Forest' under the Northern Forest Region-Regional Management Plan 1987-1997. This allows for multiple land use including water production.

Feasibility studies were carried out over the prospect during 1983 and 1984 to assess the probable reserves of both high-purity silica and normal aggregate sands. Based on an average mineable silica sand layer of 7 metres thickness and a maximum project area of 660 hectares, there is an estimated 74 million tonnes of high-purity sand on the site. Additionally, some 74 million tonnes of quality concrete aggregate has been identified within the lease boundaries.

During the last two years a pilot processing plant was constructed on site, to confirm the viability of the selected processing technique and produce some samples for market appraisal. This evaluation phase has been completed and pilot plant facilities have since been removed from site.

A bulk sampling and trial mining operation is currently being carried out for further market evaluation purposes. This trial mining and a subsequent rehabilitation is being undertaken subject to "Working Arrangements" determined in consultation with the Department of Conservation and Land Management.

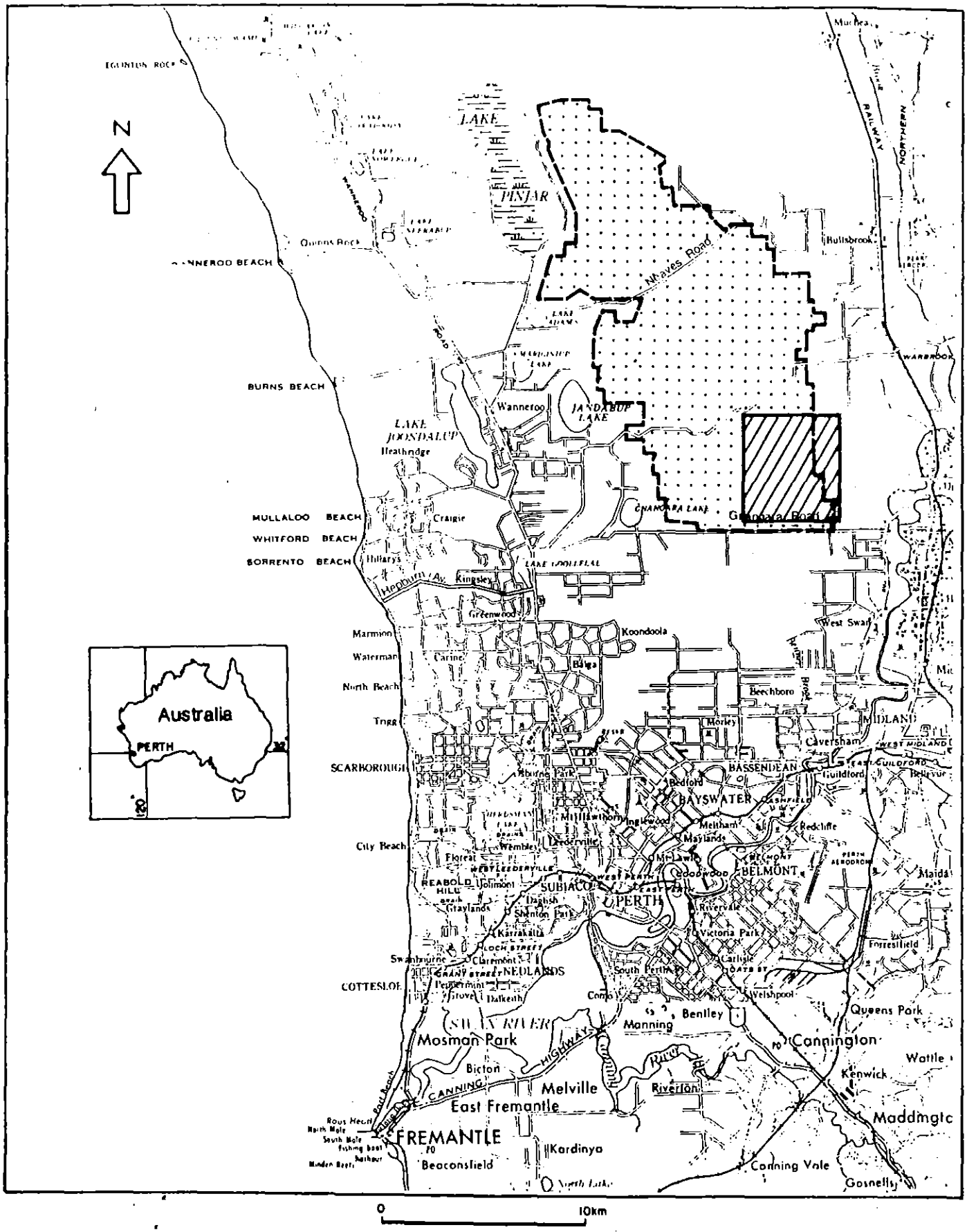
2. PROPOSAL

Mining is proposed to occur in discrete cells and would begin by using a bulldozer and scraper to remove vegetation and topsoil. Topsoil would be set aside to be replaced after completion of each production cell. An overburden layer of up to 1 metre, containing a percentage of vegetable matter, would also be set aside for later replacement. Overburden and topsoil would be stored for as short a time as possible to minimise degradation of seed stock and organic matter.

The layer of silica sand varies from 0.5 metres to 14 metres in thickness, with an average thickness of approximately 7 metres.

Sand would be excavated using a front-end loader. Digging would continue until the excavation either approached a layer of underlying yellow sand or reached within 2 metres of the winter water table. Conveying equipment would be located adjacent to the mine to receive and transfer sand from the pit to the processing plant.

Following sand extraction and transport to the processing plant the sand would be mixed with water to form a slurry. The sand slurry fed through a series of screens to remove trash such as stones and vegetable matter and separate sand by size. All trash and material over 3 mm would be returned to mined out pits prior to being progressively rehabilitated. Sand of 0.6 mm or less continues through further processing while sand between 0.6 mm and 3 mm is removed and stockpiled for sale.



Project Area (Refer Figure 2 for detail)

Boundary of State Forest No. 65 (Extract from Public Environmental Report)

LOCALITY PLAN

Figure 1

The final benefication process involves gravity separation of the fine sand particles to remove the minor heavy mineral fraction which would be returned to the pit.

During the successive stages of processing a fine material by-product or "slimes" will be produced consisting primarily of fine organic material and clay particles. As this material has relatively poor settling characteristics a series of small ponds would need to be constructed to allow the tailings to settle. The excess water would drain through the soil profile back to the groundwater aquifer or be evaporated. Dry tailings would be re-excavated and returned to worked-out sections of the pit prior to rehabilitation. No toxic reagents would be used in the processing of the material.

Process water would be supplied from groundwater production bores established for the project. It is envisaged that overall water consumption would be relatively low as a large proportion of the process water would be recycled through the treated water retention pond.

The finished silica sand product would be stockpiled and removed from site in trucks.

Initial output is expected to be approximately 300 000 tonnes per year and ultimately increase to a rate of about 800 000 tonnes per year.

Given an average mineable sand layer of 7 metres thickness, it has been calculated that at the initial proposed production rate excavation would disturb approximately 3.4 hectares per year. At full capacity this disturbance would be in the order of 9.0 hectares per year. All disturbed areas would be sequentially recontoured and rehabilitated.

The proposed silica sand mining operations would occur primarily within an area of State Forest No.65 which has a multiple land use zoning.

Extraction of aggregate sands has also been proposed to be undertaken on an area of private land to the east of the proposed silica sand mining area. The extraction of these sands would be undertaken in a similar manner to the silica sand mining operations. As silica sand also occurs coincidentally with the aggregate sand all proposed areas of operation would require a Mining Lease under the provisions of the Mining Act 1978.

3. EXISTING ENVIRONMENT

The proposed silica sand mine is located within the Northern Swan Coastal Plain. The project area is wholly within the geomorphic unit known as the Bassendean Dune System.

The Bassendean Dunes, which characterise the project areas, have relatively low relief, varying from minor hills and ridges to gently undulating or level terrain. The principal units of the Bassendean Dune System represented in the project area are the Jandakot unit and the Gavin unit. The mining is proposed to take place primarily within the Jandakot unit while adjacent pine plantations are established on the Gavin unit. A significant portion of the mine area in the northern section of the lease has relatively steep, high and irregular dunes which are normally mapped as Jandakot Steep, a subunit of the Jandakot unit.

The dunes are composed almost entirely of siliceous sands. Surface soils generally consist of quartz sand which are grey at the surface indicating the presence of organic matter, which rapidly change to an almost white sub-surface. There is often a yellow sand at depth.

Due to the high permeability of the dunes there is significant recharge from incident rainfall to the unconfined aquifer. The aquifer generally occurs well beneath the depth of silica sand occurrence. The winter water table generally ranges from between 10 metres and 40 metres below the ground surface in the proposed mining area depending on the topography of the particular area.

The proposed project area is within ground water control areas comprising part of the Gnangara Mound.

The vegetation types found within the project area area typified by a transition vegetation complex and consist of low open forests and low woodlands of banksia. The vegetation community composition and distribution through the area appears to be influenced primarily by land relief and soil conditions.

Although the presence of Jarrah dieback is not widespread, it does appear to exist in localised patches. Eucalyptus todtiana (coastal blackbutt) and the various banksia species which form the major vegetation component of the area, are susceptible to this disease.

The proposal impinges upon an area of State Forest No 65 which is zoned 'State Forest' under the Northern Forest Region-Regional Management Plan 1987-1997, to allow for multiple land uses. The majority of this state forest area is currently pine plantation. However, the specific area affected by the proposal is natural bushland. Part of the project area also extends over an area of private land to the east of the State Forest boundary which again is primarily native bushland.

4. PUBLIC AND GOVERNMENT SUBMISSIONS

One public submission and eight responses from State and Government agencies were received during the public review period. A summary of the respondents and issues raised are provided in Tables 1 and 2.

Table 1. Summary of Submissions

ISSUE	NO OF SUBMISSIONS
Access	4
Water Management	3
Water Table and Salinity	2
Rehabilitation	
(i) Tailings Management	1
(ii) Revegetation	5
(iii) Provision for early closure	1
Die back	1
Dust and Erosion	3
Land Use	3
Geophysical Observatory and Forestry Settlement	2
Aboriginal Sites	1
Land Prices	1
Flora	1
Fauna	2
Monitoring	1

Table 2 Submissions Received

LIST OF RESPONDENTS

State Planning Commission
Department of Conservation and Land Management
WA Museum
Main Roads Department
K & L Dunstan
Water Authority of WA
Department of Primary Industries and Energy
Department of Agriculture
Department of Mines

The predominant concerns were mainly with regard to access, water management and effects on local hydrology, rehabilitation, dust, ongoing land use and impacts on flora and fauna. A detailed review of the submissions is included in Appendix 1.

The Company has subsequently addressed the issues raised by the public and government agencies in their submissions and by the Authority. Silica Sales Pty Ltd's response is in Appendix 2.

5. ENVIRONMENTAL ISSUES

In considering the Company's initial proposal the Environmental Protection Authority determined that the potential for environmental impact was such that the proposal would require assessment under Part IV of the Environmental Protection Act, 1986, and that the level of assessment would be Public Environmental Report.

A Public Environmental Report has been submitted and has undergone an eight week public review period, which finished on 5 October 1987.

Following a review of the environmental aspects of the proposal, in light of public and government agencies' submissions, the Environmental Protection Authority determined that the proposal would be environmentally acceptable, subject to a number of conditions as discussed in the following sections of this report.

RECOMMENDATION 1

The Environmental Protection Authority concludes that the proposal described in the Public Environmental Report is environmentally acceptable and recommends that it could proceed subject to the Environmental Protection Authority's recommendations in this Assessment Report and the commitments made by the proponent for environmental management including:

- **rehabilitation of disturbed areas;**
- **monitoring of ground water levels;**
- **application of appropriate measures for the control of dieback disease in State Forest according to "Working Arrangements" to be developed in conjunction with the Department of Conservation and Land Management; and**
- **undertake vegetation surveys prior to clearing of new areas for mining.**

5.1 WATER MANAGEMENT

Effects of the proposed sand mining and processing operations on underlying ground water resources were considered with respect the following:

(i) ground water abstraction for process water;
(ii) proposed waste disposal; practice on groundwater quality; and
(iii) alterations to the evapotranspiration regime by removal of significant quantities of sand.

The proposed project area is located above an important unconfined aquifer known as the "Gnangara Mound". Groundwater is extracted from two production borefields in the area by the Water Authority of Western Australia for public water supply purposes.

It is proposed that both process water and potable water supplies would be drawn from the same aquifer. The Company has made a commitment that the location of groundwater production bores and design of the well field would be determined in liaison with the Water Authority of Western Australia. It is also noted that that a licence would be required limiting the maximum allowable water extraction rate.

The effects of waste water disposal from processing and domestic water usage was also considered to ensure that usable ground water resources would not be contaminated.

Process water would not suffer significant deterioration in quality as the process does not entail additions of soluble materials or chemicals to the water. Recycling of water from the tailings disposal ponds and product stockpile areas would be incorporated where practicable. It is envisaged that there will be some loss of water from the tailings disposal ponds through seepage and evaporation.

Domestic waste water from the ablution block would be disposed of through a septic tank and soil absorption system. This system would need to be located in an area where the winter water table is more than 5 metres below the ground surface so that there is at least 2 metres between the bottom of the tanks and the groundwater.

The Company has made a commitment that the location and design of this system would be determined in consultation with the Water Authority of Western Australia and maintained in accordance with appropriate by-laws.

In its assessment of the proposal the Authority determined that waste oil from vehicles and contaminated water from vehicle washdown facilities may have significant potential for contamination of groundwater.

RECOMMENDATION 2

The Environmental Protection Authority recommends that all waste oils and vehicle washdown water is collected and treated, or disposed offsite, to the satisfaction of the Water Authority of Western Australia.

Storage of fuel onsite was also identified as having potential to cause contamination of groundwater resources in the event of spillage or accidental tank failure.

RECOMMENDATION 3

The Environmental Protection Authority recommends that fuel storage facilities are constructed and operated in accordance with the requirements of the Water Authority of Western Australia.

The issues of alteration of the ground water regime by evapotranspiration through the removal of significant quantities of sand was also considered during the assessment. The Company has undertaken to control the depth of the excavation to no less than 2 metres above the winter water table. Careful selection of plant species for rehabilitation would ensure that the evapotranspirative regime would be minimal. It is proposed that rehabilitation would be designed such that the mined area would remain a nett ground water recharge area.

5.2 REHABILITATION

Rehabilitation of areas disturbed by mining and processing operations is proposed to be carried out in a progressive manner. An objective would be to have as small an area as possible open at any one time. This may be achieved by returning waste materials to the mined out pits to be covered by overburden material and recontoured to obtain a gently undulating topography with smooth compacted surfaces. Following the clearing of the vegetation topsoil and remaining vegetable material would be stripped to be respread over recontoured areas. It is proposed to restored native vegetation which resembles the existing vegetation as closely as possible in terms of plant species, composition, diversity and structure. Topsoil would be stored for a minimum period of time to minimise deterioration of biologically active material. Respreading of tree limbs, shrubby stems and leaf matter is proposed to provide initial surface stabilisation against erosion and to enhance the soil surface microclimate in favour of germination and resprouting.

The Company is currently carrying out rehabilitation trials in conjunction with trial mining operations to determine how the revegetation technique can be optimised. These trials are being undertaken in consultation with the Department of Conservation and Land Management.

The feasibility of introducing plant species which presently occur in the area, but are under pressure from commercial wildflower picking is also being assessed as part of the rehabilitation trials.

Field trials are proposed to continue throughout the early years of the project and ongoing monitoring and modifications to the technique would be conducted as site experience is gained through results of trials and full scale revegetation programmes in the initial mining areas.

A further objective for rehabilitation would be to establish a stable vegetation landform capable of plant succession and regeneration to suit the present land use priority of water production.

RECOMMENDATION 4

The Environmental Protection Authority recommends that the proponent submits brief annual reports to the Department of Mines for approval describing rehabilitation programmes and summarising monitoring results with respect to environmental management programmes adopted for the project.

RECOMMENDATION 5

The Environmental Protection Authority recommends that rehabilitation on private land be to an end land use agreed with the land owner provided that disturbed areas are left in an environmentally acceptable condition to the Environmental Protection Authority's satisfaction.

5.3 DUST AND NOISE

Impacts on the local community through increased dust and noise associated with the proposed operations were also considered in the assessment of the proposal with respect to controlling the generation of dust the Company has undertaken to maintain adequate surface stability in the topsoil stockpile. Overburden and pit areas would be monitored in consultation with appropriate regulatory authorities. Access corridors would be maintained and managed in a manner such that dust would be kept to a minimum.

RECOMMENDATION 6

The Environmental Protection Authority recommends that prior to commissioning, a dust management programme be developed to control dust migration from unstabilised operations areas to the satisfaction of the Department of Mines. This programme should include a proposal to install an appropriate dust suppression system such as a mobile water cannon to control dust during adverse weather conditions.

Noise levels would need to be in accordance with those prescribed under the Environmental Protection Act, 1986.

5.4 GENERAL ISSUES

Other issues considered during the assessment of the proposal were generally with regard to Jarrah dieback controls, overall impact of mining on flora and fauna, domestic waste disposal, visual impacts, transport of materials and fire control. It has been determined by the Authority that the proposed environmental management programmes as discussed in the Public Environmental Report would be adequate to manage these impacts.

Impacts on existing facilities in the area such as the gas pipeline, geophysical laboratory and Gnangara Forestry Settlement were also considered.

Operations would need to be carried out in such a manner that adverse impacts on these facilities are minimised. This may require the Company to forego access to some of the silica sand resource.

In the submissions and subsequent response from the Company it was determined that satisfactory arrangements have been agreed to between the Company and relevant government agencies with regard to the gas pipeline and the Gnangara Forestry Settlement. However, significant disturbances as a result of mining and transport operations on the integrity of the Geophysical Laboratory need to be further addressed. This facility was established in 1957 to record long term (years) and short term (minutes) variations in the Earth's magnetic field. The site was selected on the basis of there being no large local magnetic anomalies and artificial magnetic

fields and earth current. Localised magnetic disturbances may result from some of the equipment that would be used in the proposed mining operations such as electric motors, motor vehicles, radio transmitters, power lines and steel buildings. Due to the importance and ongoing nature of this facility the Authority believes that an adequate buffer zone would need to be maintained between the Geophysical Laboratory and proposed operations.

RECOMMENDATION 7

The Environmental Protection Authority recommends that no mining activities are carried out within 500 metres of the Gnangara Magnetic Observatory for such a period that the Magnetic Observatory is in operation.

RECOMMENDATION 8

The Environmental Protection Authority recommends that in order to reduce the effects of vibration and magnetic disturbances on the Gnangara Magnetic Observatory, heavy vehicle access to and from the project area be diverted from Gaskell Avenue to maintain a distance of at least 500 metres from the Gnangara Magnetic Observatory.

6. CONCLUSION

Upon assessment of the Silica Sales Pty Ltd proposal the Authority has concluded that the proposed Speciality Silica Sand Project at Gnangara would be environmentally acceptable subject to the operations being carried out in accordance with the commitments in the Public Environmental Report and subsequent correspondence (Appendix 3) and the Environmental Protection Authority's Recommendations.

REVIEW OF SUBMISSIONS

ACCESS

A number of submissions expressed concern about proposed access routes to the mining operation, for instance Gnangara Road would have an increased volume of traffic and mining operation trucks using the route would pose a considerable danger to usual road users.

A few submissions said that Gaskell Avenue should not be used for trucking operations.

In relation to the Gnangara Forestry Settlement, a suggestion was made that trucking operations use roads north and east of the settlement for example Wetherell Road which was at a distance and which would reduce the noise and safety hazard.

One submission perceived that the volume of traffic due to mining development would cause conflict with forest operations and forest users. It recommended the development of adequate safety measures and signposting.

WATER MANAGEMENT

It was mentioned that approval would be required from the Water Authority for water supply, drainage and pollution control and that liaison with the Authority would be necessary to ensure that mining activities did not detrimentally affect the construction of future works for public water supply.

WATER TABLE AND SALINITY

There was some concern that increased draw of water would jeopardize wetlands in surrounding areas.

One submission raised the question of the effect of vegetation clearing for the mining operation on the water table levels and/or salinity.

REHABILITATION

TAILINGS MANAGEMENT

A suggestion was made that fine tailings could be blended into the surface layers of the rehabilitated areas because of their high moisture retention.

REVEGETATION

Submissions favoured the replanting of native species consistent with those of the general area.

One submission indicated that the mining proposal affected land that was currently being considered as part of an integrated open space network in the review of the Corridor Plan. As the land was part of an ecological link, the submission said that the environment would have to be rehabilitated to a healthy condition without affecting the ecological resource.

In relation to the revegetation programme, a suggestion was made for a back-up technique of seed collection and sowing in case of failure of the proposed method. To improve infiltration, planting of deep rooted species such as trees was suggested.

A submission said that smooth compacted surfaces were not suitable for rehabilitation and that altered soil structure and possibly changed water table could prevent long term establishment of existing plant species.

PROVISION FOR EARLY CLOSURE

There was a request that the proponent be committed to leaving the area in an environmentally acceptable condition in the event of early closure of operations.

DIEBACK

A submission indicated additional information about dieback ecology and some points for management.

DUST AND EROSION

Submissions were of the opinion that relying on moisture in the sand was insufficient to avoid a dust problem and suggested use of a sprinkler system or covers.

One submission pointed out that the report did not outline measures for protection of soil surface areas from erosion during mining operations. Suggestions were made for stabilisation of the open pit, overburden and topsoil stockpiles, and product stockpiles.

LAND USE

A submission indicated that the proposal affects Swan Location 5892 and an extractive industry licence from the Shire of Swan would be required.

Submissions said that the mine operations should not interfere with the groundwater resources and gas pipeline facility.

It was mentioned that the Gnangara Fire Tower and scenic lookout were in conflict with the extraction of silica.

GEOPHYSICAL OBSERVATORY AND FORESTRY SETTLEMENT

Because of concern of magnetic and vibrational disturbances to the Geophysical Observatory, it was recommended that the mining, processing plants and access roads should not encroach nearer than 500 metres to the observatory boundary. There was also a recommendation of no mining south of the Forestry Settlement as the buffer zone would leave very little lease area for mining south of the Settlement.

ABORIGINAL SITES

A suggestion was made that the proponent could organise an inspection of the area concerned as the area had not been examined and Aboriginal sites could exist there.

Contact with Aboriginal people was recommended because of the Nyoongah Community's concern about developments which could affect water levels in some lakes in the area which are of significance to Aboriginal people.

LAND PRICES

There was some concern expressed that the mining venture would cause reduced land prices and retard land development in the vicinity.

FLORA

One submission said that the proposed mining activity should not interfere with any valuable areas of natural vegetation.

FAUNA

Some submissions said that in view of the lack of information on fauna in the area, a fauna survey should be conducted and the area should be monitored over the operation life of the project to determine the return of faunal species.

MONITORING

One submission said that there should be strict guidelines and a system of monitoring to ensure that the proponent adhered to its commitments of preserving the environment in the future.

THE PROPOSAL

Two submissions said that they had no objection to the proposal.

One submission indicated that it would prefer that mining did not occur in the area.

RESPONSE TO PUBLIC SUBMISSIONS TO THE SILICA SALES P E R

A summary document describing the nature of public submissions to the Speciality Silica Sand Project at Gnangara - Public Environmental Report was prepared for the Company by the EPA. The Company's responses to public submissions are summarised below on a point by point basis.

1. ACCESS

In transferring raw materials to Kwinana for export the Company will seek to choose the shortest suitable route so that transport costs will be minimized.

It is not anticipated that any additional risk to road users will be posed by the travelling operation. However, the Company will monitor the situation and will seek advice from appropriate authorities if necessary.

Acceptable traffic routes within the lease area will be discussed and agreed with CALM when Working Arrangements for the project are developed. The proximity of agreed routes to the Gnangara Forestry Settlement will also be considered at the time.

Signposting and other necessary safety measures will be employed as directed in CALM's working arrangements.

2. WATER MANAGEMENT

The company will maintain regular contact with the Water Authority throughout the project. The Company recognises that it will need to gain licences for groundwater recovery and slimes dewatering from the Water Authority, and will observe established licencing procedures.

The Company will also liaise with the Water Authority in relation to possible future works for public water supply.

3. WATER TABLE AND SALINITY

It is anticipated that the use of groundwater by the project operation will be very small and will have little effect on the superficial water table. Further, monitoring of groundwater levels will be routinely conducted and results reported to the Water Authority.

If there is any measurable water table response to clearing it will likely show as a small increase in height. Temporary absence of vegetation cover prior to revegetation may enable higher rainfall infiltration and thus higher groundwater levels.

Further, whilst the lease area is larger, the area of land undergoing silica sand mining at any one time will only be a small proportion of the total area of the lease.

The land is believed to have little or no potential for salinity problems as a result of vegetation clearing.

4. TAILINGS MANAGEMENT

Fine tailings may well prove useful in the site vegetation programme. A number of revegetation trials have already been established and important further investigations will be initiated in the near future.

A portion of the fine tailings may also be sold as a mineral by-product.

5. REVEGETATION

Revegetation methods proposed by the Company involve the exclusive use of native species consistent with both the site and the general area.

The proposed revegetation method has been developed in consultation with CALM. It involves returning topsoil and vegetation matter collected prior to mining, to the completed mine areas. The primary objective of this approach to revegetation is to assist the original plant species to recolonize and establish.

A back-up programme of seed collection may well be useful in revegetation. As clearing will be conducted in stages, a seed resource will always be available in adjacent vegetation should collection prove necessary.

Deep rooted species of trees such as Eucalyptus todtiana occur naturally on site and will likely reappear in the regenerated vegetation.

The surfaces of mined out areas will not necessarily be left in a smooth and compacted condition.

The revegetation process proposed includes respreading of chopped woody material and the tree trunks removed from site during the clearing phase of operation. These materials will "roughen the surface."

Experience gained during the initiation of an approved trial mining exercise indicated that the types of earth moving machinery used for topsoil and brush respreading caused significant furrowing of the sandy surface soils.

6. PROVISION FOR EARLY CLOSURE

The Company is committed to leaving the area in an environmentally acceptable condition in the event of early closure of operations. Only a small proportion of the lease

will be undergoing active mining at any one time, and rehabilitation will be conducted progressively as each mine area is exhausted.

7. DIEBACK

The Company has sought specialist advice from CALM in relation to dieback and has accepted their recommendations in relation to site management. The Company would be pleased to receive additonal background information.

8. DUST AND EROSION

It is anticipated that the surface treatments applied during revegetation, which include chopped vegetation materials and banksia tree trunks, will provide stabilisation against erosion and dust.

Dust and erosion control within operating mine cells will be monitored by the Company in consultation with the Mines Department. Appropriate nuisance conditions prevail.

Maintenance of adequate surface soil stability in topsoil stockpile, overburden and pit areas will also be monitored in consultation with appropriate regulatory authorities.

9. LAND USE

The Company has consulted Swan Shire Council in relation to Swan Location 5892. Their advice was that mining activity on Location 5892 would be dealt with as part of the whole project and that a seperate extractive industry licence would not be required.

The Company will observe and comply with SECWA requirements in relation to protection of the gas pipeline facility.

The Company is liaising with CALM in relation to the Gnangara Fire Tower and scenic lookout. When necessary the tower will be transferred, at the Company's expense, to a location chosen by CALM.

10. GEOPHYSICAL OBSERVATORY AND FORESTRY SETTLEMENT

Mine planning will account for the location of both the Geophysical Laboratory and the Forestry Settlement when selecting the location and orientation of pits, processing plants and access road.

The Company recognises the importance of protecting the integrity of these installations and will undertake all reasonable necessary measures to ensure that mining does not cause conflict.

11. ABORIGINAL SITES

The Company's consultants have previously contacted the Aboriginal Sites Department at the WA Museum. Discussion

confirmed that no registered sites were either on the project area or near surrounds.

In March 1979 the WA Museum conducted a survey of aboriginal sites along the route of the Dampier - Perth Natural Gas Pipeline. The pipeline traverses the entire north-south length of Silica Sales exploration area. The Museum's survey did not find any aboriginal sites along this section of the pipeline route or nearby areas.

Water levels in local wet lands are not expected to be influenced by the mining operations. The results of groundwater monitoring will be forwarded to, and regularly discussed with the Water Authority.

12. LAND PRICES

The Company does not believe that the project will adversely affect land values in the area. Careful management of site operations will prevent unacceptable impacts on local land and the site will be totally rehabilitated at completion.

13. FLORA

No rare plant species are known to occur within the area of the proposed mining. Vegetation surveys will be routinely conducted during the project prior to clearing new areas for mining. These surveys will provide necessary technical information for revegetation work and will likely identify any valuable species, should these be located in future.

14. FAUNA

Mining of the silica resource will take place sequentially thus only relatively small areas of vegetation will be cleared and unavailable for habitat at any one time.

Mobile fauna within the cleared land can be expected to relocate in adjacent uncleared land.

There will be opportunity for recolonization by local species after mining as revegetation treatments will be applied immediately. The Company's revegetation objectives recognize the importance of re-establishing faunal habits.

15. MONITORING

The Company intends to provide full co-operation to environmental regulatory authorities in their requirements for site monitoring during the project. The Company will maintain an internal environmental management programme which will routinely conduct technical work to the standard and detail required by goverment agencies.

ENVIRONMENTAL MANAGEMENT COMMITMENTS

The Company undertakes to carry out a management programme which may be broadly summarised as follows:

- The location of ground water production bores and design of the well field will be determined through liaison with the Water Authority. It is anticipated that a licence will be required and that there may be a condition on the maximum allowable production rate.

- The location and design of the septic tank and soil absorption system for the ablution block will be determined in conjunction with the Water Authority and the installation will be maintained in accordance with the appropriate by-laws.

- Detailed "Working Arrangements" will be prepared in conjunction with CALM which will define management techniques to be adhered to during the mining operation. These will include rehabilitation of excavated pits. Plans for rehabilitation trials are already in progress and there is on-going discussion with CALM personnel.

- In general terms the objectives of the rehabilitation programme will be:

  (i) stabilisation of the surface sands against erosion;

  (ii) minimisation of disturbance to the hydrological balance within the proposed lease area and adjacent land, and

  (iii) establishment of a diverse, effective and permanent vegetation cover capable of plant succession and regeneration to suit the present priority land use of water production.

- Compliance with the requirements of all applicable Acts and Regulations.

- Conduct routine monitoring of groundwater levels and report results to the Water Authority of Western Australia on a regular basis.

- Establish trials incorporating the use of fine tailings material in surface soils to assess suitability for rehabilitation.

- Ensure that areas affected by mining are left in an environmentally acceptable condition in the event of early closure of operations.

- Apply appropriate measures for the control of dieback according to "Working Arrangements" to be developed in conjunction with the Department of Conservation and Land Management".

- Undertake vegetation surveys prior to clearing new areas for mining with respect to rare plant species.

- Maintain an internal environmental management which will routinely conduct technical work to the standard and detail required by relevant government agencies.