PRELIMINARY ENVIRONMENTAL REPORT

CARLTON TRIAL MINING PROJECT

OPEN FILE

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* In rear pocket
1.0 SUMMARY

1.1 Introduction

This Preliminary Environmental Report (P.E.R.) has been prepared by Douglas Martin and Associates Pty Ltd on behalf of Arimco N.L. The company was originally proposing to carry out a trial gold mining operation for six weeks during September and October 1991 involving the transport of 70,000 tonnes of ore from the mining area near Pine Creek township to the existing processing plant at Moline – 45 kms to the east along the Kakadu Highway. Due to changes in corporate planning, it is now planned to commence operations as soon as possible in the dry season (i.e. March–April, 1992).

The proponent’s address is Level 14, 20 Berry Street, North Sydney NSW 2060 and the contact person is Mr R Swan.

This report is divided into a number of sections including:
- project background and approval procedures
- a description of the proposal
- a description of the existing environment
- an impact analysis and recommended management program

1.2 Project Background

Arimco NL is an Australian company which has a 50% participation in the Moline Gold Mine, in joint venture with Greenbushes from WA. This mine is in its third year of operation of its proposed four year life and is seeking other possible deposits of ore to prolong the viability and the estimated life of the mine. Arimco NL presently holds mining tenements covering the Carlton prospect, which is located immediately north of the existing Renison Goldfields Pine Creek Mine adjoining Pine Creek township. It was originally envisaged that development of this prospect to a full scale mine would be carried out with new or renovated processing facilities from Moline on or near the site.
Feasibility Study

In order to determine whether mining Carlton gold ore and transporting it to the Moline Mine for processing is a viable proposition Arimco proposes to carry out a Trial Mining exercise commencing March 1992. This project will provide valuable information for calculating the economic feasibility of such a future programme.

The P.E.R. is to be submitted to the Minister for Conservation according to the requirements of the N.T. Environmental Assessment Act, 1982. Any need for a full Environmental Impact Statement (E.I.S.) would be determined by the N.T. Minister for Conservation.

1.3 Project Description

Figure 1 shows a plan of the proposed pit on the Carlton prospect, which will be developed on Gandy's Hill. The location of the pit can be seen in relation to the Stuart Highway, the Old Stuart Highway, Renison Goldfields Pine Creek Mine and the Kakadu Highway. The duration of the trial mining period will be six weeks during March – April 1992.

Volumes to be mined

- Tonnage of ore to be mined = 70,000 tonnes
- Stripping ratios = 2:1
- Volume waste = 140,000 tonnes

Allow 24,000 tonnes for road works
- Waste emplacement = 116,000 tonnes (50,000 bcm)

Mining will be conducted in daylight hours, utilising conventional open cut mining techniques and equipment. A contractor will be engaged to do the mining, under the supervision of an Arimco representative. Appropriate grade control methods will be applied and bench faces and pit floors will be accurately mapped, sampled and assayed as the project progresses.
Drilling and blasting is not intended, but this may have to be reviewed during mining. The maximum depth of excavation will be 15m and the average depth 10m over an area of 150m N-S by 40m E-W (Figure 2). A waste rock stockpile will be developed on MCN160 approximately 400 metres to the north of Gandy's Hill (Figure 1). A temporary ore stockpile will be established on MCN762.

1.4 Existing Environment

The environment in the vicinity of the site has already been greatly modified by exploration and past mining operations. In 1983, the Gandy's Hill area was classified by Fatchen (1983) as being part of the Brocks Creek Ridge land system (Wood, 1977). The top 15m of Gandy's Hill is made up of either drill pads or exposed faces and costeans. Below approx 250m R.L. the slopes are gentler and support a mixed woodland vegetation on shallow skeletal soils. On the gentler slopes there has been more soil development and the vegetation is taller and well-developed. This land system occurs extensively in the Pine Creek area.

Drainage from the site flows to the Pine Creek sub catchment of the Cullen River. The site is close to the boundary with the Caledonian Creek Catchment which flows to the north-east but also drains to the Cullen.

Gandy's Hill is a prominent feature near Pine Creek township and can be seen in the foreground from the Stuart Highway for approximately 400 metres. From the Kakakdu Highway a small portion of the hill can be seen in the middle distance for approximately 300 metres. This part of the hill will not be affected by the trial mine.

1.5 Impact of the Proposal

The environmental impacts of this proposal are limited due to the duration, location and nature of the proposal. First, the proposal will be completed within six to eight weeks. Second, the location of the main activities are approximately 2 km from Pine Creek township which has already been affected by existing mining operations. The main issues are:-
4.

- rehabilitation in the event of a decision not to proceed to a full scale mine
- the reduction in elevation by 15 m of Gandy's Hill which is a prominent feature and is visible from the Stuart Highway.
- the potential reduction in safety for tourist traffic travelling along the Kakadu Highway
- the modest short-term socio-economic impact of the proposal on Pine Creek business and service industries.

1.6 Management Recommendations

In order to ensure that a rehabilitation program would be carried out if a large scale mine were not to proceed a rehabilitation strategy has been outlined in Section 6.1. Also a bond would be posted with the N.T. Department of Mines and Energy.

A traffic management program will implemented according to the requirements of the N.T. Department of Transport and Works and additional proposals are discussed in Section 6.2.
2.0 PROJECT BACKGROUND & APPROVED PROCEDURES

2.1 Project Background

Arimco NL is an Australian company which has a 50% participation in the Moline Gold Mine, in joint venture with Greenbushes from WA. This mine is in its third year of operation of its proposed four year life and is seeking other possible deposits of ore to prolong the viability and the estimated life of the mine. Arimco NL presently holds mining tenements covering the Carlton prospect, which is located immediately north of the existing Renison Goldfields Pine Creek Mine adjoining Pine Creek township. It was originally envisaged that development of this prospect as a full scale mine would be carried out with new or renovated processing facilities from Moline on or near the site.

2.2 Feasibility Study

In order to determine whether mining Carlton gold ore and transporting it to the Moline Mine for processing is a viable proposition Arimco proposes to carry out a Trial Mining exercise commencing March/April 1992.

This project will provide valuable information for calculating the economic feasibility of such a future programme, including:

(i) A reconciliation study between geological interpretation from drill holes and actual exposure of mineralised zones.

(ii) the degree of difficulty of grade control.

(iii) the nature of mining required.

(iv) the efficiency of transporting ore from Carlton to Moline.

(v) the weathering behaviour of waste and ore.

(vi) the metallurgical behaviour of Carlton ore.
(vii) the head grade of ore and recovery of gold.

(viii) the operating costs and revenue.

In order to complete the study, to a level of high accuracy, a plan was developed to extract a large enough bulk sample which would satisfy all the above requirements. A trial pit was designed to expose all types of mineralisation in the oxide zone, so that the parcel of ore would be as representative as possible, given the constraints of the trial mining exercise.

The opportunity would be taken to process this ore through the Moline treatment plant in between its fortnightly Moline ore milling campaigns. This would provide true scale information rather than laboratory or pilot plant testwork which has inherent scale-up inaccuracies. It was also considered necessary to transport a quantity of ore from Carlton to Moline which was large enough to accurately determine all costs involved.

A combination of all of these requirements was developed and it was calculated that a bulk sample of approximately 70,000 tonnes will provide all the information required for this feasibility study.

2.3 Approval Required

Further to the advice received from the Minister of Conservation dated 27th May 1991, a Preliminary Environmental Document (hereafter referred to as P.E.R.) is required for the trial mining pursuant to the Northern Territory Environmental Assessment Act 1982.

The P.E.R. document is to be submitted to the N.T. Conservation Commission (C.C.N.T.) and copies distributed to relevant Government Departments. There are no formal requirements for public exhibition of this document. Guidelines issued by the C.C.N.T. in order to facilitate preparation of the document have been reproduced as Appendix 1 in this document.
3.0 PROJECT DESCRIPTION

3.1 Location

The Carlton Prospect is located immediately north of the existing Renison Goldfields Pine Creek Mine on two parallel north-south anticlines known as the International (generally located within MLN790) and the Enterprise (generally located within MLN782). The western anticline is also known as Gandy's Hill. (See Figure 1 & 2).

3.2 Tenements

The Carlton prospect is made up of tenement No's:

- Mineral Leases Northern 39, 782 and 790.

Mineral Leases Northern 39, 782 and 790, together with Mineral Claims Northern 761, 763 and 3699, are presently being consolidated into one Mineral Lease, pursuant to Section 168 of the Mining Act. A formal application for a Mineral Lease will be made in due course.

3.3 Trial Mining Plan

Figure 1 shows an aerial photo of the proposed pit area, which will be developed on Gandy's Hill. The location of the pit can be seen in relation to the Stuart Highway, the Old Stuart Highway, Renison Goldfields Pine Creek Mine and the Kakadu Highway. The duration of the trial mining period will be six weeks during March-April 1992.
8.

Volumes to be mined

Tonnage of ore to be mined = 70,000 tonnes

Volume

Stripping ratios = 2:1

:. Volume waste = 140,000 tonnes

Allow 24,000 tonnes for road and ore stockpile works

Waste emplacement = 116,000 tonnes (50,000 bcm)

Mining will be conducted in daylight hours, utilising conventional open cut mining techniques and equipment. A contractor will be engaged to do the mining, under the supervision of an Arimco representative. Appropriate grade control methods will be applied and bench faces and pit floors will be accurately mapped, sampled and assayed as the project progresses. For the accumulation of the maximum information, 1.5 metre benches are proposed, but this could be reviewed during mining. Drilling and blasting is not intended, but this may have to be reviewed during mining. (Prior approval for drilling and blasting would be required by the N.T. Department of Mines & Energy.) The maximum depth of excavation will be 15m and the average depth 10m over an area of 150m N-S by 40m E-W (Figure 2). A waste rock stockpile will be developed on MCN160 approximately 400 metres to the north of Gandy's Hill (Figure 2). A temporary ore stockpile will also be established on MCN762.

3.3.1 Design Parameters

Final floor level : 250RL
Batter angles : 60°
Maximum batter height : 10 metres
Slope of haul road : 10:1 maximum
3.3.2 Mining Methods

1.2.1 Drilling and Blasting

At present, no blasting is considered necessary. However, if required the ground will be drilled with hydraulic rigs (Atlas Copco 712 or 812) prior to blasting and mining. Prior approval for drilling and blasting would be required from the N.T. Department of Mines & Energy.

The drilling and blasting parameters to be used are:

- Normal bend height: 6m
- Hole diameter: 100mm
- Burden & spacing: 4m x 3m
- Explosive: Anfo if dry, packaged explosives (Tovex) if wet
- Firing method: Detonating cord, safety fuse, delays, boosters. Max 250kg/delay.
- Firing times: To coincide with PGC times where possible

3.3.3 Mining Machinery

Both ore and waste will be mined with hydraulic excavators (Komatsu PC100/PC650) and loaded into dump trucks (Caterpillar 777B) for haulage to stockpiles on MLN762.

From there the ore will be loaded onto road trains with a front end loader for haulage to Moline Gold Mine.

The expected machinery on site will be:

- Hydraulic Excavator (5) : (1)
- Dump Trucks : (2)
- Front End Loader : (1)
- Water Truck : (1)
- Maintenance Truck : (1)
Bulldozer : (1)
Grader : (1)
Drill Rigs : (2)
Light Vehicles : (4 - 5)

3.3.4 Facilities to be established on site

Crib Room/Office : Existing
Machinery Service Area : Transportable workshop

Other Contractors/Services used:

AAL, Pine Creek : Sample assays

3.4 Representativity of Sample

Mineralisation extends the entire N-S length of Arimco's tenement MLN782. Cross sections from 2750N to 3200N, show traces of drill holes and grades of ore intersected, which supports the N-S extent of mineralisation and also suggests an apparent anticlinal nature of the deposit, indicating a disjointed mineralised width of 25-100m. The deposit appears to peter out at a depth of about 100m at the most developed section.

Data compiled to date indicates an ore resource of approximately 2.5 million tonnes, at a grade of approximately 2.5g.Au/t, using a cut-off grade of 1.0g.Au/t.

The designed outlay of the proposed pit shows that a representative quantity of high, medium and low grade ore will be extracted, in order to average 2.5g.Au/t.ore represents 3% of the estimated resource. Only 15 metres of the ore deposit depth will be probed.

3.5 Access & Transportation

The proposal is to haul the ore from Carlton to Moline Mine by conventional road trains, via the Old Stuart Highway (1km), the present
Stuart Highway (410m) and the Kakadu Highway (45km). (See Figure 1.) The transportation operation would be carried out in daylight hours on a six day week basis, during the Northern Territory "dry season".

Access to the site would be from the Old Stuart Highway, across MCN762 and then across property controlled by Renison Goldfields. A permit pursuant to Section 182(2) of the Mining Act has been submitted in order to obtain the necessary approval.

3.6 Water Supply

Water requirements for the trial mining are minimal and will be supplied from the dam located at the disused quarry Site on MLN 39 which is owned by Arimco N.L.

3.7 Accommodation

A small project workforce of approximately ten people would be accommodated in Pine Creek and at the Moline Mine commute camp.
4.0 EXISTING ENVIRONMENT

4.1 Land Systems

The proposed site is located on the Brocks Creek Ridge land system. The system is composed of north-south aligned ridges up to 250m in height, with relatively steep slopes, sharp crests and numerous immature ephemeral creeks. This system contains the major hills in the area and includes Gandy's Hill and the Kohinor Anticline. The hills have foothills with slopes up to 10%, with considerable rock outcrop and a surface cover of gravel and stone. Undulating areas with slopes of less than 3% make up the lower land unit of the Brocks Creek Ridge land system. Soils throughout are stony and shallow (lithosols). On the stony ridge crests, deciduous open woodlands develop, while the skeletal and shallow soils of the lower slopes are covered with mixed eucalypt woodland. The alluvial flats are covered by open eucalypt woodland with Pandanus along the streams.

4.2 Meteorology

4.2.1 Rainfall

Rainfall has been recorded at Pine Creek Post Office since 1874. Mean rainfall is 1146mm and medium rainfall is 1116mm. The mean number of rain days for the recording period is 74 days. The highest total rainfall on record occurred in 1973 with 1623mm.

4.2.2 Temperature

Mean daily temperatures vary between 21° in winter to 30° in summer. Mean only maximum temp in summer (October) was 36.8°C and in winter (July) 30°. Mean daily minimum varies from 24° in December to 12.3°C in July.

4.2.3 Wind Direction

Wind Direction Records have been kept at Pine Creek for thirteen years between 1957 and 1969. The wind roses are shown in figure 4.1. For this proposal, the important months are March and April.
Figure 4.1
WIND-ROSES,
PINE CREEK POST OFFICE

Source: Bureau of Meteorology
Note: Wind direction is direction from which wind blows
During April the strongest morning and afternoon winds blow from the E, SE and South. The dominant wind strength is from 1-5km/hr for the morning and increases to 6-10km/hr in the afternoon. March is a transitional month for winds to change from the north-west quadrant to the south-east. Wind strength is similar to April. For the majority of the time of the operation the wind will be blowing away from Pine Creek township at relatively low speed.

4.3 Hydrology

4.3.1 Surface Water

The proposed trial mining operations are close to the boundary between the Pine Creek sub-catchment draining to the south-east and the Caledonian Creek sub-catchment draining to the north-east both of which eventually flow to the Cullen River. For the purposes of environmental management it was assumed that drainage would flow to the south-east (i.e. the Pine Creek catchment) toward the more sensitive downstream land-use area of Pine Creek township.

4.3.2 Ground Water

Between fifty and sixty bores have been drilled in the Pine Creek area to obtain water supplies for the township and for a number of small alluvial mining operations. The majority of holes have been drilled to depths of 50m to 60m and penetrate the Burrell Creek Formation. In 1979, seven holes were drilled to test the alluvial and weathered profile of the Cullen Granite in the upper reaches of Copperfield Creek. These bores revealed that permeability and storage were low in these sediments, and that the area was unsuitable for township water supply development (Pine Creek Joint Venture, 1983).

4.4 Vegetation & Fauna

Vegetation in the areas to be affected by trial mining is made up of four vegetation mapping units prepared by Fatchen (1983). The vast majority of the higher section of Gandy's Hill would now be classified as greatly modified.
1. Deciduous Woodlands of Ridges

Ridgetops and steep upper
slopes with much rock
outcrop

Deciduous low woodland - low open
woodland: Eucalyptus Tintinins,
E. dichromophloia, E. bleeseri and E.
setosa; sparse grass cover, primarily
annual Sorghum sp.

2. Mixed Woodlands of Lower Hill Slopes

Moderate lower hill slopes
with shallow to skeletal soils

Woodland of mixed eucalypt and non-
eucalypt species, often with a tall
shrub layer: Eucalyptus tectifica, E.
clavigera, E. ferruginea, E.
dichromophloia, and E. miniata, with
Buchanania, Gardenia, Terminalia and
Calytrix spp. and Grevillea decurrens.
Some immature Callitris.

Gentle slopes of drainage heads with lithosols,
shallow to moderate yellow earths

Mixed woodland with well-developed tall
shrub layer in places: Eucalyptus
tectifica, E. latifolia, E. clavigera,
E. ferruginea, Erythrophleum,
Grevillea decurrens, C. pteridifolia,
Melaleuca viridiflora, Gardenia,
Calytrix, Livistona spp. and
Eucalyptus apodophylla on deep soils,
occasional Pandanus sp.

6. Greatly modified areas

Regrowth on former mine workings

Variable; on slopes, as described in
Unit 2 above

Other cleared or largely cleared areas

Often bare ground with some shrub
colonization. Otherwise open woodland
similar to adjoining units.

Fauna

As described in the vegetation section, significant fauna habitat which
will be affected by the trial mine is minimal. Following discussions
with the CCNT (W. Freeland, 19/2/91) the area was inspected for
existing adits which may support local bat species. However,
exploration activities had already disturbed the vast majority of the
terrain on the top of Gandy's Hill. If a larger mine were proposed
additional studies of terrestrial fauna would be contemplated.

From field inspection and review of the studies completed there were no
rare and endangered species found in the proposed trial mining area.
Flora and fauna on the site is well represented within the immediate
vicinity and region and no significant impacts are anticipated to result from the trial mine.

4.5 Land Use

Nearly all the District is presently taken up by pastoral lease or grazing licence, or held under some form of mineral lease, licence, claim, or reserve. The pastoral industry has failed to develop, mainly due to the low nutritional value of natural pastures for a long period each year. Stock are generally of poor quality. Land-use on the area of trial mining operations has been all exploration in recent years. There are numerous tracks and drill pads and the waste stockpile areas were previously used as a borrow pit.

Approval has been granted by the N.T. Department of Lands & Housing for removal and relocation of the trig station at Gandy's Hill.

4.6 Archaeology – Aboriginal Heritage

The study area has been heavily impacted by initial exploratory works, and the locations for the proposed trial mine have already been effectively destroyed. Surface levels are up to three (3) metres below the original surface layer, and the likelihood of archaeological material surviving in these areas is minimal.

One prehistoric Aboriginal site was located during the survey, as were several historic (Chinese) diggings. The prehistoric site will not be directly affected by the trial mining, and has already been disturbed by road works along the top of International Anticline.

The conclusion of the archaeological survey was as follows:

"There are no archaeological constraints on the trial mining, and it is recommended that this proposed development can proceed without further archaeological investigation. It is recommended, however, that if full scale mining is to proceed in this area that further detailed archaeological work is required. This will involve further survey and recording work in those areas of the study area which have
not been disturbed by exploration." The Chinese diggings on the International Anticline will also require detailed recording if not covered by Pearce in 1982 (Macdonald, 1991) (Appendix III). Discussions have been carried out with the N.T. Aboriginal Areas Protection Authority and authority certificates have been issued for all tenements in the Carlton Prospect area. (Appendix IV).

4.7 European Heritage

The Pine Creek environs and township were extensively surveyed for cultural relics and items of historic significance by Pearce (1982). One site of historic significance was found to being in the vicinity of the trial mine. This site will not be affected by trial mining and is also outside the area that would be affected by a larger mine. The site is called:

"Gandy's Gully: Mining Warden's Camp Site"

Grid Reference 5270 049702

Location: the location of the warden's camp site has not been substantiated. However it is thought to have been located on Pine Creek in the vicinity of the clearing occupied by Peter Teague's hut, about 250m north of the former Stuart Highway Pine Creek crossing." (Pearce 1982).

4.8 Transport & Access

The road transport system is shown on Figure 1. The main highway is the Stuart Highway which is built to National Highway standard. The main route affected by the proposal is the Kakadu Highway which is built to 100km standard with a 5-6 metre pavement and 1-2m shoulders. This road is fully sealed and flood free to the Moline processing plant. The old Stuart Highway section is a low standard 4-6 metre road with a low level crossing over Pine Creek. Sighting distances on this section are restricted, mainly due to woodland vegetation growing in close proximity to the road.
Plate 4.8.1

Intersection of the Old Stuart Highway with Stuart Highway. Kakadu Highway turnoff shows in distance

Plate 4.8.2

Sighting distance from Kakadu Highway turnoff along Stuart Highway to the north
Recorded traffic volumes on the Kakadu Highway may be subject to error due to the placement of counters. A more reliable estimate of existing through traffic was taken in July 1989 midway between Waterfall Creek turn off and Big Nellie Creek. This count showed existing traffic to average 89 in an easterly direction and 60 vehicles in a westerly direction. The actual number of vehicles may be less due to the method of counting only axles. Given a growth rate of 6%/year for the period 1989-91 the July average daily traffic was estimated at 180. Volumes in March and April can be expected to be lower.

4.9 Socio-Economics

Pine Creek township had a population of 393 at the last Census in June 1986. A census is currently being completed and it is anticipated that the town has maintained a stable population even though mining industry employment has declined due to the cutbacks in exploration programs and the development of new projects. This stability is considered to be due to the growth of small service industries for the mining industry and some growth in the tourist industry due to the impact of better access to Kakadu National Park and other destinations in the region. A breakdown of industry in the township is shown in Table 4.9.1.

4.10 Aesthetics

Gandy's Hill is a prominent feature of the landscape in the vicinity of Pine Creek township. It has approximately the same elevation as the former terrain to the immediate south which has now been mined by Renison Goldfields. The hill can be seen from the Stuart Highway for approximately 300 metres immediately south of the Kakadu Highway turnoff and for a similar distance entering Pine Creek township from the east near the racecourse. Plates 4.10.1 and 4.10.2 illustrate the existing views of the hill. Photograph locations are also shown on Figure 1. The portion of the hill shown in Plate 4.10.2 will not be affected by trial mining.
Plate 4.10.1

View of Gandys Hill from Stuart Highway travelling north

Plate 4.10.2

View of southern end of Gandys Hill from Kakadu Highway travelling into Pine Creek from the east (not affected by trial mine)
### Table 4.9.1

**Employment - Pine Creek Township**

*by Industry*

<table>
<thead>
<tr>
<th>Industry</th>
<th>Total (Inc NS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agric., Forestry, Fish &amp; Hunting</td>
<td>0</td>
</tr>
<tr>
<td>Mining</td>
<td>61</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>2</td>
</tr>
<tr>
<td>Electricity, Gas, Water</td>
<td>2</td>
</tr>
<tr>
<td>Construction</td>
<td>6</td>
</tr>
<tr>
<td>Wholesale &amp; Retail Trade</td>
<td>7</td>
</tr>
<tr>
<td>Transport and Storage</td>
<td>4</td>
</tr>
<tr>
<td>Communication</td>
<td>2</td>
</tr>
<tr>
<td>Finance, Prop &amp; Bus Services</td>
<td>12</td>
</tr>
<tr>
<td>Public Admin. Defence</td>
<td>6</td>
</tr>
<tr>
<td>Community Services</td>
<td>18</td>
</tr>
<tr>
<td>Rec. Personal Other Servives</td>
<td>19</td>
</tr>
<tr>
<td>Non-Classifiable Econ Unit</td>
<td>2</td>
</tr>
<tr>
<td>Total (inc. not stated)</td>
<td>152</td>
</tr>
</tbody>
</table>

Source: ABS Census, 1986
5.0 IMPACT OF THE PROPOSED TRIAL MINE

5.1 Land Systems

The impact of the mining component of the proposal will affect approximately 2.6ha (including mining, ore-stockpile, waste rock area and haul road). The vast majority of the trial mining area has already been severely affected by previous exploration programs on this project and past mining activities. If the trial mining leads to a full-scale project, additional impact studies will be carried out. If not, the mining, haul road and waste storage areas will be rehabilitated as discussed in Section 6.1 of this document.

5.2 Nuisance Impacts (Noise & Dust)

It is important to stress the short-term duration of the proposal (six weeks). Assuming that the work is carried out in March and April, the noise and air quality effects on Pine Creek township are not anticipated to be significant.

The existing noise environment is already affected by the operations of the Renison Goldfields mine. As the dominant winds are blowing from the SE quadrant and that Gandy's Hill is at least 1.5km further from Pine Creek township than Renison, no significant effects are anticipated.

Noise from the truck movements are not anticipated to cause significant effects as the route skirts all existing residential areas. Truck movements will be spaced between 20 - 40 minutes and only operate during daylight hours.

Similarly, any dust arising from the mining component and not controlled by the management program will not significantly affect Pine Creek township.

5.3 Transport

In order to transport the required 70,000 tonnes to the processing plant at Moline, a total number of 900 road-train loads would be necessary (payload: 78 tonnes each). Total trips generated would be
1800 (i.e. both directions) or 60 trips per day for 5 weeks. It is envisaged that 3 trucks would be used and no more than two trucks would be on the haul route at any one time. Approximate spacing between loads would vary from 20 to 40 minutes.

Assuming that the operation will be completed during the 1992 dry season, no road capacity or loading problems are anticipated.

As the Kakadu Highway is used for tourist and holiday traffic an escort vehicle with flashing light and signboards will be despatched with each load and fixed signboards will be placed in accordance with traffic management recommendations from N.T. Department of Transport & Works.

Traffic on the old Stuart Highway past the Renison operations is presently less than 50 vehicles/day. Appropriate warning signboards would be posted at the one road junction affected by the proposal.

5.4 Aesthetics

As the proposal will remove the top 15m of Gandy's Hill, the effect of the proposal will have a significant visual impact when viewed from the major roads leading into Pine Creek from the south and east. The two sections most affected will be:

- on the Stuart Highway from the turnoff into Pine Creek township for approximately 400 metres to the intersection with the old Stuart Highway;

- on the Kakadu Highway from the proximity of the racecourse to the turnoff into Pine Creek township for approximately 300 metres. This portion will not be affected by trial mining.

It should be emphasised that on the Stuart Highway portion, the viewshed is already affected by the Renison mining operation. Consequently, it would not be considered to be out of character with the surrounding foreground landscape. A management program is discussed in Section 6.0. to rehabilitate the top of the hill (If necessary).
5.5 Tailings Management

At present the Moline mine is forecast to produce 360,000 tonnes of tailings for the year 1991-92. There are additional probable reserves which would generate an additional 350,000 tonnes of tailings during 1992-93. The anticipated mine life at Moline will require 2.3m tonnes of storage.

Recently the secondary tailings dam wall was lifted to provide an additional 580,000 tonnes of capacity taking the total capacity to 2.5m tonnes. An additional lift on the main tailings dam wall to R.L.128 would provide a further 700,000 tonnes to reach the design capacity of 3.2m tonnes.

It can be concluded that there is excess capacity within the existing tailings system of 200,000 tonnes to store the 70,000 tonnes from the trial mining operation. At this stage no further expansion of the tailings area is required. If a full-scale mine was contemplated additional investigations of tailings capacity and hydrological background data would be completed.

5.6 Socio-economics

If this project proceeds, the immediate benefits to Pine Creek township will be modest. Additional business will be generated in the town from purchases and accommodation required by contractors and any Arimco staff. Pine Creek laboratories will be used to carry out the relevant analyses. Of greater significance is the possibility of a full-scale mine which would have significant socio-economic impacts on the Pine Creek township. This analysis would be one component of a full Environmental Impact Statement.
6.0 MANAGEMENT RECOMMENDATIONS

6.1 Rehabilitation

In the event that the Trial Mining feasibility study shows that the Carlton deposit is worth developing on a large scale, rehabilitation will be addressed in the Environmental Impact Statement which will form part of the Carlton Mining Feasibility Study which will follow.

Should the Trial Mining feasibility study show that the Carlton deposit is not worth developing on a large scale, or alternatively should the decision be taken to defer development for a lengthy period of time, then the following rehabilitation programme will be undertaken:

Mining Area

- Sharp edges will be smoothed and shaped.

- the horizontal floor of the pit will be deep ripped (about 1 metre) topsoiled and revegetated.

- Floor drainage will be set up to flow to the eastern catchment dam between the Enterprise and International Anticlines. A 2m bund will be placed around the perimeter of the excavation and covered with soil and seed for vegetation regrowth.

- All plant, equipment debris and scrap will be removed from the site.

- If there is no further mining activity local tree species would be grown on the bund walls in order to minimise the visual impact from the Stuart Highway.

- The mining area and waste rock dump will be fenced for security reasons pursuant to Part II Section 40 of the Mines Safety Control Act (1982).
Waste Rock Area

A waste rock emplacement will be developed on MCN160 which is the northern most tenement in the Carlton area held by Arimco N.L. It will cover approximately 1 ha with a total volume of 50,000 bcm. Approximately 1,000 bcm will be composed of transitional material which contains a small amount of sulphide material and the remaining 49,000 bcm will be oxide material. As reported in Appendix 2 there is no sulphur in the oxide waste material. The oxide material will be compacted at the surface to ensure there is no hazardous leachates from other metals.

Existing vegetation will be cleared and pushed to a central wind-row areas for burning. All available top soil will be separated from vegetation and stockpiled for subsequent re-use. As the operation will be completed within six weeks there should be adequate seed and nutrient reserves contained within the top layer for revegetation purposes (Applegate, 1983).

In order to ensure that there is no leachate from the small quantity of transitional material, it will be encased inside a compacted layer of laterite material which is present in adequate quantities at the Gandy's Hill mining site. Perimeter waterways will be designed to divert clean surface water flow and a toe drain with cut-off key would be constructed on the down-hill side. The surface of the area will have contour drains with a long fall along the contour not exceeding 2% slope (see figure 6.1). It is not proposed to mine any sulphide material as it would require trial mining to an additional depth of 10-15m.

Haul Road

All haul roads will be built with oxide waste material. If required, the entire haul road surface would be deep ripped and covered in top layer material prior to stabilisation. Haul road batter slopes will be constructed at no greater than 1 in 3 slope in order to promote revegetation and reduce run-off erosion. Catch drains on either side of
the road will have intermittent temporary sediment traps to also help in reducing run-off erosion.

Monitoring

In the event of no action being taken to develop a full-scale mine, a monitoring program will be carried out to audit the following potential sources of pollution:—

- any leachate from the waste rock dump
- surface water quality downstream of the mining and waste rock area
- any potential for soil erosion
- any potential for increases in noxious weeds present on the site (pursuant to the N.T. Noxious Weeds Act, 1980)

6.2 Traffic Management

Discussion with the N.T. Department of Transport and Works has been carried out in order to develop an adequate traffic management approach to this project. Recommendations to be implemented include:—

(i) a (temporary) 60 kph speed zone to be instituted along the Stuart Highway in the vicinity of the road train movements, with the existing 80 kph speed zone placed further out from Pine Creek.

(ii) Warning signs be placed at suitable points in the vicinity of the Stuart Highway movements. The signs should warn motorists of roadtrains crossing the road and be accompanied by amber flashing hazard lights.

(iii) Amber flashing hazard lights be placed at appropriate points along each roadtrain in conformity with Traffic Regulation No. 76.

(iv) A small escort vehicle with amber flashing lights will travel ahead of each roadtrain on the Kakadu highway in order to minimise any conflict with tourist traffic.
CARLTON PROJECT

TOP COVER LAYER tested
'mulch' surface cover and
topsoil fertilized and seeded
with selected grass and shrubs
0.4m (min) thickness

OXIDE WASTE

COMPACTED OXIDE WASTE

TRANSITIONAL WASTE

1:200 crossfall

lease boundary

sump

catch drain

catch drain

catch drain

top layer cover

Waste 50000m³

original ground level

no greater than 35°

FIGURE 6.1

CROSS SECTION THRU
PROPOSED WASTE
EMPLACEMENT MCN 160

diagrammatic: 4 times vertical exaggeration
(v) Overhanging vegetation along the verge of the Old Stuart Highway will be cleared in order to maximise sight distances between the site and the turnoff at the Renison mine entrance.
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<td>All recommendations of the N.T. Dept. of Transport and Works to be implemented. Also escort vehicles to accompany all roadtrains. Vegetation clearance along the verge of the old Stuart Highway.</td>
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<td>Socio-economics</td>
<td>Modest increases in business activity in Pine Creek township for 6-8 weeks.</td>
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REFERENCES


Churchill S.K., Freeland N.J. & Fry K (undated) "When in a Cave Dwelling but Considered Rare Endangered: the Case of Macroderma Gigas" (Dobson 1880) C.C.N.T. Publication
APPENDIX I

Copy of Guidelines from the
Northern Territory Conservation Commission
Mr R H Swan
General Manager Operations
ARIMCO NL
PO Box 1510
NORTH SYDNEY  NSW   2059

Dear Mr Swan

I have been advised by the Department of Mines and Energy of your proposal to conduct a trial mining operation at the Carlton gold deposit near Pine Creek, and that you have been nominated as proponent of the proposal.

While your proposal involves processing of ore at an existing facility and a relatively small initial operation, I consider that there is still potential for significant environmental effects which require examination before I can be satisfied that impacts will be appropriately minimised.

I therefore direct you to prepare a Preliminary Environmental Report covering the issues outlined in the attached guidelines for assessment under the Environmental Assessment Act. Ms Maryanne McKaige of the Conservation Commission's Environment Protection Unit will be co-ordinating assessment of your report and you should contact her on (089) 89 4471 if you have any queries.

I would advise you to supply Ms McKaige with a draft of your report for comment to ensure that it provides adequate information before preparing the 18 copies required for assessment purposes.

Yours sincerely

MIKE REED
19/5/91
GUIDELINES FOR A PRELIMINARY ENVIRONMENTAL REPORT:
GANDYS HILL / CARLTON GOLD MINE

The PER should be concise but contain sufficient detail to allow advisory and assessment authorities to fully understand the scope and implications of the proposal. The report should identify the main environmental impacts associated with the development and the management strategies or safeguards proposed to minimise or ameliorate these impacts.

Of primary concern with a mining proposal of this type is the containment, management and treatment or disposal of wastes, particularly those associated with processing of ore and stockpiling of overburden, as well as the physical impacts of ore extraction. Social effects of transport of ore will also be a consideration with this project.

The PER should include maps, diagrams, tables, photos, etc., as appropriate for clarification of the text.

1. GENERAL INFORMATION

This section provides a brief introduction to the proponent and the proposal. Details should include:

- Name and address of proponent (company) including contact officer;
- Background, objectives;
- Present status such as stage of planning, design, approvals obtained, etc;
- Alternatives and justification of the proposal as the preferred option;
- Summary of key environmental management issues.

2. DESCRIPTION OF PROPOSAL

This section should describe the project in sufficient detail to allow a thorough understanding of all stages of construction and operation. Aspects to be covered include:

- Location, design and layout;
- Staging/time frames for extraction and processing;
- Quantities of ore to be processed;
- Process type and predicted types and quantities of process wastes, including aqueous, atmospheric or dust emissions;
- Waste management at Moline processing facility and capability for handling this new ore source;
- Management of any overburden or waste rock including physical and chemical properties of this relating to final landform, leaching, runoff and rehabilitation;
. Transport requirements;
. Workforce requirements, accommodation, conditions, etc.;
. Brief economic analysis of project including proof of the need/validity of the trial mining proposal;
. Outline of larger picture for mining at Gandys Hill, given that this proposal is presented as a trial operation.

3. EXISTING ENVIRONMENT

This section should describe the biophysical and socioeconomic environments affected by the proposal.

Biophysical Environment

. Geophysical data for Gandys Hill (include land forms, geology, and any relevant climatological information such as rainfall relating to water management);
. Hydrological data for Gandys Hill and where relevant for Moline (including drainage characteristics, flood levels, surface and groundwater hydrology);
. Flora, fauna and habitats occurring on the Gandys Hill site or which may be affected adjacent to the site. While any rare, endangered or unusual species should be identified, the biological environment should also be described in terms of its general regional context (i.e. similarity to adjacent areas, representativeness, unusual features, etc).

Socio-economic Environment

. Existing and possible future alternative land uses on and adjacent to the site; land tenure arrangements.
. Significant Aboriginal or non-Aboriginal sites including cultural, archaeological, or scientific sites on or potentially affected by the proposed development site.
. Location and demography of relevant population and service centres.

4. ENVIRONMENTAL IMPACTS

This section combines the information in Sections 2 and 3 to identify the potential environmental impacts or issues surrounding the development. Impacts may be direct, indirect, short or long-term. Some will be temporary occurrences while others will be irreversible changes. All of these need to be identified.

Aspects to be covered include:
Clearance of vegetation, earthworks and habitat destruction. Potential for erosion, etc;

Potential creation or exacerbation of weed and feral animal problems;

Changes to hydrology/water resources, e.g. potential groundwater drawdown if this is to be a major water supply for processing at Moline or through pit dewatering;

Impacts of release of any effluents or emissions, deliberate or accidental. This should include any acid or otherwise contaminated leachate or runoff from the site such as from pit dewatering, waste rock, etc., and an outline of increased risks of impacts of these, if any, at Moline as a result of the proposal;

Impacts on significant sites, flora, fauna from operations at Gandys Hill;

Effects on existing and adjacent landuse including tourism/recreation if relevant;

Effects on local communities (may include beneficial effects).

5. ENVIRONMENTAL MANAGEMENT (SAFEGUARDS)

This section should outline the environmental management practices and general safeguards proposed to minimise or ameliorate the adverse effects described in section 4. A table should be prepared which sets out each of the predicted impacts in section 4 in point form, and the corresponding safeguard or management measure proposed to achieve environmental protection. This table should be quite comprehensive and can reduce the amount of discussion on these points required in the text in both sections 4 and 5.

Environmental management should include:

- Erosion control;
- Containment/treatment/disposal of all wastes and emissions, including any acid leachate or runoff from the site, in particular from waste rock;
- Water management;
- Significant sites, flora, fauna protection;
- Weed and feral animal control;
- Monitoring programs to demonstrate that protection measures are adequate;
- Rehabilitation programs, both progressive through the operational phase, and final rehabilitation at decommissioning.

A rehabilitation concept should be presented which demonstrates a commitment to the containment or
appropriate disposal of wastes, site stabilisation from erosion, restoration of vegetative cover and monitoring to ensure that these are achieved over a reasonable time frame.

Appendices

The appendices should include the data from all studies undertaken for preparation of the report, sources of information, references, copies of any approvals obtained (e.g. Aboriginal Areas Protection Authority), etc.
APPENDIX II

Analysis of Geo-Chemical Characteristics of Waste Rock
APPENDIX

GEOCHEMICAL CHARACTERISATION OF OXIDE WASTE MATERIAL

In order to characterise the geochemistry of the waste rock, two samples were taken from the site and multi-element analysis was conducted by the Australian Assay Laboratories Group. The two samples were taken from DGG018 on Section 13000 from 0-13 M and 11 from GDD016 on Section 129500N from 8-13 M (see attached Figures 11-1 and 11-2.)

GDD018 was selected because it gave a complete section through the proposed pit from the surface to the floor. Most other holes had intersected zones of gold mineralisation.

GDD016 was selected because it was 50m from GDD018 and would indicate whether there was any substantial change in the trace element analysis along strike.

In summary, assessment of the multi-element data indicate that the oxide waste rock material is expected to be non-acid forming with less than 0.01% sulphur observed in both samples— the level of mercury, uranium, radium226 and arsenic are at or below trigger levels and are unlikely to pose any potential environmental concern. If a large mine were anticipated more detailed characterisation and assessment would be required.
# Analysis Report

## Moline Gold Mine

**Client reference:** 3144  
**Report:** PC 028348  
**Date:** 17/07/91  
**Cost code:**  
**Copies to:** R. SWAN

**Samples**  
**Received:** 17/06/91

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### ANALYSIS REPORT

**REPORT**: PC 028548

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APPENDIX III

Archaeological Survey Report
Archaeological Survey
of proposed
Carlton Trial Mining Project
at
Pine Creek, NT.

July, 1991
Archaeological Survey
of proposed
Carlton Trial Mining Project
at
Pine Creek, NT.

July, 1991

Josephine McDonald

Report prepared for Douglas Martin & Associates Pty Ltd
on behalf of
ARIMCO NL
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1. INTRODUCTION

This report was commissioned by Douglas Martin and Associates Pty Ltd on behalf of Arimco N.L. It details an archaeological survey undertaken for the Carlton Trial Mining Project at Pine Creek. This development proposes to remove relatively small amounts of deposit (60-70,000 and 2-3,000 tonnes respectively) from Gandy's Hill and an adjacent anticline ("International") in order to assess the gold content of the deposits.

The intention of this survey was to assess whether there were any archaeological constraints on the Trial Mining operation. It is not known at this stage whether further mining operations will occur in the Carlton Project. Recommendations are made with regards further archaeological work which will be required if mining operations proceed.

Given the preliminary nature and restricted extent of the trial mining work, the highly modified nature of current trial mine sites, and the extremely low surface visibility across the study area as a whole, this report should be viewed as a preliminary reconnaissance and not a detailed or comprehensive study.

Summary of findings and recommendations

The study area has been heavily impacted by initial exploratory works, and the locations for the proposed trial mine have already been effectively destroyed. Surface levels are up to three (3) metres below the original surface layer, and the likelihood of archaeological material surviving in these areas is minimal.

One prehistoric Aboriginal site was located during the survey, as were several historic (Chinese) mines. The prehistoric site will not be directly affected by the trial mining, and has already been disturbed by road works along the top of International. The only Chinese mine to be affected by the proposal is already partially destroyed by drilling and other exploration works.

There are no archaeological constraints on the trial mining, and it is recommended that this proposed development can proceed without further archaeological investigation. It is recommended, however, that if full scale mining is to proceed in this area that further detailed archaeological work is required. This will involve further survey and recording work in those areas of the study area which have not been disturbed by exploration, and which are currently obscured by dense wet season vegetation. The Chinese mines on the eastern spur will also require detailed recording. It is recommended that this further work should be undertaken in the dry season.

2. THE STUDY AREA

The study area is located less than five kilometres north-west of Pine Creek township (see Figure 1). It is immediately north of the Renison Goldfields Pine Creek open cut Gold Mine. The study area consists of two parallel north-south anticlines known as the International and the Enterprise. The latter (western) anticline is locally known as Gandy's Hill. There is a Trig Station on the top of Gandy's Hill.
Pine Creek runs across the southern end of the study area, and two tributary creeks flow into this from the study area: one from the western side of Gandy's Hill, the other from between the two anticlines.

There is a dam on the tributary between the two anticlines and this central gully area has been subject to extensive siltation as a result of initial exploratory work on the two spurs. The dimensions of the study area are approximately 1300m x 600m. The two trial mine areas measure around 300m x 100m and 150m x 50m respectively.

Geology

The geology of the area is dominated by the Cullen Granite overlain by the Burrel Creek formation (siltstones, greywacke). At the interface of these two formations occur extensive hornfels outcrops. These have been recorded previously outside the current study area and have been identified as the foci for Aboriginal quarrying activity (Baker and Deveson 1983).

The distribution (in this study area) for the outcropping hornfels cobbles and small boulders, appears to be largely restricted to the lower slopes of the two anticlines: no large cobbles were observed in situ on the top of either anticline. Some small pockets of cobbles were identified on an exposed track towards the top of the Enterprise anticline, on its eastern face. The bedrock in the trial mine areas (all very much exposed by preliminary exploratory work: see Photos #1, 2 and 5) consists primarily of slate and greywacke with numerous brittle quartz reefs.

Vegetation

The vegetation in the study area comprises mainly an open forest of savannah eucalypts, such as E. alba (Poplar gum), E. tetradonta (Stringybark), and E. conifera (Applegum). Grass cover is equally divided between annuals and perennials up to two metres in height. Main species include Sorghum, Allotropis semilatata (cockatoo grass), and Heteropogon triticeus (giant spear grass). At the time of the survey (February 1991) the grass cover was dense and comprehensive in areas of minimal disturbance (see Photos 3 & 4). Visibility in these areas was virtually nil.

Likely Impact of the proposed development

The study area includes three Mineral Lease areas (MLN 39, 782 & 790) and six Mineral Claim areas (MCN 160, 297, 761, 762, 763, & 3699). When the survey was completed it was planned to trial mine areas on both anticlines. The proposal to trial mine the International anticline has now been abandoned. The Enterprise trial mine location falls within MLN 782 & 790 and MCN 160, 762 & 3699 (see Figures 2 and 3: the location of the proposed International trial mine site is plotted to indicate where the survey was concentrated in this area). It is proposed to use an existing access track in from the north-western side of Gandy's Hill to truck the deposit away from the Trial Mine for processing to Moline Mine, 45km east of Pine Creek.

It is estimated that between 60-70,000 tonnes of deposit will be excavated from Gandy's Hill. This would be removed from an area of approximately 300m x 100m and to a depth of 15 metres. From International a much smaller amount of deposit was to be removed (2-3,000 tonnes) from an area of <50 x 50m and excavated to a depth of < 3 metres. The Gandy's Hill trial area is located on the western sides of the hill. There will
be an ore stockpile on MCN 762 adjacent to the old Stuart Highway at the foot of the haul road. A waste rock dump will be located on MCN160. The two trial mine locations, haul road and stock pile locations are indicated in Figure 3.

Existing Impacts in the Study Area

The two trial mine areas have been extensively disturbed by preliminary exploration (eg. drilling, drillpads, costeens etc.). In some areas the existing surface level is up to 3 metres below the original surface level. The Trig station on top of Gandy's Hill has been shored up with rubble in an effort to maintain its height integrity. The entire trial mine area, proposed haul and access routes are so disturbed that the likelihood of artefactual material being present (let alone surviving in situ) is almost nil.

3. ARCHAEOLOGICAL CONTEXT

While there has been only limited prehistoric archaeological work undertaken in the Pine Creek area, this is highly relevant to the current investigation. Baker and Deveson (1983) undertook an archaeological survey immediately south of the current study as part of the Pine Creek Gold Mine EIS (Pine Creek Joint Venture 1984). Their study detailed the history of the Pine Creek area and the effects of early contact on the Aboriginal people living in the area, as well as completing a comprehensive survey of the proposed mine site. As the geology, vegetation and topography in the two areas is very similar, the results of this earlier survey deserve a detailed review.

Site definition: the definition for a site used in this earlier study was peculiarly arbitrary. While a site was conventionally described as "the remains left by concentrated human activity in specific locations", such a location was defined as "an area in which at least twenty artefacts could be found by one person in ten minutes" (Baker and Deveson 1983?: 7). It was not stated whether this was a wet season or dry season standard (although their survey was undertaken in the dry), nor whether the definition allowed for vagaries in the person's eye sight/ general competence/ willingness to find artefacts etc.. By this definition, however, it can be assumed that 20 artefacts was the minimum considered necessary to comprise a site, although the area across which these may be distributed is not known. This definition was not used in the current study, not only because this was undertaken during the wet season. On quarry sites a more objective definition was applied. This involved locating artefact concentrations of 100/m² while the site boundaries were defined as where the artefact density dropped below 1/m².

In order to maintain a degree of comparability however, the site definition used here is a compromise of the definitions used by Baker and Deveson. A site is defined as 20 (or more) artefacts occurring over an area, where the average artefact density is > 1 artefact/m². Boundaries will be defined as where the artefact density drops below 1/m².
Summary of Baker & Devesons’ Results

A total of 53 sites were found and recorded in the Baker/Deveson survey. Most of these (44 - 83%) were hornfels quarry sites; seven (13%) were open artefact scatters while the remaining 2 sites (4%) were open scatters with quarry components (Baker and Deveson 1983: 10).

Most of the sites were sample recorded, and from estimated average artefact densities and estimated extent of site areas, the total number of artefacts present were also estimated. For the artefact scatter sites, total artefact numbers ranged between 22 and 600. For the hornfels quarry sites, estimates of artefact frequency ranged between 100 (at nine sites) and 40,000 (at site 12) (Baker and Deveson 1983: Table 1).

Quarry sites: On the quarry sites, the only raw material recorded was hornfels. These sites displayed considerable internal variation. Working floors were identified which consisted of small flat or hollowed areas cleared of large rocks. These hollowed areas were cleared to provide somewhere comfortable to sit, and it is not thought that they indicate excavation to reach outcrops of raw materials. The assemblage associated with these working floors were usually a dense concentration of small flakes. It would appear that the production of large blades was the purpose of the hornfels quarrying, and a generalised reduction sequence is proposed by Baker & Deveson (1983: 11-12). Axe blanks were identified on a number of sites: the reduction sequence for these was distinguishable from that used for blades. Also found on most sites were (naturally) exfoliated fragments: these were distinguished as being large curved pieces with no impact scars.

Four weathering phases were identified by Baker and Deveson, suggesting that quarrying activity took place in these locations over a considerable period of time (1983: 11-17).

Surface Scatters: On the open scatter sites, hornfels also dominates the raw materials used, but there is a greater range observed. This range includes chert, quartz, quartzite and silcrete (Baker and Deveson 1983: 10). Two of the open scatters contain only hornfels and these are relatively small sites: one (site 1) is located on a hilltop and consists of highly weathered artefacts. The other (site 4) is located on an alluvial outwash fan and consists of transported hornfels cobbles (?) and the artefacts made in this location from these "cores" (Baker and Deveson 1983: 10).

Four of these sites are located along creek margins; the other three occur on hilltops. There was no locational information for the remaining two scatter sites (#’s 20 and 31).

Average artefact densities ranged between 1.5 - 15 artefacts/m². Site areas ranged between 4 - 250 square metres.

4. ABORIGINAL CONSULTATION

Consultation with the Northern Territory Aboriginal Areas Protection Authority was undertaken by Doug Martin. By this process it was ascertained that no sites of significance to the Local Custodians exist within the study area. An authority certificate for all leases and mineral claims has been issued by the Northern Territory Aboriginal Areas Protection Authority.
5. FIELDWORK PROCEDURES

The fieldwork was completed by the Consultant assisted by Doug Martin on the 14th February, 1991. The two areas proposed for the trial mining exercise were comprehensively surveyed on foot (80-100% coverage). In the remainder of the study area only areas with decent visibility (i.e. minor level of disturbance: eg. tracks) were surveyed. The majority of the study area was heavily vegetated and wet season grasses made visibility in undisturbed areas <5% (see photo #4).

Quarry site 12 recorded by Baker and Deveson (1983) was visited during the current survey. This was inspected both to assure a comparability of definition, and also because it is located very close to the current study area (separated from it only by the Stuart Highway). Dense vegetation impeded the relocation of this site, and indeed nowhere near the number of artefacts recorded in the earlier work could be found. Given the field conditions, this was hardly surprising. If further mining work proceeds and the remainder of the study area is investigated, the relocation of this site should be achieved.

6. SURVEY RESULTS

One open artefact scatter was located during the survey. This was located on a track running along the centre of the International anticline towards its south-eastern end. It will not be affected by the trial mining.

Gandy's Site 1 (G1) \text{\textit{\textcolor{red}{\text{\textsuperscript{Not shown on map}}}}}

This site is exposed in a vehicle track (~3m wide) along the eastern side of the ridgetop on the International anticline (see photograph #10). The site consists of several areas of high artefact density along approximately 150m of track. The site is considerably disturbed by the track - both by the initial grading and by subsequent vehicle usage. Many artefacts are recently shattered by vehicular passage and estimating the original number of artefacts was difficult given the superficial nature of the preliminary reconnaissance.

The maximum artefact density observed was 10 artefacts/m², and a total of 25 definite artefacts were recorded. In the area of maximum density a total of 85 hornfels pieces/m² were counted. These includes artefacts (large & possibly some small debitage) and both recent and patinated exfoliated shatter (see photograph #11).

Of the 25 artefacts recorded, two were cores (14 x 7.5 x 4.5 cm; 6.5 x 4.5 x 4.0 cm (broken)), and one was a bifacially flaked tool (7.5 x 5.5 x 3.0 cm). Recent road damage has resulted in the removal of a flake (4.5 x 3.0 x 1.2 cm.) from one face: this was found immediately adjacent to the tool. The remaining artefactual material was unmodified debitage: mostly flakes. Given the presence of naturally and artificially shattered material in the area, the presence of negative and/or positive flake scars was a necessary criteria for artefact identification (therefore flaked pieces were only rarely identified).

Detailed recording of weathering phases (a la' Baker & Deveson) evidence by the the artefacts at the site was not undertaken. It was observed however, that while the majority of the patination could be described as Phase 1 (due to recent damage) that Phases 2 and 3 (as defined) were observable.
No artefacts were observed off the track, but this is considered to result from the very low visibility in these heavily vegetated areas.

As the site will not be impacted upon by the proposed trial mine, no further recording work was deemed necessary at this point. If, however, the full scale mining operation does proceed in the study area, further recording work should be undertaken to determine the exact nature and extent of this site.

**Historic relics**

Goldmining started in the Pine Creek area as early as 1873, and the Chinese were renowned for their extensive mining in the area, and the presence and location of much of this early mining activity is well documented (Daly 1887, Pearce 1982).

A number of historic Chinese goldmining pits were observed in the study area. One of these was on Gandy's Hill (see photographs # 7 & 8) within the trial mining area. This has already been partially destroyed by costeening and drilling in the vicinity. This disturbance has resulted in the subsidence of the lower part of the pit: the top section of this rectangular hole is, however, still intact.

Along the top of the International anticline a number (in the order of 10-15) Chinese pits remain in undisturbed condition. These occur along the ridgetop and are located amongst the heavily grassed undisturbed areas between the tracks and drill pads. On the whole, these pits are rectangular and measure approximately 1m x 2m. One was observed to have wooden poles still in place across the pit: wire had been twined around sections of two poles (see photographs # 8 & 9).

No pits were found in the trial mine site on the Enterprise anticline, nor in the areas between the two anticlines. Before any further mining occurs within the study area, these historic sites should be surveyed by an archaeologist with historic training.

7. **DISCUSSION**

No archaeological sites will be affected by the trial mining proposed for the Carlton Project. There are no archaeological constraints therefore on the trial mining exercise.

Given the imperfect nature of the field conditions at the time of this reconnaissance, comprehensive survey of the entire study area was not feasible. If the trial mining proves successful and fullscale mining proceeds, further archaeological work will be required in order to assess the nature and extent of archaeological resources present within the area. Much of the study area is as disturbed as that area already inspected, and it is envisaged that the periphery of the study area will be the only area where archaeological material occurs intact. Given the observed distribution of the hornfels outcrops across this area, this would also be the most likely location for hornfels quarries to be located.

Baker and Deveson identified the quarry sites in the Pine Creek area as being of high archaeological significance (1983: 18-9). They also identified the need for these to be adequately quantified and described so that this site type could be viewed both specifically (in terms of artefact reduction sequences, the time frame for site usage, etc.) and in the broader archaeological context (eg. regional patterning, artefact
exchange routes etc.). Further archaeological work on in the study area should keep such questions in mind.

8. RECOMMENDATIONS

The following recommendations are made on the basis of the following:

1) the results of the preliminary archaeological reconnaissance in the proposed trial mining areas;

2) the degree of existing disturbance in the proposed trial mining areas;

and,

3) the provisions under the Native and Historic Objects and Areas Preservation Act 1980, whereby it is illegal to destroy an archaeological site without the prior written consent of the Director of the Northern Territory Museum.

It is recommended that:-

1. There are no archaeological constraints on the proposed trial mining exercise;

2. If full scale mining is to proceed then further archaeological survey and recording work will be necessary to determine the nature, extent and management requirement of any prehistoric archaeological sites within the study area;

3. Further archaeological work is required to record the nature and extent of the historic Chinese goldmine pits along the top of the International anticline.
10. REFERENCES

Baker R & Deveson, T 1983 Pine Creek Gold Mine Environmental Studies, Archaeology. Part of the Pine Creek Goldmine EIS, Report to Kinhill Stearns.

Daly, DD 1887 Digging, squatting and pioneering life in the Northern Territory of South Australia. Sampson Low, London.

Pearce, H 1982 Pine Creek Heritage Scheme Report. A report to the National Trust of Australia (Northern Territory).

Pine Creek Joint Venture 1984 Pine Creek Gold Mine EIS.
Photographic Record

1. View across Gandy's Hill towards the south. Trig station visible on remaining crest of hill.

2. Gandy's Hill Trig station: note the rubble used to bolster the height of the marker.

3. View across to the International anticline from the top of Gandy's Hill. The now abandoned proposed trial mining site is located directly opposite: exposed location to left of photo.

4. Dense grass vegetation which covers all undisturbed parts of the study area.

5. Disturbed Chinese goldmining pit on Gandy's Hill. The base of the historic pit is exposed by a costeen. Camera facing north.

6. The top of the disturbed Chinese goldmining pit on Gandy's Hill. Camera facing east.

7. The trial mining site on the International anticline. The area proposed for testing has already been cleared as shown.

8. One of the Chinese goldmining pits found on International anticline, showing the surface visibility. The pits were frequently associated with pile of rubble (to the left of the photo).

9. The same goldmining pit found on International anticline, as shown in photo 8. The pieces of wood are thought to be original structural detail: strands of wire can be seen (centre-left of photo).

10. Site G1: view of the northern part of the site, camera facing south-west.

11. Site G1: area of maximum artefact density recorded at the site. Hornfels artefacts and recently fractured material can be seen.
Figure 1 - The Study Area showing proximity to Pine Creek township, mining lease and claim numbers and location of the proposed trial mine areas: (Scale 1:10,000).
Figure 2 - Aerial photo showing location of proposed impact areas.
Figure 3 - Aerial photo showing location of prehistoric Aboriginal site found.
APPENDIX IV

Copy of Authority Certificates from the
Northern Territory Aboriginal Areas
Protection Authority
ABORIGINAL AREAS PROTECTION AUTHORITY

AUTHORITY CERTIFICATE
Issued in accordance with Section 22 of the Aboriginal Sacred Sites Act

Reference: D89/199:90:307
Certificate No: C91/27

APPLYING TO: Arimco Leases at Gandys Hill, Pine Creek: MCN160, MCN762, MCN3699, MLN782, MLN39, MCN763, MCN297, MLN790.

PROPOSED WORK OR USE: Mining. Initial trial mine to involve MLN782, MCN3699, MLN790

ISSUED TO: Arimco N.L.
Level 14, 20 Berry Street
NORTH SYDNEY NSW 2059

CONDITIONS:

1. It is the responsibility of the recipient of this Certificate to:
   (i) Include the conditions of this Certificate in any subsequent contract or tender document commissioning works described in this Certificate and,
   (ii) Otherwise inform agents and employees of the conditions of this Certificate and obligations under the Aboriginal Sacred Sites (NT) Act 1989

The COMMON SEAL of the
ABORIGINAL AREAS PROTECTION AUTHORITY
was hereto affixed on the 21st day of March 1998

DAVID RITCHIE
Chief Executive Officer
28th March 1991

Arimco N.L.
Level 14
20 Berry Street
NORTH SYDNEY  NSW  2059

ATTENTION:    MR. ROY SWAN

RE:       ISSUE OF AUTHORITY CERTIFICATE FOR ARIMCO
LEASE MCN 761 AT GANDYS HILL, PINE CREEK

Dear Mr. Swan,

I refer to your application for an Authority Certificate, received on the 13th February 1991, for the above lease.

Accordingly, under the powers delegated to me under Section 19 of the Aboriginal Sacred Sites Act 1989 I am pleased to issue the attached Authority Certificate.

Yours faithfully,

[Signature]

DAVID RITCHIE
CHIEF EXECUTIVE OFFICER
REFERENCE: D89/199; 90/307

APPLYING TO: Arimco Lease MCN 761, Gandys Hill, Pine Creek.

PROPOSED WORK OR USE: Mining.

ISSUED TO: Arimco N.L.
Level 14
20 Berry Street
NORTH SYDNEY NSW 2059

CONDITIONS:

1. It is the responsibility of the recipient of this Certificate to:
   (i) Include the conditions of this Certificate in any subsequent contract or tender document commissioning works described in this Certificate and,
   (ii) Otherwise inform agents and employees of the conditions of this Certificate and obligations under the Aboriginal Sacred Sites (N.T.) Act 1989

The COMMON SEAL of the
ABORIGINAL AREAS PROTECTION AUTHORITY
was hereto affixed on the 28th
day of March 1991

DAVID RITCHIE
Chief Executive Officer
1st August 1991

The Manager
Arimco N.L.
Post Office Box 1510
NORTH SYDNEY NSW 2069

Dear Sir,

RE: ISSUE OF AUTHORITY CERTIFICATE FOR VARIATION TO C91/27 - MCN 160

I refer to your application for an Authority Certificate dated 26th July 1991 for the above works.

Accordingly, under the powers delegated to me under Section 19 of the Aboriginal Sacred Sites Act 1989 I am pleased to issue the attached Authority Certificate.

If you require further information please contact Ms Lesley Mearns on 814700.

Yours faithfully,

[Signature]

DAVID RITCHIE
CHIEF EXECUTIVE OFFICER

Encl.
ABORIGINAL AREAS PROTECTION AUTHORITY

AUTHORITY CERTIFICATE

Issued in accordance with Section 22 of the Aboriginal Sacred Sites Act

Reference: D89/199;90/307
Certificate No: C91/117

APPLYING TO: Arimco trial mine at Gandys Hill, Pine Creek

PROPOSED WORK OR USE:
Trial mining on MCN 160. Variation to C91/27.

ISSUED TO: Arimco NL
PO Box 1510
North Sydney NSW 2059

CONDITIONS:
Nil conditions

The COMMON SEAL of the
ABORIGINAL AREAS PROTECTION AUTHORITY
was hereeto affixed on the 31st day of July 1991

DAVID RITCHIE
Chief Executive Officer