ANNEXURE 7.7

A Conceptual Study for Long Hole Stoping at Union Section Declines

K.A.Rhodes: 02 November 1998
A CONCEPTUAL STUDY FOR

LONG HOLE STOPING

AT UNION SECTION DECLINES

K.A.RHODES: 02 NOVEMBER 1998
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SECTION DECLINES

1. INTRODUCTION
Trials with a long hole production drill rig, a Tamrock Solo H606 RA drill rig, have been proposed at Union Section Declines (Declines). This rig is one unit of a fleet of equipment which is operating at the Declines in terms of a full lease and maintenance service agreement with Tamrock. The purpose of the trials is to confirm production parameters in order that definitive costing can be done for a long hole stoping system (LHS) for the Declines.

This report therefore sets out a conceptual design for LHS including a provisional estimated working cost for such a stoping system.

2. GENERAL CONCEPTUAL LAYOUT
The LHS concept where long holes are drilled on strike will provide for the application of throw blasting into an access stope drive (ASD) and a reef driving drive (RDD). Blasted rock from the stope panels will be thrown against the strike pillar immediately positioned below the ASD and the unmined ground downdip of the RDD. Refer to Figure 1 and Figure 2. It is realised that these conditions can only be maintained if control is exercised over the mining sequence.

It is believed at present that the length of any hole drilled with the long hole rig should not exceed 25 metres and therefore the strike distance between RDDs will be 25 metres (not centre to centre) and in terms of rock engineering considerations the distance between pillars should be no more than 18 metres (15 metres in stope and a 3 metre wide ASD). These dimensions and development end sizes are detailed in Figure 2.

It must be emphasised that there are other possible stoping configurations that may prove to be more favourable from practical aspects and more cost effective, however the layout described above has been used for costing purposes. An optimised layout with defined efficiencies and costs will be recommended for LHS following completion of the trials.
3. **STOPE DEVELOPMENT**

With reference to Figure 2 the length of the RDD between ASDs is 39 metres, this being defined by the necessity to develop the RDDs downdip no steeper than -10°. The distance between RDD's (between nearest sidewalls) is 25 metres, this being determined by the maximum length of the long holes drilled by the rig. The total development for a stoping block of 25 metres x 15 metres is therefore 64 metres. If it is assumed that 5000 metres can be drilled by the long hole drill rig in one month and at a burden of 1 metre (two holes), the monthly performance of any stoping unit with one long hole drill rig is 2500 m²/month. Total trackless development required to support one long hole rig is therefore calculated at 427 metres/month (ASDs and RDDs).

4. **ROCK ENGINEERING CONSIDERATIONS**

The LIIS system is intended to provide for a stoping method which does not require persons to work within the stope panel and therefore it is not proposed to install any support within the panel. Such a requirement influences any rock engineering recommendation for the span between pillars and in this design this distance is restricted to 18 metres (15 metres of stope panel and ASD width of 3 metres). Development drives (ASDs and RDDs) will be supported by roofbolts. Refer to Annexure 1 for supporting comments from the Group Rock Engineering Consultant.

5. **PRODUCTION PARAMETERS**

Certain production parameters and production performance are now briefly considered.

**Long Hole Drill Performance**

LHS is based on the performance of the long hole drill rig and the centaes (and tons reef) which can be produced from a single rig. It is assumed that 5000 metres can be drilled in any month with such a rig. In known world class operations in narrow tabular orebodies this performance would be at least 6000 metres.

If it is further assumed that the drilling pattern provides for a burden of 100cms between holes (two rows of holes drilled) then the monthly production from the one long hole rig is 2500 m².
Stope Development
As previously defined the stope development metres (trackless development) is 427 metres/month.

Monthly Tonnage
Reef and waste tonnages are calculated below:

<table>
<thead>
<tr>
<th></th>
<th>Reef</th>
<th>Waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stope Panel</td>
<td>15 000</td>
<td>Nil</td>
</tr>
<tr>
<td>Stope Dilution</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>Development Reef</td>
<td>7 747</td>
<td>Nil</td>
</tr>
<tr>
<td>Development Waste</td>
<td>Nil</td>
<td>4718</td>
</tr>
<tr>
<td>Totals</td>
<td>22 747</td>
<td>5018</td>
</tr>
</tbody>
</table>

Notes on the above.
1 Stope dilution is assumed to be 2% and is waste and trammed as reef.

2 All ASDs and RDDs are of dimensions 3,0m (wide) x 2,7m (high). These dimensions will accommodate the proposed equipment. In terms of a channel width of 1,50 metres it can be shown that the reef and waste tons from these drives are 56% and 44% respectively.

Reef Tons/month:
427 x 8,1 x 0,56 x 4 = 7747 tons

Waste Tons/month:
427 x 8,1 x 0,44 x 3,1 = 4718 tons

Assuming 50% waste tons in development is left underground or trammed as waste, the monthly reef production sent to mill is 26 000 tons.

6. STOPING CYCLE OF OPERATIONS
If it is assumed that the stope grid is developed in advance of stoping operations thereby enabling stope drilling and blasting to take place uninterrupted, then the stoping cycle is as follows.

Long Hole Drilling
Long hole drilling of the stopes is seen as a continuous operation enabling the stope panels to be pre-drilled allowing blasting operations to take place as and when required. It is envisaged that a typical drill rig to carry out this operation would be the Tamrock Quasar P-Low 1F
rig. This rig is in use for similar work in other parts of the world. Some details of this specific rig are given in Annexure 2. An alternative rig would be Atlas Copco’s Simba H157.

Subject to information gained during the trials it is planned to use a drill string of a retrac bit (48mm), one guide tube immediately behind the bit, male/female rods and a shank adaptor. When drilling at percussion pressures which do not exceed 100 bars and with the selected drill string it is believed that drilling accuracy will be within acceptable limits (10 - 15 cms deviation over the 25 metre long hole).

Holes 25 metres in length will be drilled on strike from one RDD to the next adjacent RDD. It is important that these holes drill through in order that their accuracy can be determined. In addition the rig is designed such that holes can be drilled in close proximity to the hanging wall of the RDD, without the necessity of developing a hanging wall slot in the RDD, and also to provide for automatic rod handling (see Annexure 2).

**Long Hole Blasting**

It has been assumed for this exercise that pumpable emulsion explosives will be used to blast the stopes. In respect of hanging wall control this may well have to be the case, however the use of anfex should not be discounted. Blasting with anfex will reflect significantly lower blasting costs.

The number of holes to be blasted for any one blast will clearly depend on production requirements but will be dictated by certain factors which would be primarily the throw of the blast and the capacity of the ASDs and RDD into which the blast is directed, the effect of the blast on the stope hanging wall conditions and the drilling pattern. The advance/blast can be expected to be between 2 and 3 metres.

The blast design assumed for this exercise is two rows of holes drilled close to the top and bottom reef contacts with a burden of 1,0 metres. The evaluation of a blast design for LHS will depend on the practical experience gained early in the project and the assistance of specialist explosives engineers.

**Cleaning**

Throw blasting will ensure that the blasted face rock will be contained in the ASD and the RDD. An LHD (of capacity 6 tons) will load and
tram the stope blast to a truck tipping point in a major roadway (either strike or decline). Final cleaning of the face is expected to be carried out by water jet operated from the supported RDD.

It has been assumed that ore clearance from Union Declines remains the same as at present. However it is proposed at the feasibility stage of planning for an LHS project that rock transportation by conveyors be considered.

**Support**

As stated previously the stope panel will not be supported. However the ASDs and RDDs will be supported by resin roofbolts.

7. **EQUIPMENT**

In addition to the production drill rig the other trackless equipment is defined below.

**Development Drill Rigs**

It has been estimated that 427 metres of development by trackless equipment has to be carried out in a month to meet the production target of 26 000 tons reef. If it is assumed that 1,5 rounds will be completed in any shift with one drill rig, working 2 shifts per day and drilling a 3,0 metre round for an effective advance/blast of 2,7 metres then the number of rigs required will be three. A rig will complete approximately 190 metres of development/month. The rig would typically be the Tamrock Quasar P-Low 1F.

**LHD’s**

The total tonnage to be handled in a month is approximately 28 000 tons including tons waste packed. It is believed that in respect of maximum one way traming distances of 150 metres, two LHD’s of capacity 6 tons (Toro 301) will be required.

**Other Equipment**

Explosives transport and charging up operations will require a utility vehicle.
Summary of Equipment
The equipment required for a unit to produce 26 000 tons reef/month is therefore as follows:

- Production Rig: Quasar P-Low 1F  
  No.  
  1  
- Development Face Rigs: Quasar P-Low 1F  
  3  
- LHD’s: Toro 301  
  2  
- Explosives charging unit  
  1

Although the equipment referred to is exclusively Tamrock manufactured this does not preclude other OEM’s and is intended only to provide typical type and size of equipment.

8. EFFICIENCIES
Some important efficiencies which are to be noted for this project are as follows.

m²/stope and development worker
Stope m²/month = 2500  
m² converted from development/month = 1280  
Total m²/month = 3780  
Stope and development workers = 40  

m²/stope and development worker = 94.5

m²/m development
Stope m²/month = 2500  
Metres development/month = 427  

Stope m²/m development = 5.85

m²/m³ development
Stope m²/month = 2500  
m³ development/month = 3459  

Stope m²/m³ development = 0.72

Note
At present the theoretical m²/m³ development ratio at the Declines is 2.59 which emphasises that this LHS layout is development intensive.
9. DILUTION
It is fully realised that any trackless operation on the reef horizon which requires the excavation of footwall waste must consider the dilution aspects of the operation. A comparison of LHS and the current theoretical dilution at the Declines is therefore necessary.

At the Declines with their present layout, the theoretical dilution with double cut is 4.6% and with LHS also when practising double cut mining is 9.4%. Any increase in dilution must be of some concern but it is believed that at the feasibility stage of this project dilution could be reduced significantly with a re-orientated layout. Refer to Annexure 3 for theoretical dilution calculations.

10. COSTS
Costs have been estimated for LHS and are reflected in Table 1 (Production Costs for Stoping and Development) and Table 2 (Shaft Head Costs). In Table 2 the comparison is made between LHS and the current costs (last 3 months) at the Declines.

Although the difference in shaft head cost is R13,25 in favour of LHS (or a reduction of 12.8%) it is accepted that LHS costs at this point in time are not definitive and further detailed costing will be necessary during and on completion of the trials. Nevertheless this preliminary cost comparison shows that there is justification for further trial work.

11. FINANCIAL EVALUATION
A financial evaluation of the LHS over a 20 year period at a production rate of 70 000TPM reef assuming shaft head costs as in Table 2 and further assuming that the grade for LHS is 95% of the present grade at the Declines (this being an approximate comparison taking into account common face dilution) then the differential NPV is R20,32 million.
### TABLE 1

**LHS PRODUCTION COSTS (STOPING + DEVELOPMENT)**

**ASSUMING 26 000TPM PER LONG HOLE RIG UNIT**

<table>
<thead>
<tr>
<th></th>
<th>Rands/Month</th>
<th>Rands/Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mining Labour</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stope/Development</td>
<td>176 050</td>
<td></td>
</tr>
<tr>
<td>Bonus Payments</td>
<td>34 000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>210 050</td>
<td>8,08</td>
</tr>
<tr>
<td><strong>OEM Maintenance</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour + Spares (in terms of</td>
<td>128 120</td>
<td>4,93</td>
</tr>
<tr>
<td>maintenance service agreement)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fleet Leasing (L/H Rig)</strong></td>
<td>46 363</td>
<td>1,78</td>
</tr>
<tr>
<td><strong>TM3 Other Costs</strong></td>
<td>25 656</td>
<td>0,99</td>
</tr>
<tr>
<td><strong>Drill String</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development</td>
<td>35 915</td>
<td></td>
</tr>
<tr>
<td>Long Hole</td>
<td>20 238</td>
<td>2,16</td>
</tr>
<tr>
<td></td>
<td>56 153</td>
<td></td>
</tr>
<tr>
<td><strong>Blasting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L/H Blasting</td>
<td>54 140</td>
<td></td>
</tr>
<tr>
<td>Development</td>
<td>85 824</td>
<td>5,38</td>
</tr>
<tr>
<td></td>
<td>139 964</td>
<td></td>
</tr>
<tr>
<td><strong>Support</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development only (no support in</td>
<td>24 700</td>
<td></td>
</tr>
<tr>
<td>panel)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drill string for roofbolting</td>
<td>790</td>
<td>0,98</td>
</tr>
<tr>
<td></td>
<td>25 490</td>
<td></td>
</tr>
<tr>
<td><strong>Water Jetting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final clean-up</td>
<td>27 500</td>
<td>1,06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>659 296</td>
<td>25,36</td>
</tr>
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</table>
# TABLE 2

**ESTIMATED SHAFT HEAD COSTS FOR LHS AT UNION SECTION AND DECLINES COMPARISON**

<table>
<thead>
<tr>
<th></th>
<th>Rand/Ton Milled</th>
<th>LHS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Declines</strong> (last 3 months average)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stoping and Development</td>
<td>27,32</td>
<td>25,36</td>
</tr>
<tr>
<td>Tramming</td>
<td>2,98</td>
<td>2,98</td>
</tr>
<tr>
<td>Hoisting</td>
<td>3,09</td>
<td>3,09</td>
</tr>
<tr>
<td>Pumping</td>
<td>0,07</td>
<td>0,07</td>
</tr>
<tr>
<td>Supervision</td>
<td>3,52</td>
<td>3,52</td>
</tr>
<tr>
<td>Support (Stope)</td>
<td>3,33</td>
<td>0</td>
</tr>
<tr>
<td>Hostel</td>
<td>2,51</td>
<td>2,13</td>
</tr>
<tr>
<td>Power/Water</td>
<td>5,57</td>
<td>5,00</td>
</tr>
<tr>
<td>CARA</td>
<td>15,70</td>
<td>13,92</td>
</tr>
<tr>
<td>Other Services</td>
<td>39,07</td>
<td>33,84</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>103,16</td>
<td>89,91</td>
</tr>
</tbody>
</table>
12. CONCLUSIONS AND RECOMMENDATIONS
Amplats Mining Technology believe that this preliminary report has shown that the LHS system has the potential to become a technically proven mining method and economically viable for Amplats' platinum reefs.

Advantages
The LHS method has some significant advantages over present systems used by Amplats and certain of these are as follows:

- Marked improvements in stope efficiencies can be realised. It is probable that present efficiencies can be more than doubled if production parameters can be achieved.
- Preliminary costing indicates that shaft head costs can be reduced by some 12%.
- The method as presented shows that there will be no necessity for persons to work on the stope face or in the stope panel.
- Face advances will be appreciably higher.

Disadvantages
The main concerns with LHS are as follows.

- Development intensive.
- Overall dilution and grade control.

At the present stage in the development of LHS for Amplats' narrow reefs there are certain other factors which cannot be fully quantified and some of these are set out below:

- Long hole rig performance and drilling accuracy.
- Long hole drilling and blasting costs.
- The effectiveness of the cleaning system.

Recommendations
Notwithstanding those factors which clearly require further investigation, Amplats Mining Technology believe that the LHS concept has more than enough potential to justify its further investigation in underground practical trials at the Declines and therefore it is recommended that the Union Section trials as proposed on 02 November 1998 be allowed to commence under the conditions set out in the proposal of that date.
ANNEXURE 1

SOME ROCK ENGINEERING CONSIDERATIONS

By K.R. Noble

**Pillar Strength**
Pillar strength depends on the following factors.
- The rock mass strength of the pillar material.
- The size and shape of the pillars defined by their width and height.
- Gross structural features.

The empirical pillar design is used to calculate the pillar strength and consequently the factor of safety of the proposed design to be used for this concept. Due to the shape of the pillar the ‘effective’ pillar width was estimated using the hydraulic radius approach.

\[
P_s (\text{pillar strength}) = \frac{k w^{0.5}}{h^{0.7}}
\]

Where \( k = 28 \text{MPa} \)
\[ P_s = 56 \text{MPa} \]

The rock mass value of 28 MPa was obtained through back analysis of failed pillars at the Decline Section and is used in this exercise as the rock mass strength. Based on the proposed layout the estimated factor of safety is acceptable to a depth of 200m below surface.

**Support of ASD’s and RDD’s**
The standard pattern of support for the abovementioned excavations using 1.8m x 20mm diameter resin bonded bolts is considered to be adequate for trial purposes. The performance will however be monitored to determine whether any changes are required. The condition of the ASD and RDD intersections will also be monitored on an ongoing basis.

**Panel Span**
The stability of the proposed panel span between pillars will be monitored on an ongoing basis.
ANNEXURE 2

ROD HANDLING IN LONG HOLE DRILLING

The long hole stope drilling rig to be used for the trial at Rustenburg Platinum Mine’s Union Section was the Tamrock Solo H606RA. This drill rig is a well proven machine and was selected to ensure the maximum chance of success for the trial. It was recognised that the drilling carousel would foul the hangingwall and in the original proposal provision was made to slype the hangingwall to enable the drill rig to drill close to the hangingwall.

Detailed design work for a long hole stoping system and a more appropriate machine for narrow width stopes is the Tamrock Quasar P-Low 1F. Such a rig is in operation at the Kundana in Western Australia where it is used to drill vertical veins of less than one metre.

The attached figures show the following features.

- The cross section of the Tamrock P-Low 1F, which reflects its low profile.
- The long hole boom which would be attached the P-Low 1F with its range of movements.
- A section showing the boom in a drive and its ability to drill close to the hangingwall.
- Details of the rod handling mechanism which permits drilling close to the hangingwall.
High power extra-low face drill, four wheel drive hydraulic jumbo, for development and cross-cutting in thin seams.

**Rock drill**

<table>
<thead>
<tr>
<th>Alternative 1</th>
<th>Alternative 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Hydrastar 300 F</td>
</tr>
<tr>
<td>Standard male shank</td>
<td>R 32 - R 38</td>
</tr>
<tr>
<td>Weight</td>
<td>137 kg</td>
</tr>
<tr>
<td>Impact frequency</td>
<td>40-55 Hz</td>
</tr>
<tr>
<td>Percussion pressure</td>
<td>160-180 bar</td>
</tr>
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</table>

**Drill feed**

<table>
<thead>
<tr>
<th>Alternative 1</th>
<th>Alternative 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>CC 2500</td>
</tr>
<tr>
<td>Steel length</td>
<td>12 to 16 ft</td>
</tr>
<tr>
<td>Drill steel</td>
<td>H 32-H 35</td>
</tr>
</tbody>
</table>

**Boom**

<table>
<thead>
<tr>
<th>Model</th>
<th>B 26 F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Parallel holding</td>
</tr>
<tr>
<td>Weight (with hoses)</td>
<td>1900 kg</td>
</tr>
<tr>
<td>Feed roll-over</td>
<td>360°</td>
</tr>
<tr>
<td>Boom extension</td>
<td>1200 mm²</td>
</tr>
<tr>
<td>Feed extension</td>
<td>1600 mm</td>
</tr>
</tbody>
</table>

**Hydraulic control panel**

<table>
<thead>
<tr>
<th>Model</th>
<th>THC 500</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Functions</strong></td>
<td></td>
</tr>
<tr>
<td>Power control</td>
<td>adjustable full power</td>
</tr>
<tr>
<td>Collaring power</td>
<td>adjustable collaring power</td>
</tr>
<tr>
<td>Rotation control</td>
<td>adjustable rotation speed</td>
</tr>
<tr>
<td>Reversible rotation</td>
<td></td>
</tr>
<tr>
<td>Flushing control</td>
<td>water flushing</td>
</tr>
</tbody>
</table>

**Automatic Functions**

| Collaring, stop-and-return, anti-jamming, flushing |

**Power Pack**

| Electrical motor | 45 kW (60 hp) |
| Hydraulic pump types |
|-------------------|---------------|
| Percussion, feed & boom | 1 x variable displacement, axial piston |
| Rotation | 1 x gear |

**Tramming possibilities**

| Tramming speed | up to 10 km/h |
| Maximum operating grade | up to 20 % |
| Weight, approximate | 15500 kg |
Multi-purpose telescopic boom with auto-parallelism for either Long hole drilling, Face drilling or Cross-cutting in narrow orebodies.

**Construction**

- rectangular tube section
- easily replaceable extension tube guide pads
- adjustable and expandable cones on all boom and cylinder mounts
- 1.2 m boom extension
- acid resistant cylinder rods
- high weight carrying capacity
- large face coverage
- constant divergency user friendly

**Description**

The x-y coordinate boom movements together with the double rotation devices allows a vertical positioning on both side of the boom and the possibility to drill extremely close to the hanging and foot walls, both to the right and left, with the rock drill always in the operator’s sight line.

The B 26 LC boom is specially designed to match the LHF 2000 long hole feed equipped with rod carrousel.

**Boom movements**

1. Boom lift, up and down .................... 45° and 16°
2. Boom swing, symmetric ........................ ± 45°
3. Boom extension ................................ up to 1200 mm
4. Feed roll-over .................................. 320°
5. Feed swing, symmetric............................ ± 50°
6. Feed tilt, up and down .......................... 25° and 50°
7. Feed angle, symmetric .......................... ± 95°
8. Feed extension ................................. up to 1200 mm

**Technical Data**

- Weight, boom without hoses .................. 1850 kg
- Weight allowed ................................ 1200 kg

*Note: TAMROCK SECOMA reserves the right to change this specification without further notice.*
### Technical data

<table>
<thead>
<tr>
<th>TYPE</th>
<th>E.R.H.C. 10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Length, overall mm</td>
<td>1600</td>
</tr>
<tr>
<td>Weight (excl. rods) kg</td>
<td>300</td>
</tr>
<tr>
<td>Rod diameter mm</td>
<td>32 / 39</td>
</tr>
<tr>
<td>Rod length mm</td>
<td>1220</td>
</tr>
<tr>
<td>Number of rods normal</td>
<td>9 + 1</td>
</tr>
<tr>
<td>Hole depth max. m</td>
<td>12.2</td>
</tr>
</tbody>
</table>

### How does it works?

After drilling the first hole with the rod mounted on the drill feed...

1. Rotate the magazine.
2. Grip the jaws around the rod.
3. Slide the gripper arms to the drilling line.
4. After rod coupling, open the gripping jaws, retract the gripper arms, drill the hole, and ....ready for next rod.
ANNEXURE 3

THEORETICAL DILUTION BETWEEN PRESENT DECLINES LAYOUT AND LHS

Union Declines
The present system is depicted below.

Area of ASD = 3.8m x 3.3m = 12.54m²
Area of Reef = 1.5m x 3.8m = 5.70m²
Waste area = 12.54m² - 5.70m² = 6.84m²
For 1 metre advance
m² of stope = 32.5m x 1m = 32.5m²
Tons reef (stope) = 32.5m x 1.5m x 4 = 195 tons
ASD reef = 5.70m² x 1m x 4 = 22.8 tons
ASD waste = 6.84m² x 1m x 3.1 = 21.2 tons
Dilution with 50% waste trammed as waste is therefore
21.2 x 0.5
195 + 22.8 + (21.2 x 0.5) = 4.6%

LHS Proposal
For a block of 375m² stope reef it is necessary to develop 64 metres of ASDs and RDDs with dimensions 3.0m (wide) x 2.7m (high).
Reef stope tons = 375m² x 1.5m x 4 = 2250 tons
Reef development = 64m x 8.1m² x 0.56 x 4 = 1161 tons
Waste development tons = 64m x 8.1m² x 0.44 x 3.1 = 707 tons
Assuming 50% development waste trammed as waste, waste dilution is therefore
707 x 0.5
2250 + 1161 + (707 x 0.5) = 9.4%

NB. The above calculations are theoretical only and do not provide for any face dilution or overbreak in development or off reef mining.
ANNEXURE 7.8

Union Section concerns related to the Long Hole Stoping Method: responses by K.A.Rhodes

K.A.Rhodes: 30 November 1998
UNION CONCERNS RELATED TO THE LONG HOLE STOPING METHOD

This brief document is intended to set out responses to the concerns of Union Section related to the long hole stoping method (LHS).

1. How will the grade be affected by dilution?
   The current layout will theoretically cause an increase in dilution. However, it is believed that improvements to the layout can be effected during the feasibility stage. Present dilution calculations do not preclude consideration of the method in terms of financial evaluation.

2. What will the appointment of a drillmaster do for this project? A drillmaster was employed earlier and achieved nothing.
   The drillmaster will ensure that drilling will be carried out under conditions which will achieve maximum accuracy of holes and performance of the long hole rig. Full documentation of all holes drilled will be recorded and be available for reference.

3. It will not be possible to change rods manually
   For the trial it will clearly be more difficult to handle rods manually than by using a carousel which is not practical with a Solo rig. However, it is intended to use a Quaser type of rig for future LHS and with this machine automatic handling of rods is possible without taking a slot out of the ASD.

4. Why does the size of the hole have to be so big at 64mm?
   The smallest hole size which can be drilled with the Solo HL600 on the present machine is 68mm. For future operations it will be possible to drill a 48mm hole with the Quaser P-Low 1F or the Simba H157.

5. What are the development ratios?
   These ratios are calculated in the trial motivational report. It is accepted at this stage of the project that the method is development intensive.

6. The size of the development end must be 12m²
   This is not necessary as the proposed equipment will be able to operate in dimensions 3,0m (wide) x 2,7m (high) or 8,1m².
7. If the waste to total broken rock ratio in development is higher than 1:3 the method cannot be viable

The LHS end sizes with double cut are in the ratio 1:4,2. The present ratio at the declines is 1:3, also for double cut. See below for analysis.

**Waste to Total Broken Rock Ratios**

(a) **Declines at Present**

![Diagram of a triangle with sides labeled R and W, R = 1.5m, W = 1.8m]

Reef tons (R) = \(3.8 \times 1.5 \times 4.0\) (SG) = 22.8 tons

Waste tons (W) = \(3.8 \times 1.8 \times 3.1\) (SG) = 21.2 tons

\[
\frac{W}{W + R} = 1 : 2.0
\]

If cleaning by double cut assuming 50% of waste packed
\[
\frac{W}{W + R} = 1 : 3.1
\]

(b) **With LHS**

![Diagram of a triangle with sides labeled R and W, R = 1.5m, W = 1.2m]

Reef tons (R) = \(3.0 \times 1.5 \times 4.0\) (SG) = 18 tons

Waste tons (W) = \(3.0 \times 1.2 \times 3.1\) (SG) = 11.6 tons

\[
\frac{W}{W + R} = 1 : 2.6
\]

If cleaning by double cut assuming 50% of waste packed
\[
\frac{W}{W + R} = 1 : 4.2
\]
8. **Why not use conveyors?**
   It is proposed to consider the use of conveyors at the feasibility stage and establish a comparison with truck tramming.

9. **How will the stope be cleaned?**
   The LHS system will provide for throw blasting and final cleaning by water jetting.

10. **How will falls of ground be handled?**
    Experience will determine the extent of this problem which may necessitate changes to the layout.