APPENDIX 1

PASTE ECONOMICS MEMO
Memo

To: Larry Smith
   Will Bawden
From: Ryan Veenstra
Date: 10/23/2012
Re: Continuous Pour Economics

Introduction

This memo outlines an analysis of continuous versus staged pour economics. It is a very simple analysis with the point being to show that the analysis is valid instead of developing a complicated model with numerous input parameters and variables. The goal of the simple model is to produce a discounted cash-flow for both the continuous and staged pour methods given a similar ore body. To this end all of the simplifying assumptions and input parameters will be provided.

Background

This memo assumes that the readers know what cemented paste backfill (CPB) is and how it is used. If this analysis was to be presented in a paper then a more detailed presentation of CPB would be provided.

The main difference between a continuous pour and a staged pour is that during a staged pour the original or plug pour is allowed to sit for a period of time (3-7 days) during which the strength of the paste increased through cement hydration and consolidation. After this time period the rest of the stope is poured. The idea behind the plug pour is that it provides a shear plug protecting the barricade (and ultimately the rest of the mine) from the potential hazard of a barricade failure. However, there has been a move in recent history to explore the possibilities of going to a continuous pouring, meaning that the plug pour stage is eliminated and the entire process is sped up. The goal of this analysis is to provide an economic reason for pursuing continuous pouring.

To this end a fictional gold ore body was created. This ore body’s particulars are presented in Table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonnage</td>
<td>Tonnes</td>
<td>5,400,000</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Volume</td>
<td>m³</td>
<td>1,800,000</td>
</tr>
<tr>
<td>Grade</td>
<td>g/t</td>
<td>2</td>
</tr>
<tr>
<td>Stope Volume</td>
<td>m³</td>
<td>3,000</td>
</tr>
</tbody>
</table>
Given that the stope volume is 3000 m$^3$ and the total ore body volume is 1,800,000 m$^3$, there are 600 stopes in the ore body. Each stope is assumed equal and contains approximately 1150 troy ounces of gold. For this analysis it is assumed that the gold price is $1000/ounce. This means that each stope is worth approximately $578,000 dollars.

The following assumptions were made to simplify the problem:

- Only 1 stope can be poured at a time.
- There is always an available stope to fill.
- The plug pour takes 1 day.
  - For a staged pour there is a 7 day delay.
- The secondary pour takes 2 days.
  - This means that a continuous pour takes 3 days whereas a staged pour takes 10 days.
- Moving equipment and pipe between stopes takes 3 days.
- The stope needs to cure for 14 days before a neighboring stope can be blasted.
- There is an instantaneous payment for the neighboring stope value once the curing is complete.
- Each filled stope only has one neighboring stope.
- There is no milling limit.

It should also be noted that costs have not been included in this analysis. The reasoning for this was that the associated costs with either a staged or continuous pour (labor, material costs etc.) are reasonably similar. The other reason was that not including costs would provide a more conservative estimate of the difference in NPV between the two pour method types.

**Basic Sequence**

Figure 1 compares the basic 2 stope filling sequence of the two filling methods.

![Comparison of Basic 2 Stope Sequence](image)

This figure shows that both methods have an initial 12 days of ‘setup’ time before their respective stope filling patterns become established. To see a figure with these established filling patterns please refer to the appendix. These 12 days are not included in the analysis.

For the staged pour it observed that the first neighboring stope economic value (N-SEV) is available on the 13 day while the second N-SEV is available 5 days after that, meaning that for a staged pour 18 days are needed to collect the two N-SEVs. However, during a continuous pour an N-SEV is always available after 6 days, meaning that it takes 12 days to collect two N-SEVs.
Further Analysis

If this thought process is continued it can be concluded that over a 365 day period a continuous pour method will allow the collection of approximately 60 N-SEVs compared to the approximately 40 N-SEVs collected by a staged method. Therefore, the amount of money generated by each method per year, given that each stope is worth approximately 578,000 present-day dollars, is approximately 23.5 and 35.2 million dollars respectively.

Since the hypothetical ore body contains 600 stopes worth of ore and the number of stopes per year is known the mine-life for each filling method can be determined. A staged pouring method allows the ore body to be mined in approximately 15 years while a continuous pour method needs only 10 years to mine the same ore body. This time information, and the yearly monetary information developed above, allows an NPV analysis of each method’s respective cash-flow. Figure 2 shows the non-discounted and discounted curves for each filling method. A discount rate of 10% was used to generate the curves.

Figure 2: Non-discounted and discounted cash-flows

Figure 2 shows the expected results. The first is that the two non-discounted cash-flows generate the same amount of money over their respective mine-lives which is the expected result given a non-discounted cash-flow analysis. The amount of money generated is approximately 347 million. This amount is significantly more than either discounted amounts. The two discounted curves also show the expected trends with the continuous method curve generating a higher discounted cash-flow than the staged method curve. The amount of money generated by the continuous method was 213 million while the staged method generated 176 million. The difference between these two cash-flows is 37 million dollars. This difference is due to increased stope availability and its corresponding decrease in mine life. Both of these differences allow more money to be accessed sooner which generates a higher NPV. All related sample calculations are available in the appendix.

The final comparison that was examined was the amount of ore and the timing of its arrival to the mill. This was done as a yearly cumulative basis. Figure 3 contains the graph showing this data. This graph
shows a blue curve showing the linear mill feed generated by the continuous pour method. The red curve shows the jagged nature of the mill feed generated by the staged pour method. This may not impact the mill but there is a definite difference in the shape of the two curves.

Figure 3: A Year Long Cumulative Mill rate

Conclusions

This memo outlines a basic economic analysis aimed at pointing out the difference between staged and continuous filling methods. A hypothetical ore body was created and mining schedules for each were determined based on the time differences between the two filling methods. These inputs were used to generate the main results. The first result was the reduction of the mine-life from 15 years to 10 years between the staged and continuous pour. The second result, which is tied to the first, was that the continuous pour method generated a NPV that was 37 million dollars greater than the staged pour method. The final item compared was mill-feed rate, which demonstrated that the continuous pour rate generated a smoother feed rate than the staged pour feed rate.