**Dynamic Model with Multiple Processing Streams and without Stockpiling**

**Sets**

**Decision Variable**

• X𝑏p𝑡 = 1; if block 𝑏 is mined in period or year 𝑡 and moves

to processing facility p

X𝑏p𝑡 = 0; otherwise

• W𝑏𝑡 = 1; if block 𝑏 is mined in period or year 𝑡 and moves

to waste dump w

Wb𝑡 = 0; otherwise  
**Parameters**

𝑔𝑏 = grade of material in block 𝑏;

𝑞𝑏 = quantity of material in block 𝑏;  
𝒗bp = the undiscounted value of block 𝑏 moving to processing facility p, therefore;  
 𝒗bp = [(p−r)\*𝑔𝑏\* Ybp −m− Cp ) 𝑞𝑏]  
𝒗wb = the undiscounted value of block 𝑏 moving to waste dump w, therefore ;  
 𝒗wb = -Mining Cost\* 𝑞𝑏Metal Price [$/tonne or gram] ,

Refining Cost [$/tonne or gram] ,

Mining Cost[$/tonne] ,

Cp :Processing Cost*[P]* [$/tonne] ; for each Processing facility or stream ‘p’ ,

Discount Rate(i) [%] ,

Mt ; Mining Capacity Upper and Lower Limit during period t [tonne of material/year] ,

Cpt ; Processing Capacity Upper and Lower Limit for each processing facility ‘p’ during period t [tonne of ore/year],

Ybp : Recovery Rate[*B][P]* [%], Recovery percentage of block b if the material processed in the facility p.

**Objective Function**

Objective is to maximise the total discounted value of

Blocks going to be Processed + Blocks going to waste

**Constraints**

**Reserve Constraint**

**Mining Capacity Constraint**

**Processing Capacity Constraint**

**Precedence Constraint**

* **If block b goes to processing facility p;**

*Whereas n is the number of precedence blocks(b’) of block b and t’ is the time period where precedence blocks are to be mined.*

* **If block b goes to waste;**

*Whereas n is the number of precedence blocks(b’) of block b and t’ is the time period where precedence blocks are to be mined.*

A diagram of a three dimensional cube

Description automatically generated with medium confidenceA diagram of a process

Description automatically generated with medium confidence

**Dynamic Model with Multiple Processing Streams and Multiple Stockpile Bins**

**Sets**

**Variables**

**Decision Variable (Binary)**

• **X𝑏p𝑡** = 1; if block 𝑏 is mined in period or year 𝑡 and moves

to processing facility p

**X𝑏p𝑡** = 0; otherwise

• **X𝑏s𝑡** = 1; if block ‘𝑏’ is mined during period or year ‘𝑡’ and stored

in Stockpile bin ‘s’

**X𝑏s𝑡** = 0; otherwise

• **W𝑏𝑡** = 1; if block 𝑏 is mined in period or year 𝑡 and moves

to waste dump w

**Wb𝑡** = 0; otherwise

**Stockpile Creation Variables**

* **qs𝑡** = quantity of material stored in the stockpile bin ‘s’ at the end of the year or period ‘t’. (Continuous variable)
* **Yspt** = quantity of material removed/supplied from stockpile bin ‘s’ to processing facility ‘p’ at the time period ‘t’. (Continuous variable)

**Parameters**

**𝑔𝑏** = grade of material in block 𝑏;  
**𝑔s** = grade of material in stockpile bin s;

**𝑞𝑏** = quantity of material in block 𝑏;  
**𝒗bp** = the undiscounted value of block 𝑏 moving to processing facility p;

𝒗bp = [(p−r)\*𝑔𝑏\* Ybp −m− Cp ) 𝑞𝑏]  
**𝒗sb** = the undiscounted value of block 𝑏 moving to stockpile;

**𝒗sb**= -m\* 𝑞𝑏  
**𝒗sp** = the undiscounted value of material from stockpile s to the processing facility p;

𝒗**sp** = [(p−r) \*g𝒔\*ybp−h−cp]

**𝒗wb** = the undiscounted value of block 𝑏 moving to waste dump w;

**𝒗wb**= -m\* 𝑞𝑏

*where ;* **p** ; Metal Price [$/tonne or gram] ,

**r** ; Refining Cost [$/tonne or gram],

**h** ; Handling Cost [$/tonne or gram],

**m** ; Mining Cost[$/tonne],

**Cp** ; Processing Cost*[P]* [$/tonne] ; for each Processing facility or stream

Discount Rate(i) [%],

**Mt** ; Mining Capacity Upper and Lower Limit during period t [tonne of material/year],

**Cpt** ; Processing Capacity Upper and Lower Limit for each processing facility during period t [tonne of ore/year],

**Ybp** ; Recovery Rate[*B][P]* [%].

**Objective Function**

Objective is to maximise the total discounted value of

Where;

1. First term ensures maximises the discounted value of blocks goes to processing facility from mine.
2. Second term ensures maximises the discounted value of blocks goes to waste dump from mine.
3. Third term ensures maximises the discounted value of material stockpiled in stockpile bins.
4. The last term ensure maximises the discounted value of material received and processed from stockpile bins.

**Constraints**

**Reserve Constraint**

**Mining Capacity Constraint**

**Processing Capacity Constraint**

**Precedence Constraints**

**If block b goes to processing facility p;**

**If block b goes to stockpile bin ‘s’;**

**If block b goes to waste;**

*Whereas n is the number of precedence blocks (b’) of block b and t’ is the time period where precedence blocks are to be mined (t’t). B’ is a subset matrix of B and represents the precedence blocks b' to mine the block b.*

**Stockpile Creation Constraints**

**Ore Grade Constraint**

**Precedence Constraints**

**If block b goes to processing facility p;**

* **, u=1**

**If block b goes to stockpile bin ‘s’;**

* **, u=1**

**If block b goes to waste;**