

**RIO
TINTO**

Technology and Innovation

SOMP

Mine Optimisation

May 18, 2008

Aachen

Overview of Strategic Production Planning

Rio Tinto's formal process for ...

... identifying, communicating and implementing opportunities to increase business value by exhaustively considering alternative scales, methods and policies for mining, processing and marketing of identified or anticipated resources

A collaborative effort between the T&I Strategic Production Planning team and BU to identify, evaluate and prioritise strategic options, building upon an existing approach within the Group

SPP Cycle & Triggers



'Triggers'

- **Discovery**
- **New Technology**
- **Expansion**
- **Depletion**
- **Regulation**
- **Corporate Rejuvenation**
- **Management Change**
- **Sustainability**
- **Initiative**
- **Economic Shock**

Strategic Mine Planning in Context

RIO
TINTO

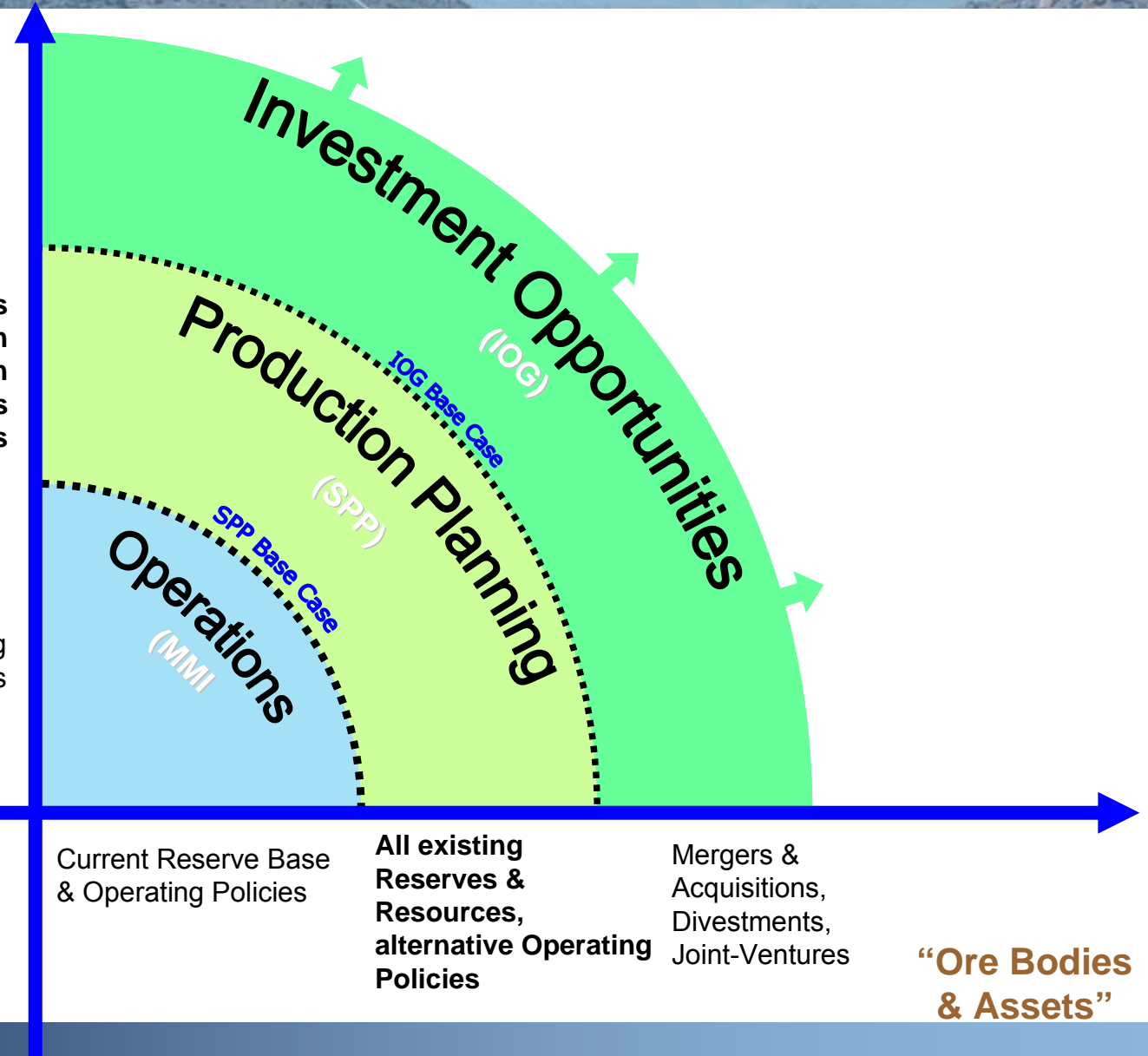
Technology and Innovation

“Processes & Technology”

New Technology
Value Chain Expansion

Mine and Process Expansions
Value Chain Optimisation
Technology Optimisation
Additional Processes
Alternative Mining Methods

Current Mining and Processing
Assets and Capacities



Value defined by Rio Tinto - Corporate Objective

- Rio Tinto's corporate objective is to increase the wealth of its shareholders by maximising the value of the company in line with the principles outlined in 'The Way We Work'.
- This involves Rio Tinto investing and managing wisely the money entrusted to it by its shareholders.
- Although Rio Tinto operating companies may have many intermediate objectives, each must support this overriding objective.

Value defined by Rio Tinto

Measure of Value

- Rio Tinto's basic measure of shareholder value is the discounted value, or net present value (NPV), of the expected incremental ungeared cash flows over the life of the project.
 - ▶ The NPV of Rio Tinto is the sum of its constituent parts
 - ▶ Rio Tinto believes that stock market value reflects this measure
 - ▶ For projects, the basic principle is that projects with a positive NPV should be undertaken.

Derivation of NPV

- **NPV improvement key metric**
- **Definition of NPV**, where C_0 , C_1 , C_n , are discrete annual life of mine cash flows in real terms.

$$NPV_r = C_0 + \frac{C_1}{(1+r)} + \dots + \frac{C_n}{(1+r)^n}$$

- **NPV is sum of component parts of the value chain:**

$$NPV_r = NPV_{r \text{ revenue}} - NPV_{r \text{ cost}} - NPV_{r \text{ capital}} - NPV_{r \text{ tax}}$$

- **Project Value**

$$\text{Incremental } NPV_r = NPV_{r \text{ with}} - NPV_{r \text{ without}}$$

Discount Rate and Prices

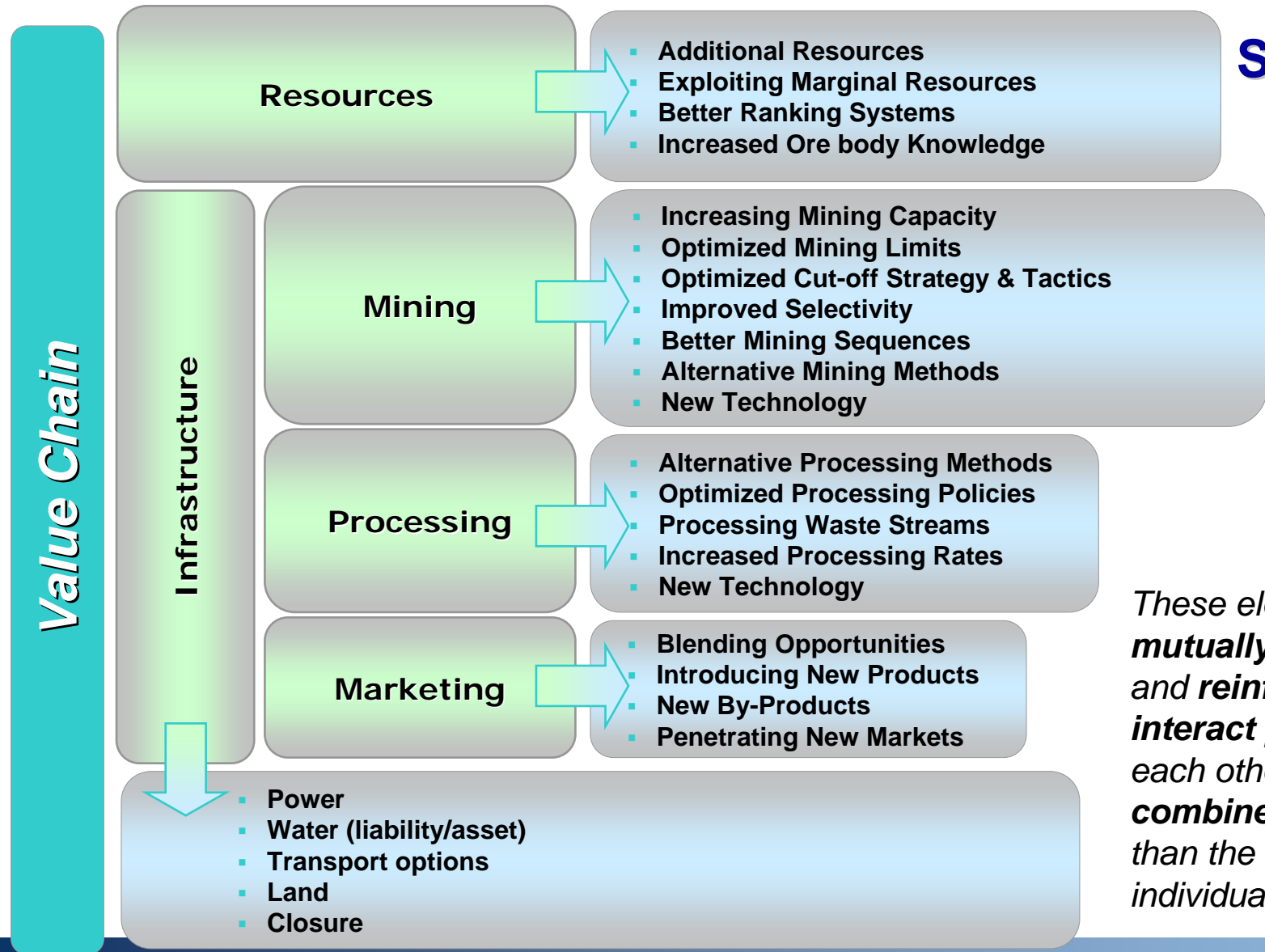
- ***The value we ascribe to any project cashflow is a function of the discount rate***
 - ▶ *A key corporate decision*
 - ▶ *Derived from the market*

The Project Cashflow is a function of Projected Prices interacting with technical factors of production

- ▶ *Price determination is a key corporate decision*
- ▶ *Based on projected industry cost curves, etc.*



Sources of Increased Value

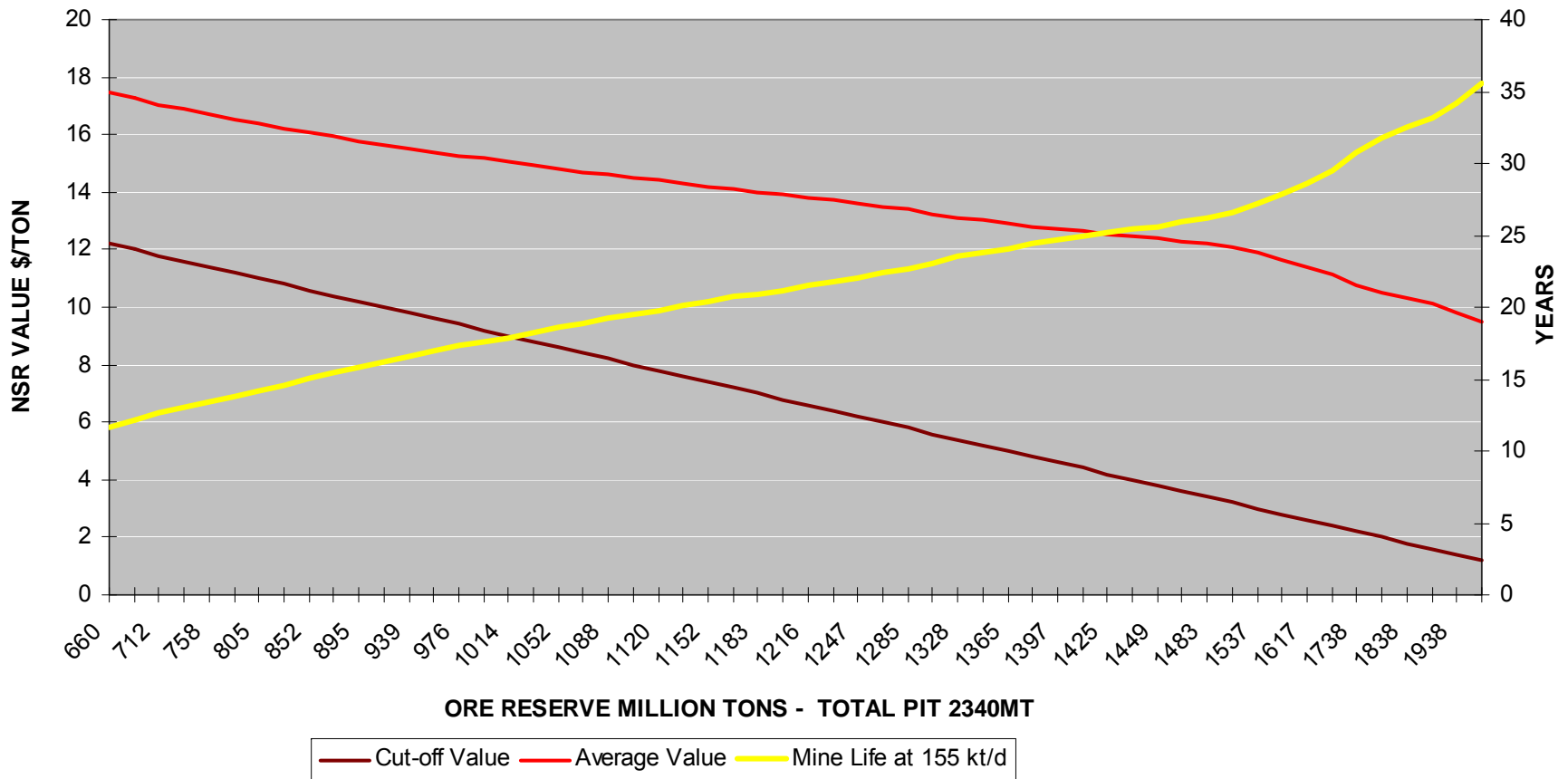


These elements are mutually dependent, and reinforce and interact positively with each other to generate combined value greater than the sum of their individual contributions



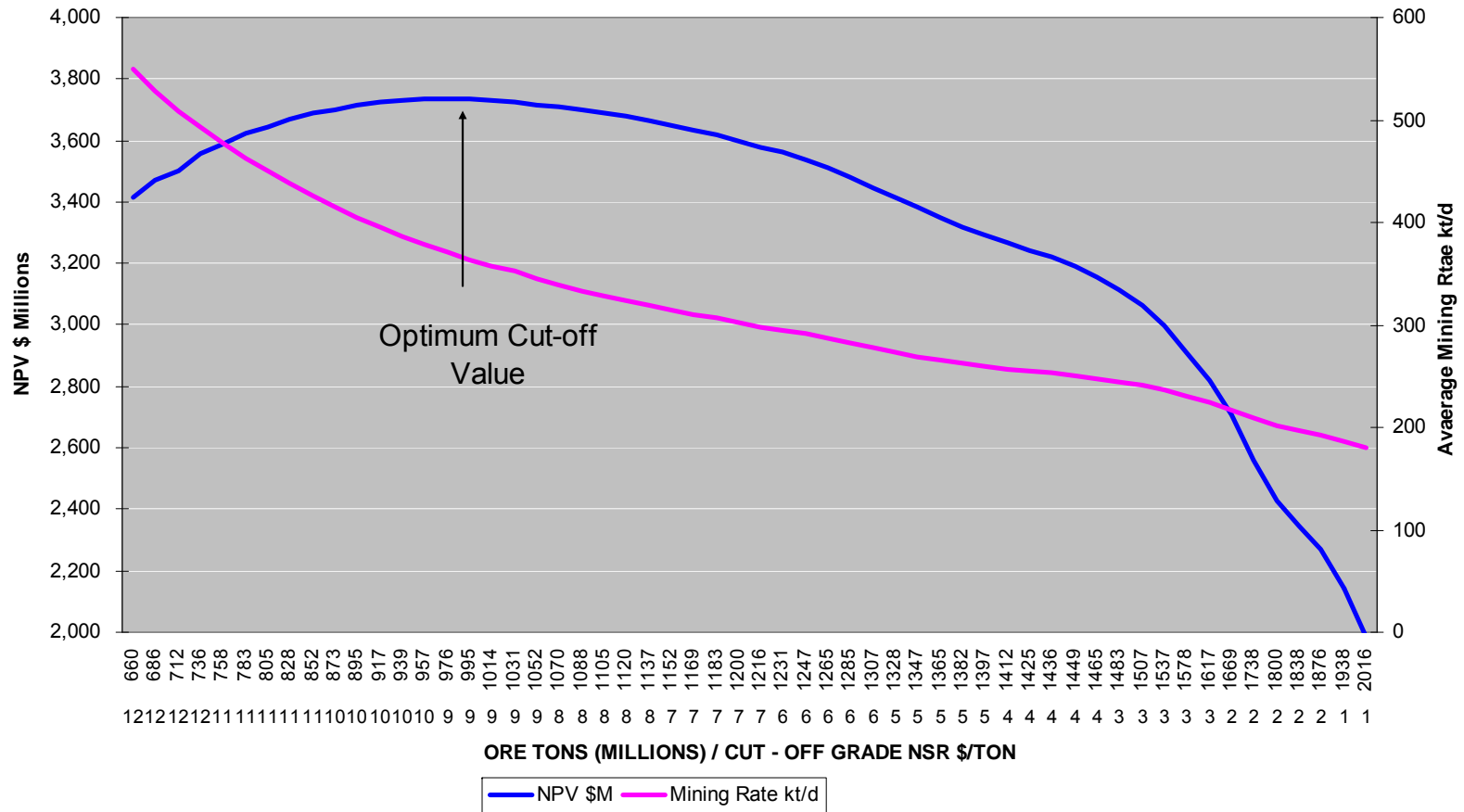
Cutoff Grade Theory – Tonnage Distribution

NSR VALUE - TONNAGE DISTRIBUTION AO4 PIT



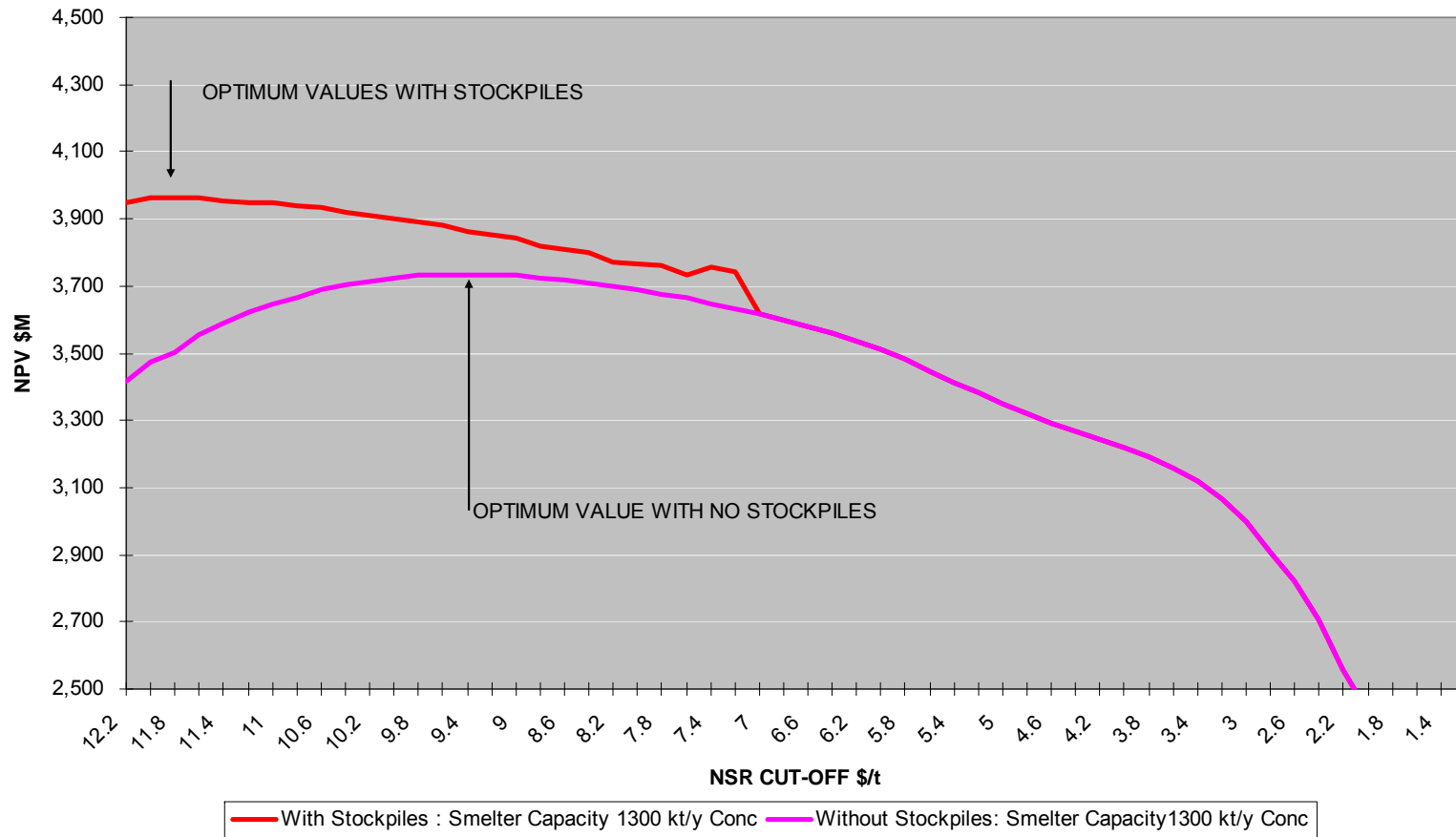
Cutoff Grade Theory – Cutoff Distribution

NPV\$M - CUT OFF DISTRIBUTION AT 155 kt/d



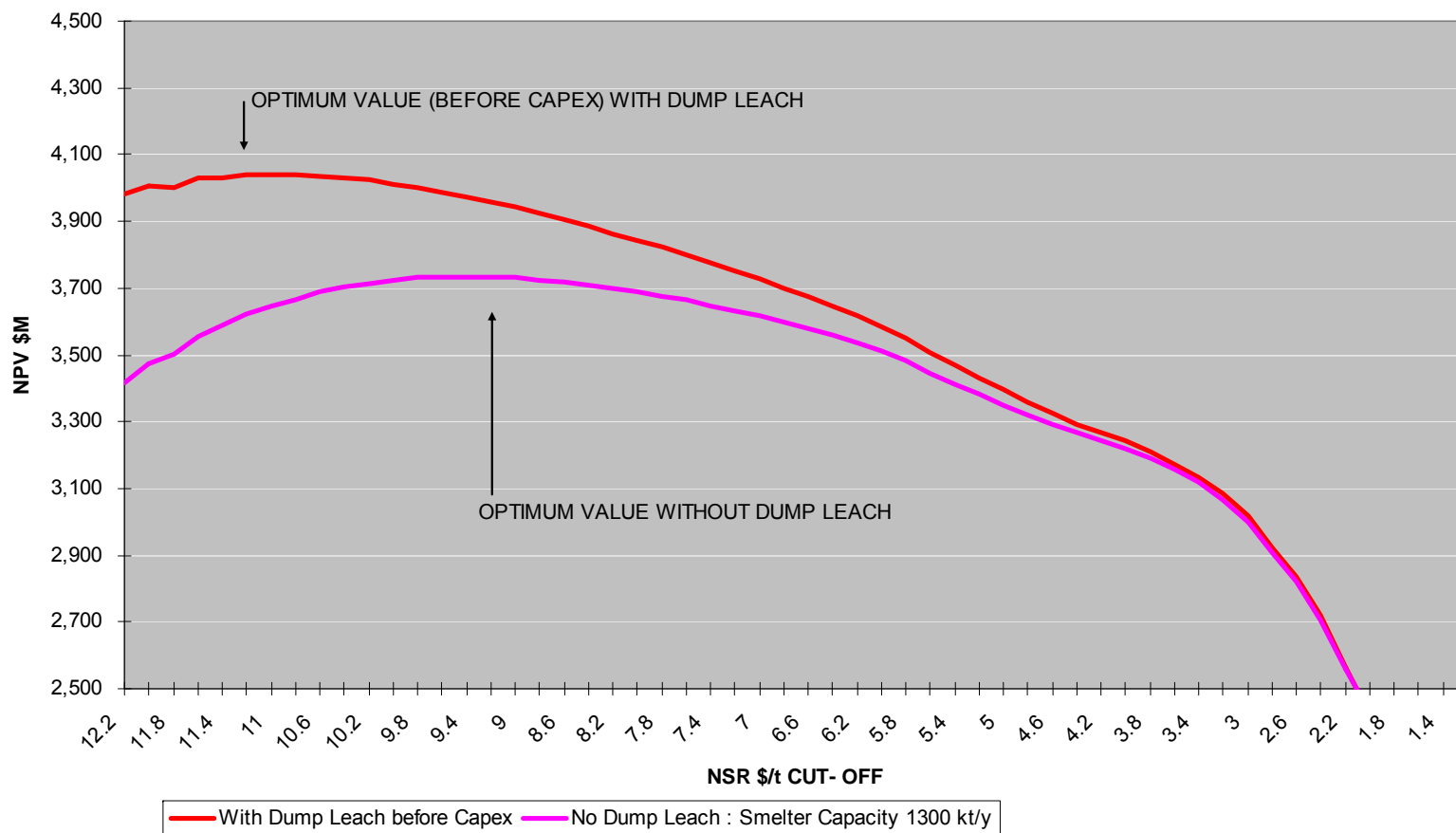
Cutoff Grade Theory – Stockpile Options

NPV - NSR CUT-OFF WITH STOCKPILES



Cutoff Grade Theory – Dump Leach Options

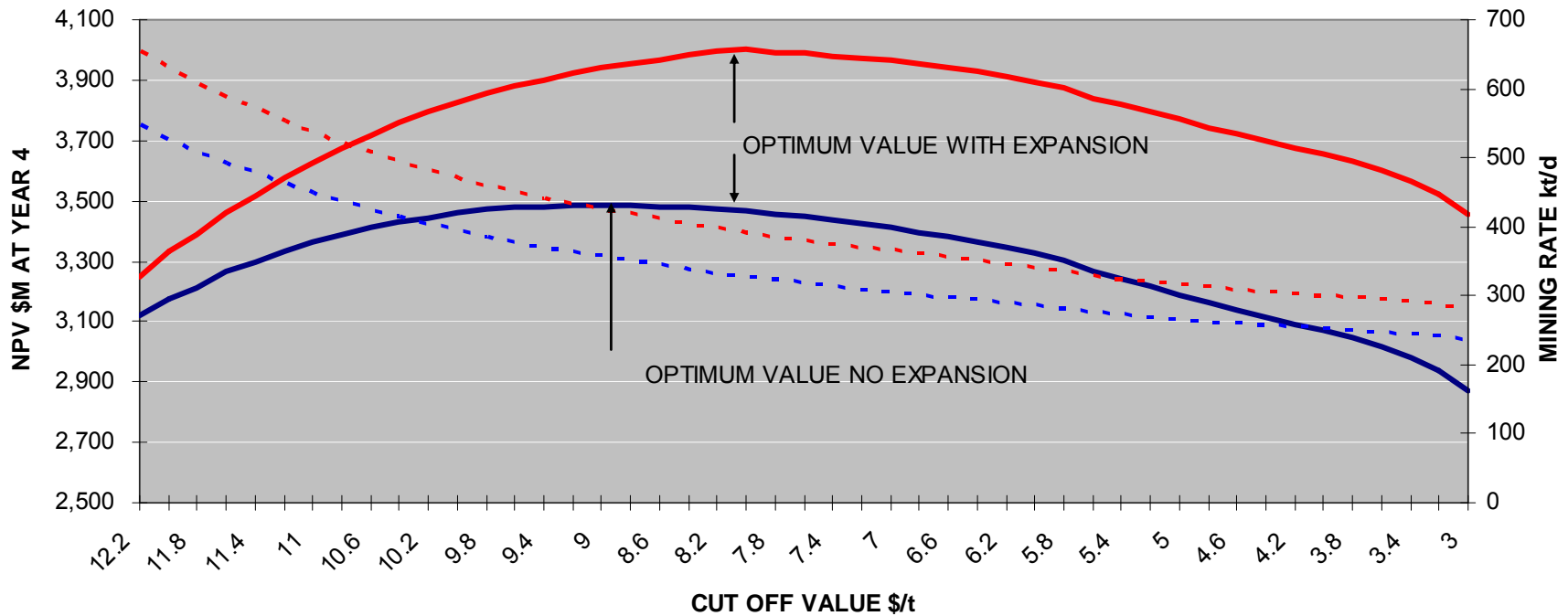
DUMP LEACH NPV \$M - NSR \$/t CUT OFF DISTRIBUTION





Cutoff Grade Theory – Mine/Mill Expansion

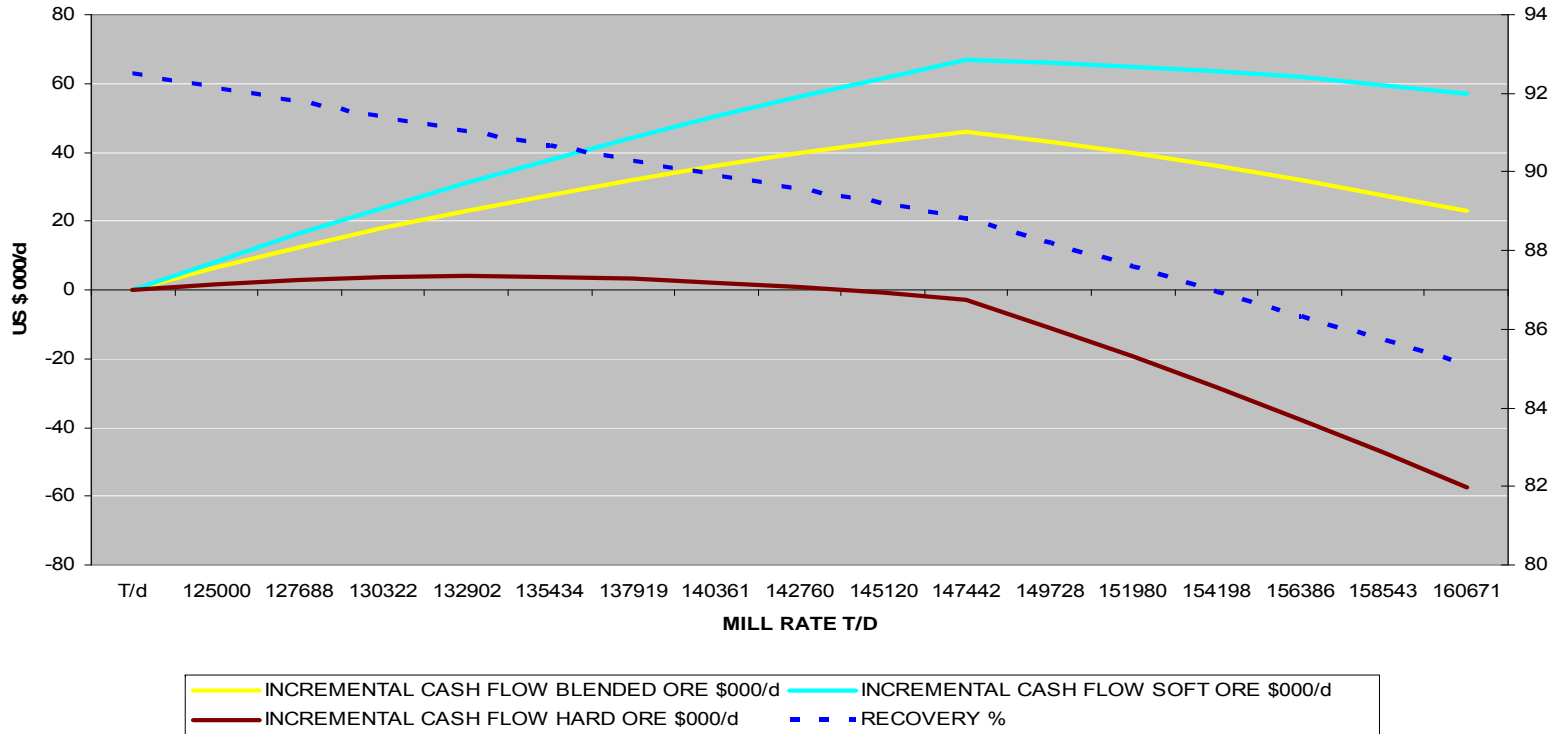
EXPANSION TO 185 kt/d AT YEAR 4 : SMELTER CAPACITY 1300 kt/y CONC



- Remaining NPV at Year 4 : No Expansion : Smelter Conc Capacity 1300kt/y
- Remaining Value: Expansion to 185 kt/d : Smelter Capacity 1300 kt/y
- - - Mining Rate kt/d No Expansion
- - - Mining Rate kt/d: Mill expansion to 185 kt/d

Cutoff Grade Theory – Grind/Recovery/Throughput Effects

COPPERTON GRIND/RECOVERY RELATIONSHIPS



Tools of the Trade

There are commercially available products to assist us in the quest of value maximisation.

Some tools employed by Rio Tinto are,

- ▶ COMET
- ▶ MineMax
- ▶ Maximiser
- ▶ MineSight
- ▶ XPAC
- ▶ Excel
- ▶ Custom

Optimisation in Practice

- Escondida

Sources of Increased Value

Technology and Infrastructure

Value Chain and Infrastructure Configuration

Resources

- Additional Resources
- Exploiting Marginal Resources
- Better Ranking Systems
- Increased Ore body Knowledge

Escondida Norte

Sulphide Leach

\$/hr ranking

Metallurgical Models
Low-Grade Ore

Higher Strip Ratio to
allow Variable Cutoff

Mining

- Increasing Mining Capacity
- Optimized Mining Limits
- Optimized Cut-off Strategy & Tactics
- Improved Selectivity
- Better Mining Sequences
- Alternative Mining Methods
- New Technology

Optimized Pit Limits

Variable Cutoff Policy
INSTEP

Pushback Optimization
Multiple Pit Optimization

Processing

- Alternative Processing Methods
- Optimized Processing Policies
- Processing Waste Streams
- Increased Processing Rates
- New Technology

Mega Shovels

Oxide Leach
Sulfide Leach

Multiple Concentrator Splits
Grind/Throughput/Recovery

Sulfide Leach
Tails Reprocess ?

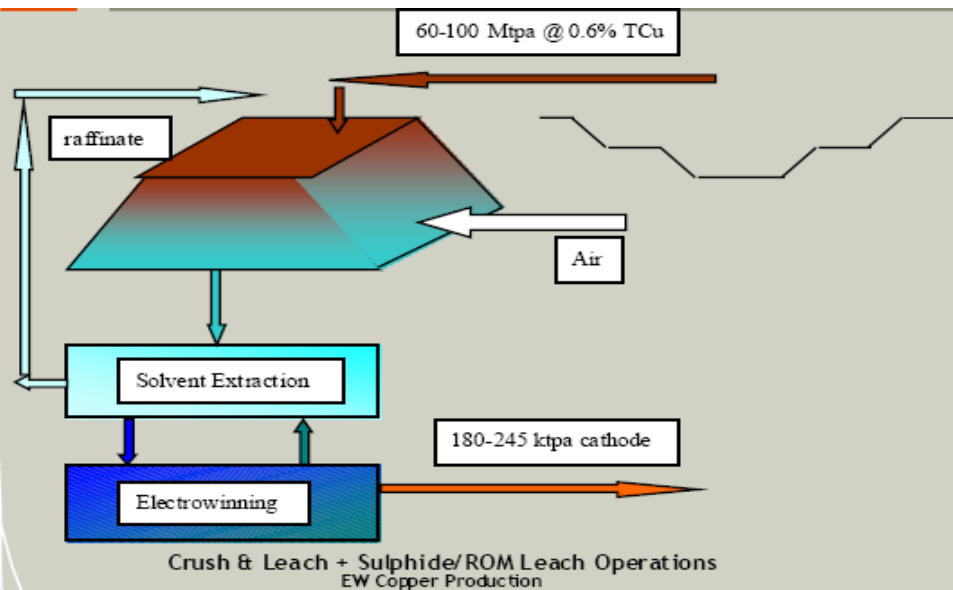
Marketing

- Blending Opportunities
- Introducing New Products
- New By-Products
- Penetrating New Markets

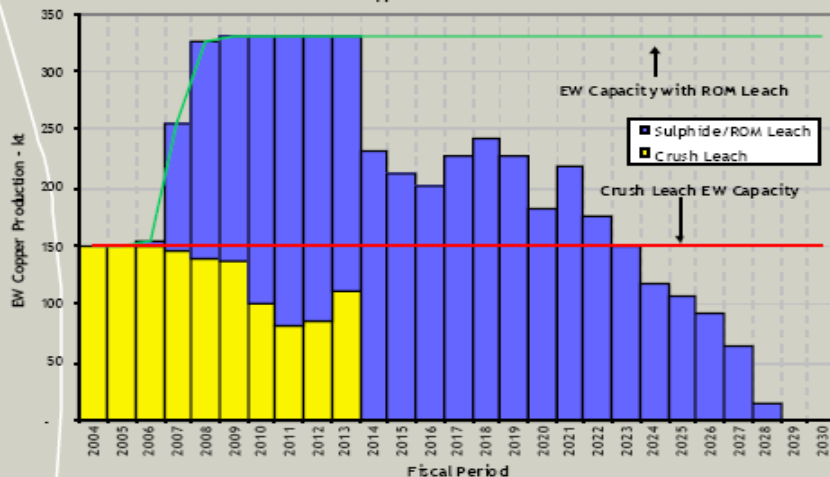
Concentrator
Expansions

Sulfide Leach

Sulphide Leach – Project Summary



- 1.6 billion t sulphide ore at 0.6%tcu
- Current stockpile 100mt
- Copper recovery by:
 - ROM leaching
 - Solvent extraction
 - Electrowinning
- Expected recovery 36%
- Approx 50% of Cu is chalcopyrite
- Initial copper production 180 ktpa
- Increasing to 245 ktpa as ore supply increases and oxide T/H capacity becomes available
- Initial capital \$ 870M (incl. water supply)
- Operating costs < \$0.35/lb Cu



**RIO
TINTO**

Technology and Innovation



Sulphide leach - Escondida

Escondida – resource/reserve growth linked to OBK & Technology

