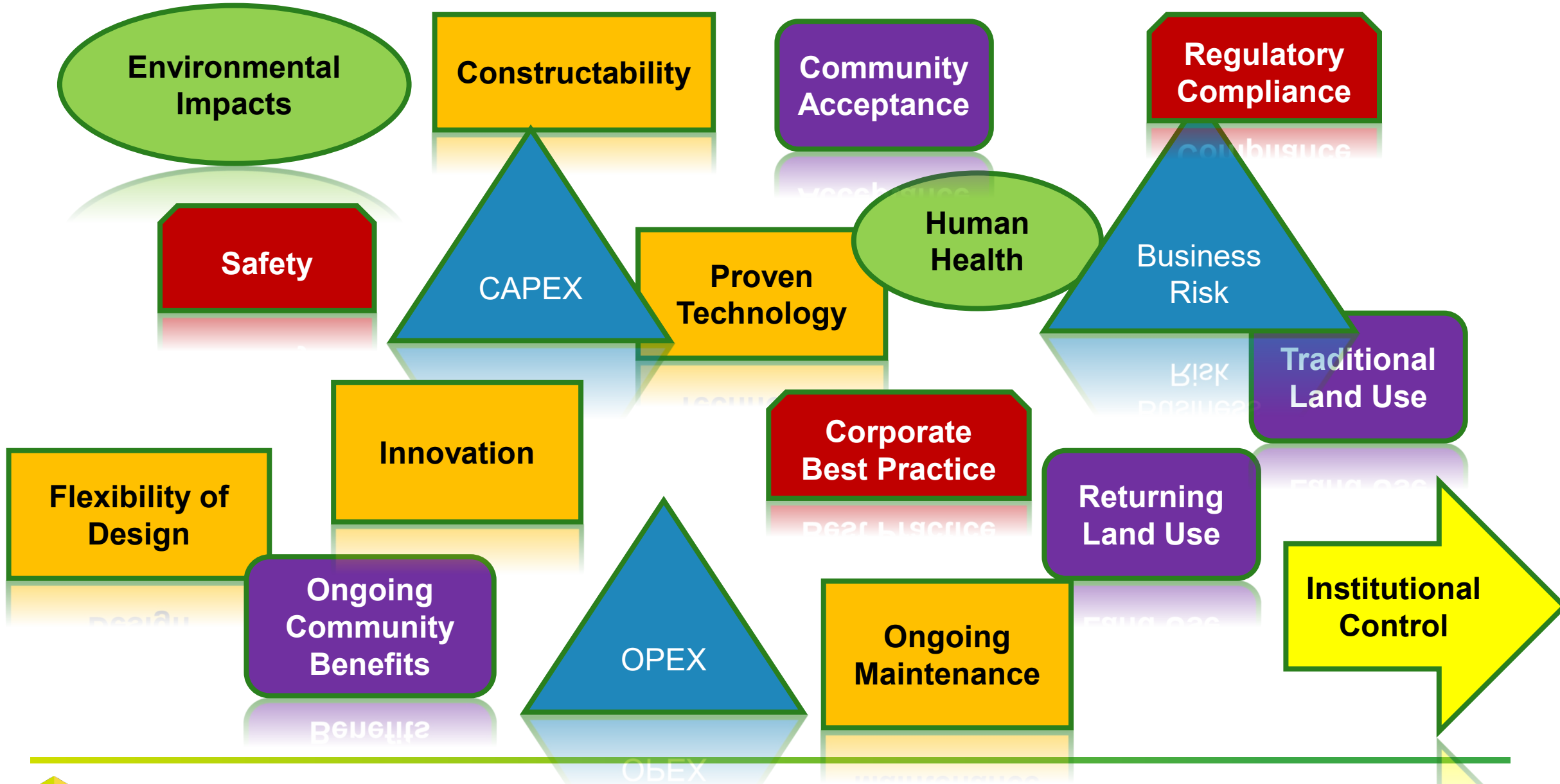# Multiple Accounts Analysis for Mine Closure Planning

THROUGH ALL STAGES OF MINE LIFE

October 20, 2021

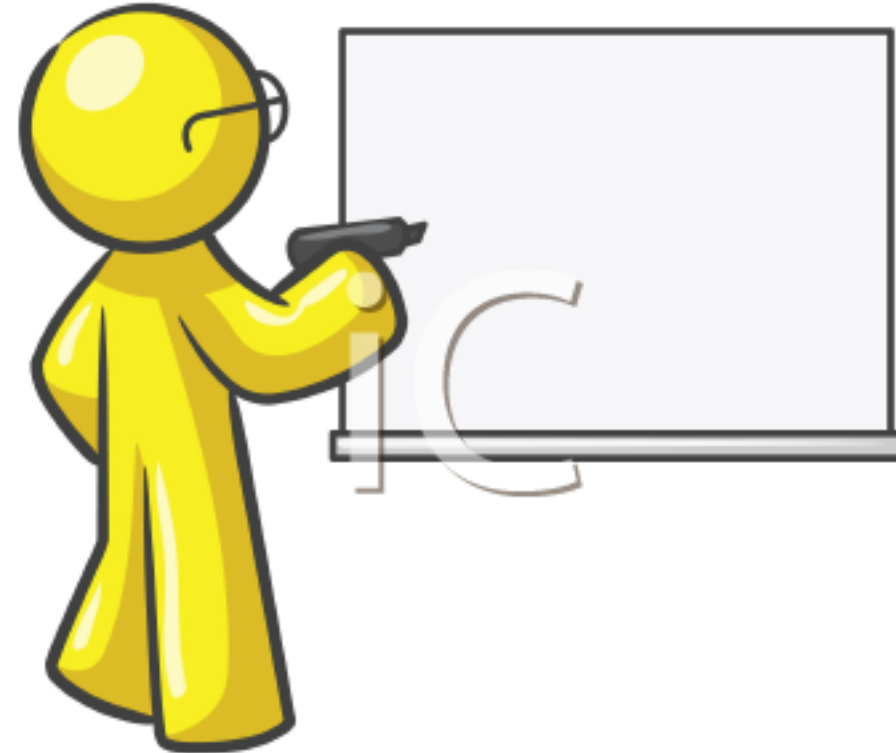# What is a Multiple Accounts Analysis?

Two-Step Process

1. Step #1: Determine options, accounts, sub-accounts, indicators, and weightings.

2. Step #2: "Value-Based Decision Process"

(Robertson and Shaw 1999)

What is a Multiple Accounts Analysis?

DEFINITIONS

❑ A tool to support decision making

❑ Is not meant to provide a definitive answer without further consideration

❑ Adaptable over mine life and over time as priorities change and new information is collected

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What is a Multiple Accounts Analysis?

MAA – multiple accounts analysis

MAOA – multiple accounts options analysis

MCDA – multiple criteria decision analysis (overarching term)

MODM – multi-objective decision making (infinite number of alternatives)

MADM – multi-attribute decision making (discrete number of alternatives)

(Environment and Climate Change Canada 2016)

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MAA Process

SIMPLIFIED FLOW

Screen Options → **Set Accounts and Sub-Accounts** → **Set Weightings for Accounts and Sub-Accounts** → **Conduct Value-Based Analysis** → **Identify Preferred Options and Alternatives**
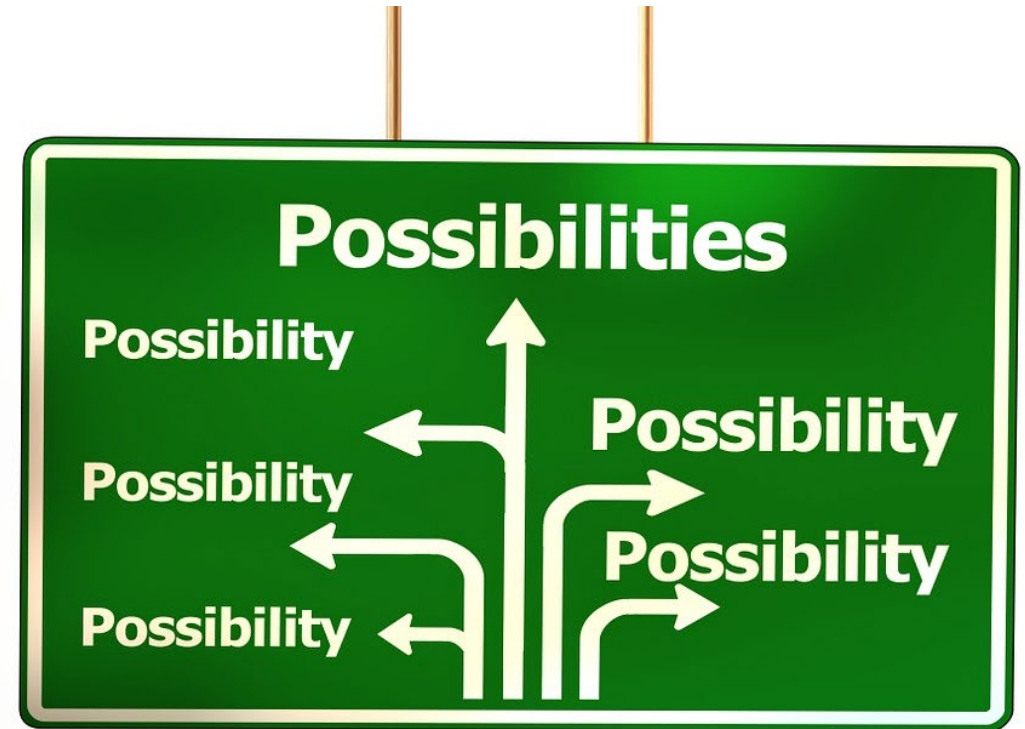
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Screen Options

IDENTIFY CLOSURE OPTIONS

1. Brainstorm Options

2. Look for Fatal Flaws

3. Advance Feasible Options to the Next Stage

Screen Options

OPTIONS

❑ Do nothing

❑ Backfill in pit or underground

❑ Encapsulate with NPAG

❑ Cover with growth medium

❑ Cover with engineered cover

❖ *Remove options that are "fatally flawed"*

❖ *For example, there is not enough room underground or in pit to hold all the PAG waste rock*

❖ *Could lead to a new option (e.g., partial backfill)*

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Set Accounts and Sub-Accounts

IDENTIFY CRITERIA

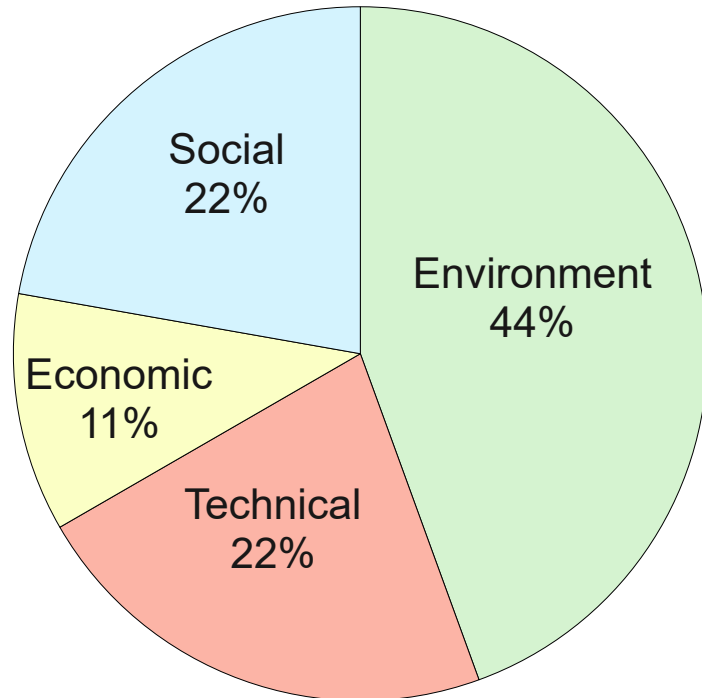| Accounts	Sub-Accounts
Environmental	Habitat & Hydrological Impacts
	Land Use
Technical	Constructability
	Flexibility
	Proven Technology
	Ongoing Maintenance & Monitoring
Economic	Capex
	Opex
	Business Risk
Social / Cultural	Community Acceptance & Involvement
	Ongoing Community Benefit
	Regulatory Acceptance

Set Weightings for Accounts and Sub-Accounts

APPLY WEIGHTS BASED ON PERCEIVED IMPORTANCE

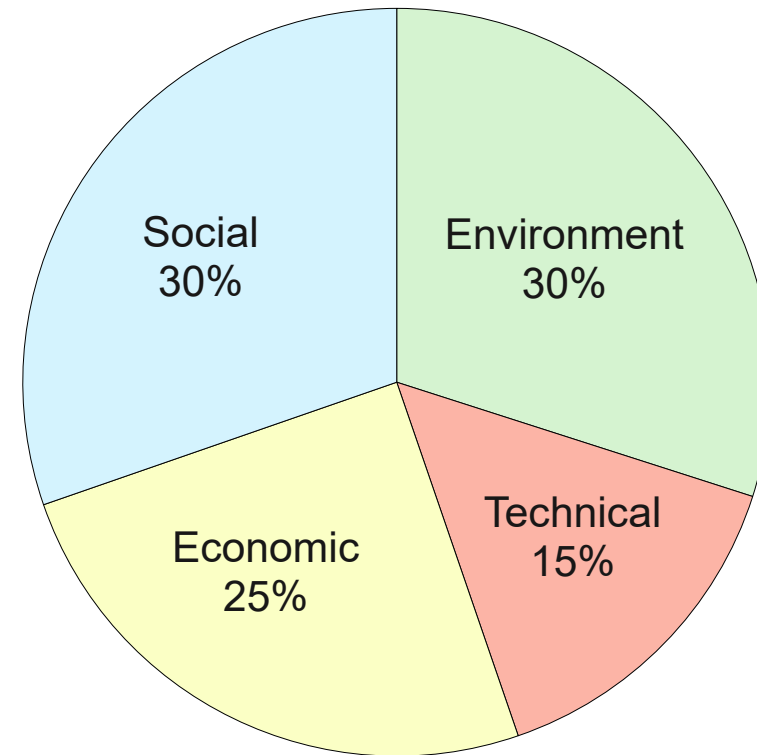| Accounts	Account Weight	Sub-Accounts	Weight
Environmental	25%	Habitat & Hydrological Impacts	50%
		Land Use	50%
Technical	25%	Constructability	25%
		Flexibility	25%
		Proven Technology	25%
		Ongoing Maintenance & Monitoring	25%
Economic	25%	Capex	33%
		Opex	33%
		Business Risk	33%
Social / Cultural	25%	Community Acceptance & Involvement	33%
		Ongoing Community Benefit	33%
		Regulatory Acceptance	33%

Set Weightings for Accounts and Sub-Accounts

APPLY WEIGHTS BASED ON PERCEIVED IMPORTANCE

Environment and Climate Change
Canada 2016

- Social 22%
- Environment 44%
- Economic 11%
- Technical 22%

Adjusted Weighting

- Social 30%
- Environment 30%
- Economic 25%
- Technical 15%

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Conduct Value-Based Analysis

ASSIGN A RANKING TO EACH OPTION

Score	Description	Layperson Analogy
1	Lowest likelihood of success	"No way this is ever going to work"
3	Potentially successful; significant risk management strategies/controls required	"This could go either way"; "This might work, but a lot of things have to go right to get there"
5	Highest likelihood of success; risk management strategies/controls limited or not required	"This is the best path forward, a no-brainer"

Conduct Value-Based Analysis

EXAMPLE CASE STUDY – PAG WASTE ROCK MANAGEMENT

Accounts	Sub-Accounts	Option 1 – Do Nothing	Option 2 – Encapsulate with NPAG	Option 3 – Growth Medium	Option 4 – Engineered Cover
Environmental	Habitat & Hydrological Impacts	1	4	3	5
	Land Use	1	4	2	2
Technical	Constructability	5	1	4	3
	Flexibility	1	1	4	2
	Proven Technology	1	4	1	4
	Ongoing Maintenance & Monitoring	1	4	1	4

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Sensitivity Analysis

CHANGE WEIGHTINGS TO SEE WHAT ACCOUNT / SUB-ACCOUNT IS MOST INFLUENTIAL

ENVIRONMENT	60%
SOCIETY	60%
ECONOMICS	55%
TECHNICAL	42%

ENVIRONMENT	54%
SOCIETY	60%
ECONOMICS	55%
TECHNICAL	42%

ENVIRONMENT	68%
SOCIETY	57%
ECONOMICS	49%
TECHNICAL	42%
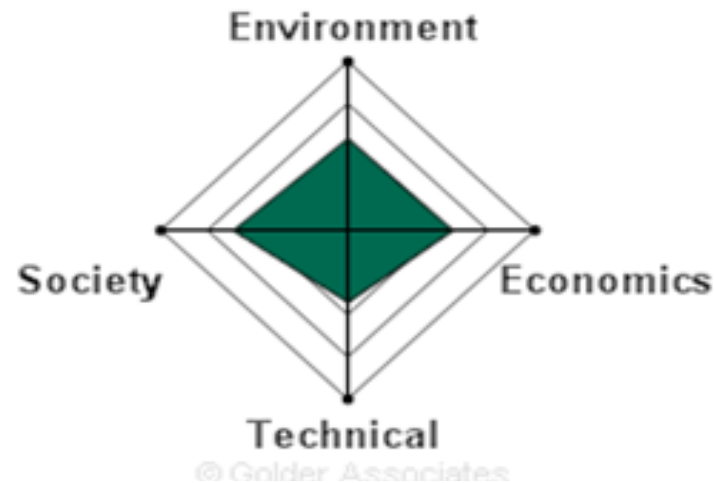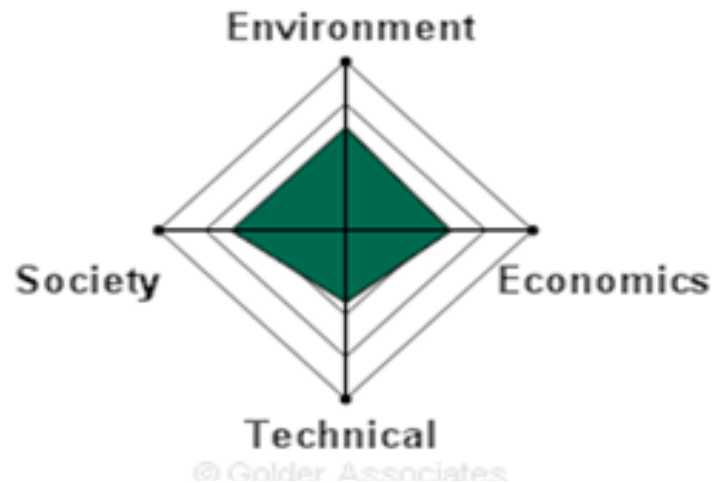
*Produced in GoldSET ©

Determine Preferred Options and Alternatives

CHOOSE OPTIONS TO MOVE FORWARD TO FURTHER PLANNING AND DESIGN

- ❖ *Using MAA outcomes to identify preferred options for further assessment*

- ❖ *Options may change as mine plans change and knowledge advances*

Next Steps (Depending on Stage of Planning):

- ❑ Conduct further research, design, and modelling

- ❑ Build water modelling assuming preferred option

- ❑ Select option for implementation

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Determine Preferred Options and Alternatives

EXAMPLE CASE STUDY – PAG WASTE ROCK MANAGEMENT

Accounts	Sub-Accounts	Option 1 – Do Nothing	Option 2 – Encapsulate with NPAG	Option 3 – Growth Medium	Option 4 – Engineered Cover
Environmental	Habitat & Hydrological Impacts	1	5	4	6
	Land Use	1	5	3	3
Technical	Constructability	6	2	6	4
	Flexibility	1	2	5	3
	Proven Technology	1	5	2	5
	Ongoing Maintenance & Monitoring	1	5	2	5
	RANKING	**4**	**2**	**3**	**1**

What Tool Should I Use?

DEPENDS ON THE STAGE OF MINE PLANNING

Conceptual Planning

- Simple Spreadsheet
- Weighting at the Accounts and Sub-Accounts Level OR Add Indicator Values and Merit Scores
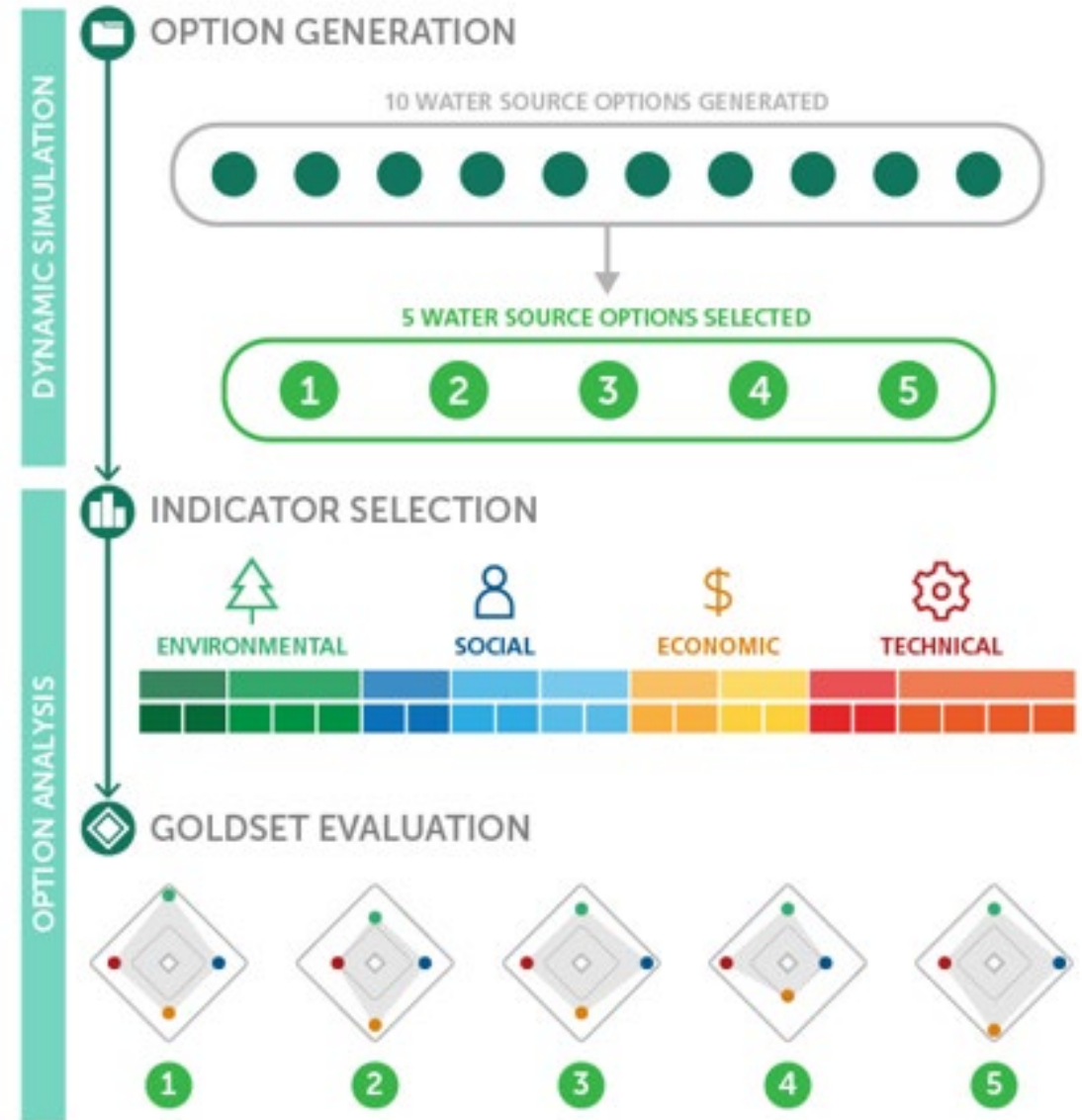
Detailed Planning

- Complex Spreadsheet with Comprehensive Accounts and Weightings
- Web-Based Tools like GoldSET ©
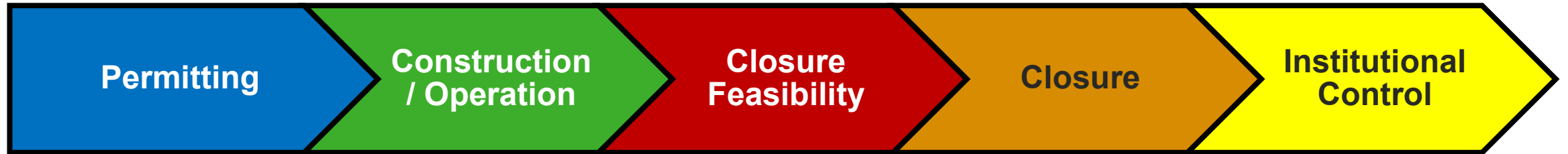
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What Tool Should I Use?

GOLDSET

❑ Uses a rigorous multi-criteria approach

❑ Simple, systematic process to evaluate alternatives

❑ Uses geospatial, qualitative, and quantitative data

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Closure Planning Cycle

Mining Life Cycle

| Permitting | Construction / Operation | Closure Feasibility | Closure | Institutional Control |

Increasing Level of Detail

| Conceptual Planning | Research / Modelling / Design | Detailed Planning | Implementation | Institutional Control |

Closure Planning Life Cycle

Benefits of Using Multiple Accounts Analysis

PROS

❑ Multi-disciplinary – able to incorporate many viewpoints and technical data from multiple areas (environmental, engineering, financial, Indigenous groups, land users)

❑ A transparent way to document decision making process and a logical ranking of alternatives

❑ Flexibly to adjust and optimize through the life of the mine

❑ Can be used to improve performance if there is a history of low performance in a specific account

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Drawbacks of Using Multiple Accounts Analysis

CONS

❑ Easily influenced by internal biases

❑ Only as good as the information you feed into it

❑ May provide different results depending on who populates it

❑ Can imply false precision

Questions?

Photo Courtesy of Martin Jalkotzy