

# *Quantitative Risk Analysis to Select a High Opportunity Exploration Jurisdiction*

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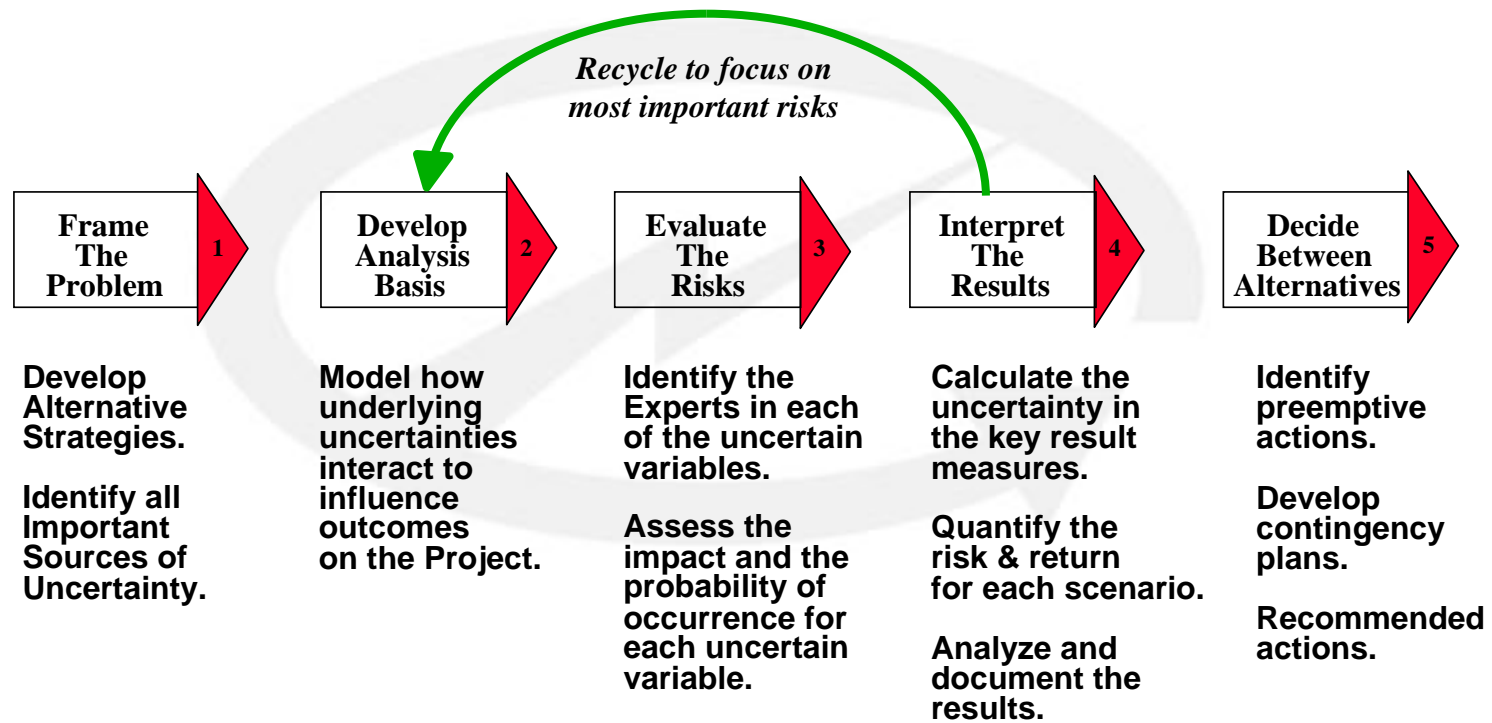
*Calgary, Alberta*



## ***Risk Analysis is a rigorous & comprehensive process that:***

- *Identifies all sources of uncertainty & assesses the probability of occurrence & impact on the measurement criteria ...*
- *Frames the decision problem, and documents a consistent set of assumptions, limitations and constraints ...*
- *allows all logical strategies to be tested in an uncertain environment and compared in a quantified manner...*
- *provides an effective communication tool so that the assumptions and uncertainties are clearly communicated to stakeholders...*
- *uses “soft” conditioning variables to model the underlying uncertainties to ensure the project/activity performs in a logical manner...*
- *assists in mitigation planning, implementation tactics, and, identifies opportunities to enhance project/activity value(s).*

*The Risk & Decision Analysis Process proceeds in a systematic sequence of five steps*



## *Strategy Table for Country Risk Analysis*

<b>Decisions</b>						
<i>Strategy</i>	<i>Country</i>	<i>Commodities</i>	<i>Mining Extraction</i>	<i>Processing</i>	<i>Smelting &amp; Refining</i>	<i>Markets</i>
<i>Increasing Reserves</i>	<i>Canada</i>	<i>Polymetallic</i>	<i>Open Pit</i>	<i>Heap Leach</i>	<i>In Country: onsite</i>	<i>In Country</i>
<i>Competitive Need</i>	<i>Indonesia</i>	<i>Precious Metals</i>	<i>Underground</i>	<i>Standard Flotation &amp; Concentration</i>	<i>In Country: offsite</i>	<i>Regional</i>
<i>Competitive Advantage</i>	<i>Russia</i>	<i>Industrial Minerals</i>	<i>InSitu Leach</i>	<i>Solvex</i>	<i>Out Of Country</i>	<i>International</i>

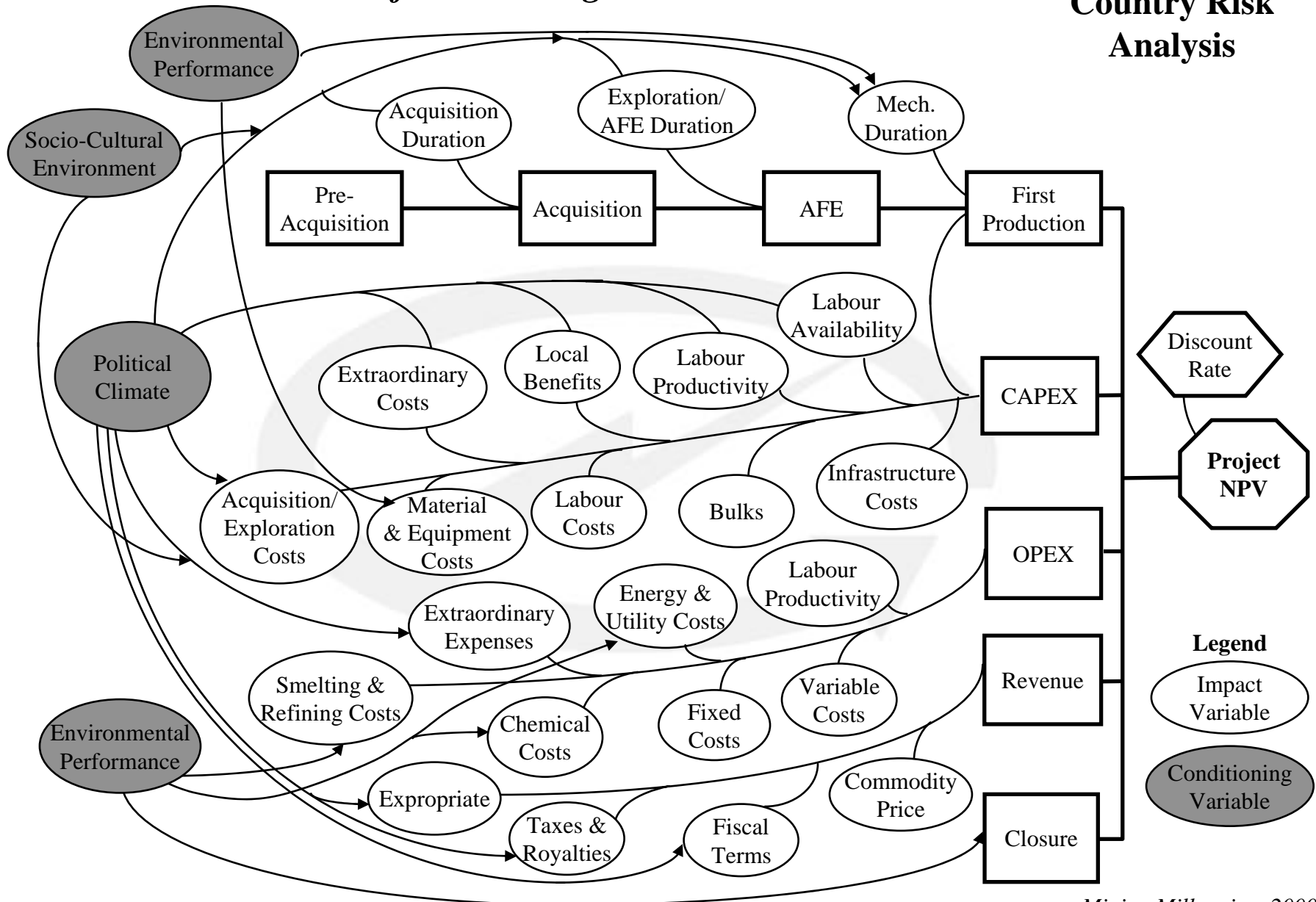
Selected Strategy     Options

# *Project Definition & Assumptions*

- *Increasing reserves strategy*
- *Canada, Indonesia & Russia comparison*
- *Polymetallic deposit*
- *Open pit*
- *Truck & shovel operation*
- *Crushing & grinding*
- *Standard Flotation & Concentration*
- *Out of Country Smelting & Refining*
- *International Markets*
- *Preacquisition, acquisition, AFE, construction, rampup, production & closure phases*
- *Au, Ag, Cu & Zn grades, recoveries, credits & prices fixed*
- *Discount Rate 12%*
- *Full cycle economics*
- *All schedules, grades, costs, production, benefits, royalties and taxes fixed*
- *Poor, Expected & Superior Conditioning Variable Nominal Performance ratings fixed, separate probabilities assessed for Canada, Indonesia & Russia*

# Influence Diagram/Risk Model

## Country Risk Analysis



## *Environmental Performance Conditioning Variable*

<i>Attribute</i>	<i>Poor, Low=0</i>	<i>Expected=5</i>	<i>Superior, High=10</i>
<b>Technology</b>	<i>static or declining science &amp; engineering research, new applications, implementations</i>	<i>continuing research, driven by financial performance objectives</i>	<i>accelerating research with financial &amp; non-financial performance objectives</i>
<b>Legislation, Regulations &amp; Guidelines</b>	<i>prescriptive, criteria-based standards based on poor science, politically driven notions</i>	<i>criteria &amp; risk-based standards supported by good science and public input</i>	<i>full acceptance of risk-based standards with high degree of public input</i>
<b>Stakeholder Content</b>	<i>low degree of public participation</i>	<i>average/static degree of public participation</i>	<i>increased levels of public participation</i>
<b>Greenhouse Gases</b>	<i>increasing levels of GHGs</i>	<i>stable levels of GHGs</i>	<i>declining levels of GHGs</i>
<b>Ecology &amp; Conservation</b>	<i>declining biodiversity &amp; renewable resource capacity</i>	<i>stable biodiversity &amp; renewable resource capacity</i>	<i>increasing biodiversity &amp; renewable resource capacity</i>
<b>Sustainable Development</b>	<i>low interest, support &amp; integration of the principles of environmental management</i>	<i>stable interest, support &amp; integration of the principles of environmental management</i>	<i>high level of support, interest &amp; integration of the principles of environmental management</i>

	<b><u>2.5</u></b>	<b><u>5.5</u></b>	<b><u>7.5</u></b>
<b>Canada</b>	<b>10%</b>	<b>75%</b>	<b>15%</b>
<b>Russia</b>	<b>75%</b>	<b>23%</b>	<b>2%</b>
<b>Indonesia</b>	<b>23%</b>	<b>52%</b>	<b>25%</b>

## *Socio-Cultural Environment Conditioning Variable*

<i>Attributes</i>	<i>Poor, Low=0</i>	<i>Expected=5</i>	<i>Superior, High=10</i>
<b>History</b>	<i>closed society, resentment of past development, reluctant to change, poor learning</i>	<i>more open to development,, prepared to accept change, good learning</i>	<i>open society, full acceptance of change, seeking challenges, learning &amp; opportunity</i>
<b>Religion</b>	<i>low tolerance of religious freedoms, expression</i>	<i>essential and basic tolerance to religious freedoms, expressions</i>	<i>high tolerance for religious freedoms, expressions</i>
<b>Resource Development History</b>	<i>negative experiences with past mining or resource development, poor social contract &amp; environmental measures</i>	<i>some positive experiences with past mining, better experience with social contract &amp; environmental measures</i>	<i>good experiences with past mining, accrued benefits from social contract &amp; environmental measures</i>
<b>Institutions</b>	<i>little or no support/respect for national and local institutions</i>	<i>essential and basic support/respect for national and local institutions</i>	<i>high support and respect for national and local institutions</i>
<b>Leaders &amp; Professions</b>	<i>little or no support afforded to leaders and the professions</i>	<i>essential and basic support afforded to leaders and the professions</i>	<i>high level of support and acknowledgment of leaders and the professions</i>
<b>Corporate Image &amp; Credibility</b>	<i>little or no acknowledgment of corporate image, credibility &amp; profile</i>	<i>acknowledgment &amp; some acceptance of corporate image, credibility &amp; profile</i>	<i>high level of acceptance of corporate credibility, image &amp; profile</i>
<b>Tolerance of Foreign Investment</b>	<i>little or no societal tolerance or acceptance of foreign investment</i>	<i>basic tolerance &amp; acceptance of foreign investment</i>	<i>high acceptance of foreign investment</i>

	<b><u>4.5</u></b>	<b><u>6.0</u></b>	<b><u>7.5</u></b>
<b>Canada</b>	<b>25%</b>	<b>50%</b>	<b>25%</b>
<b>Russia</b>	<b>67%</b>	<b>27%</b>	<b>6%</b>
<b>Indonesia</b>	<b>27%</b>	<b>45%</b>	<b>28%</b>



## *Political Climate Conditioning Variable*

<i>Attributes</i>	<i>Low, Poor=0</i>	<i>Expected=5</i>	<i>Superior, High=10</i>
<b>Representation by Population</b>	<i>low or poor level of representation, suppressed democratic freedoms</i>	<i>basic and essential representation, democratic freedoms &amp; processes</i>	<i>high level of representation and enhanced democratic freedoms &amp; processes</i>
<b>Resource Legislation &amp; Regulation</b>	<i>ownership highly uncertain, older mining code, uncertain permitting process</i>	<i>newer, best mining practices driven legislation &amp; permitting process, ownership regulations defined</i>	<i>modern mining code linked with economic, environmental and societal policy and best practices, highly favorable ownership regulations</i>
<b>Business Environment</b>	<i>tax &amp; royalty driven regulation, shareholder ransom, restrictions on profit repatriation</i>	<i>some tax and royalty incentives, shareholder acknowledgment, flexibility for profit repatriation</i>	<i>tax/royalty role fully balanced with incentives, full shareholder &amp; global business case acknowledgment</i>
<b>Public Policy</b>	<i>little commitment to improving, democratizing public policy design &amp; execution</i>	<i>basic commitment to improving &amp; democratizing public policy design &amp; execution</i>	<i>high level of commitment to improving &amp; democratizing public policy design and execution</i>
<b>Foreign Policy</b>	<i>poor relations with neighboring countries and international community</i>	<i>better &amp; improving relations with neighboring countries and international community</i>	<i>high level of interaction and relations with neighbors &amp; international community</i>
<b>Stability</b>	<i>fragmented electoral processes, entrenched positions, regulatory disorder</i>	<i>essential electoral processes, improving political maturity and regulatory order</i>	<i>long periods of stable responsible government with consistently maturing political &amp; regulatory order</i>

	<b><u>3.0</u></b>	<b><u>5.5</u></b>	<b><u>7.5</u></b>
<b>Canada</b>	<b>20%</b>	<b>70%</b>	<b>10%</b>
<b>Russia</b>	<b>64%</b>	<b>34%</b>	<b>2%</b>
<b>Indonesia</b>	<b>37%</b>	<b>44%</b>	<b>19%</b>

# Probability Assessments

*For a direct schedule variable:  
operating days*

<u>P10</u>	<u>Exp.</u>	<u>P90</u>
270	300	330

*For a direct cost variable:  
material & equipment costs (US\$mm)*

<u>P10</u>	<u>Exp</u>	<u>P90</u>
65	85	95

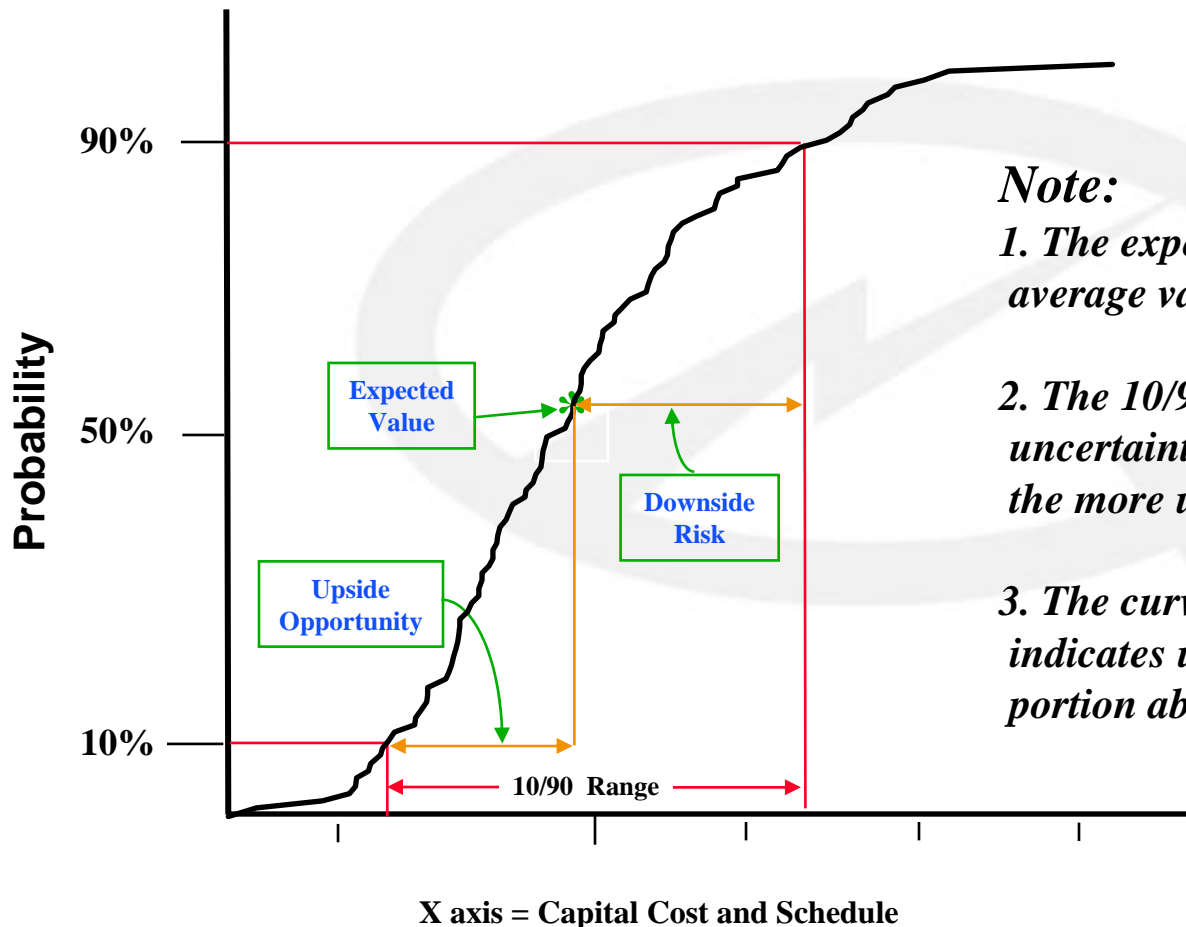
*For a direct schedule variable:  
Exploration/AFE duration (mo)  
Conditioned by Socio-culture Environment:*

	<u>P10</u>	<u>Exp</u>	<u>P90</u>
<i>Superior</i>	9	15	36
<i>Expected</i>	18	36	54
<i>Poor</i>	24	40	60

*For a direct cost variable  
Royalties (% on revenue)  
Conditioned by Political Climate:*

	<u>P10</u>	<u>Exp</u>	<u>P90</u>
<i>Superior</i>	4.0	4.8	5.5
<i>Expected</i>	5.5	6.5	7.5
<i>Poor</i>	6.5	8.5	9.5

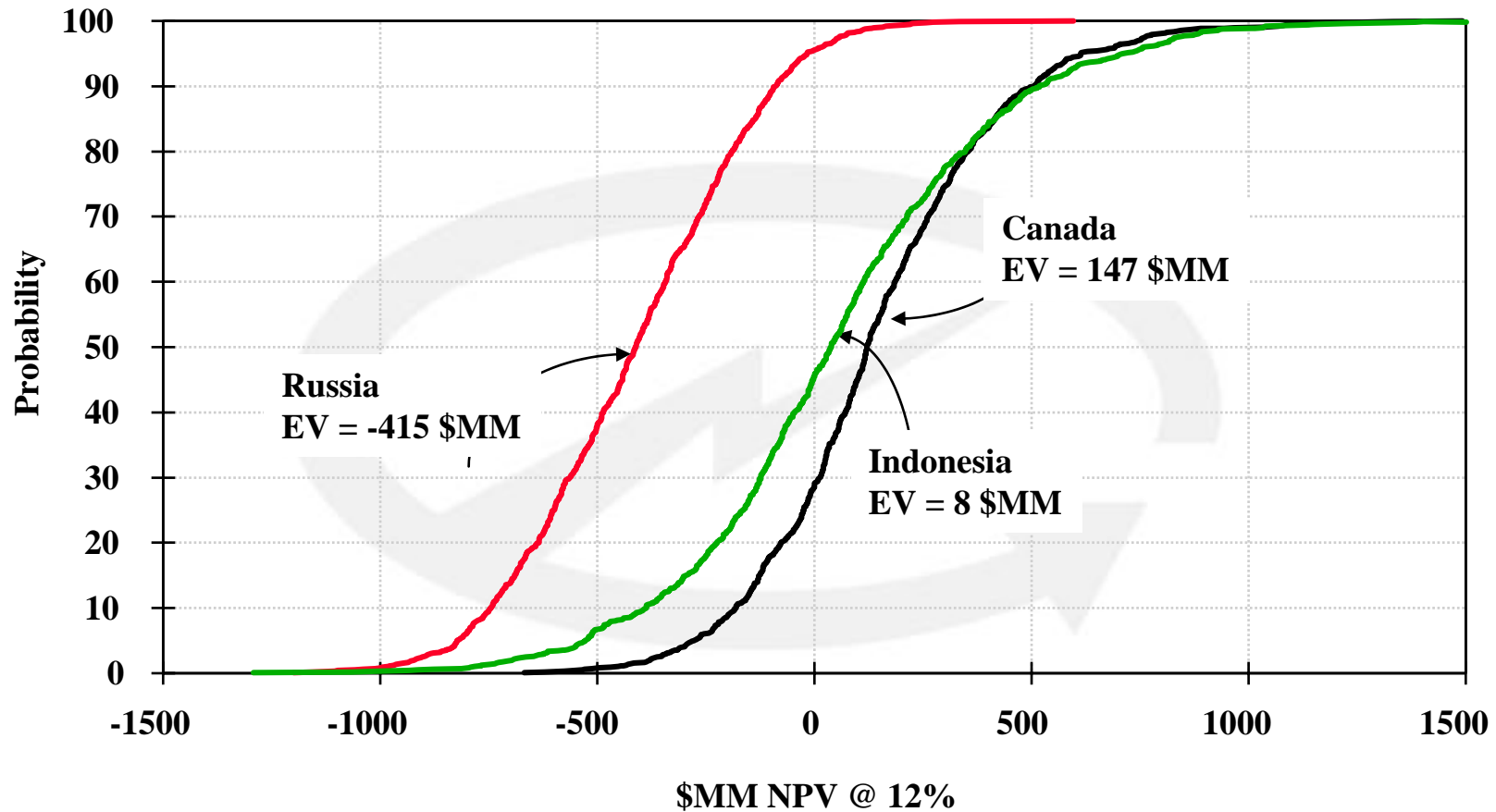
*The accumulated probability distribution indicates the range of uncertainty in the results. Each point on the curve is a result from a single Monte Carlo trial.*



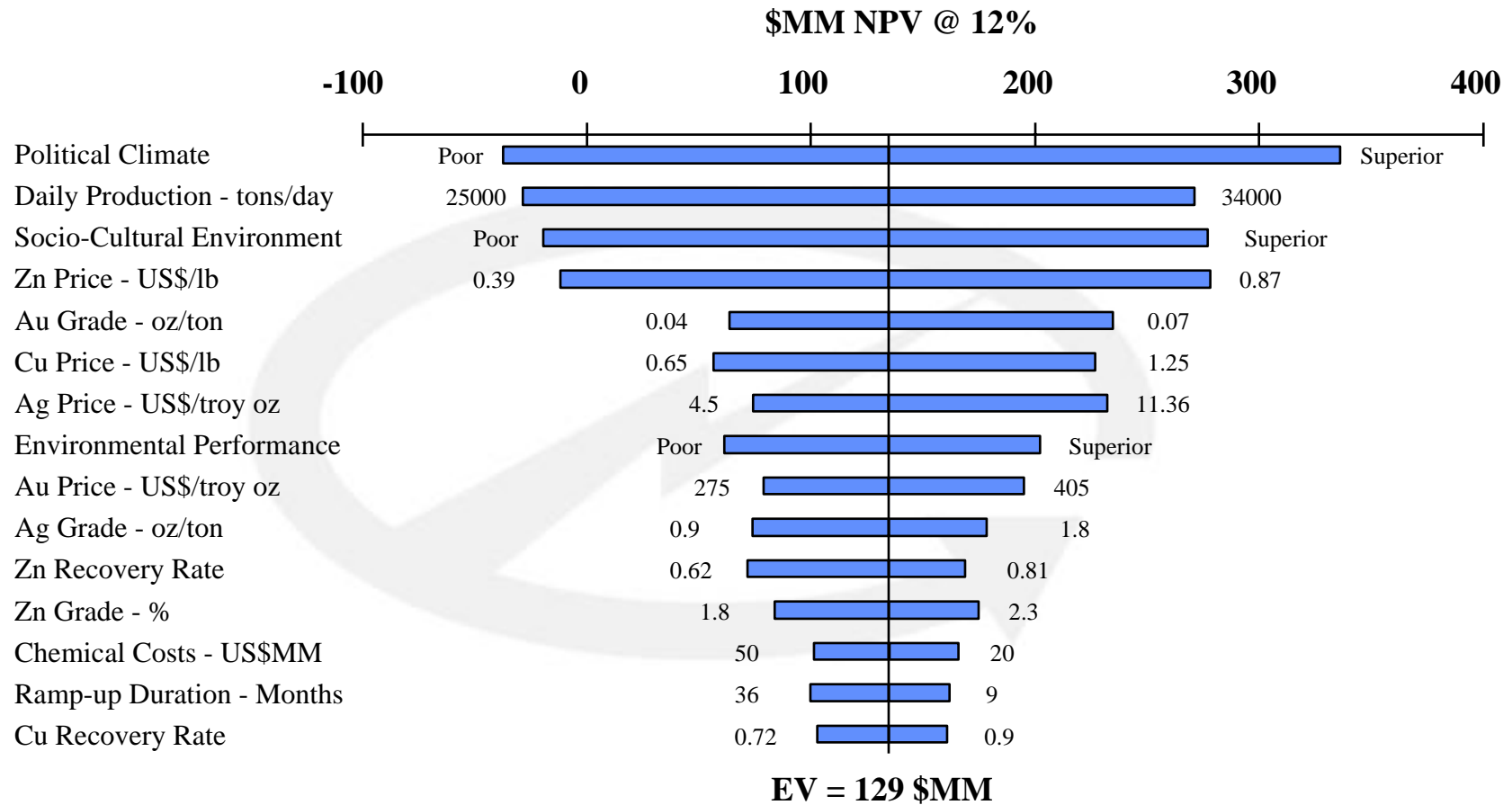
**Note:**

- 1. The expected value represents the average value of all the trials.*
- 2. The 10/90 range represents the uncertainty, the flatter the curve, the more uncertainty.*
- 3. The curve below expected value indicates upside opportunity, the portion above shows the downside risk.*

## NPV Country Case Comparison

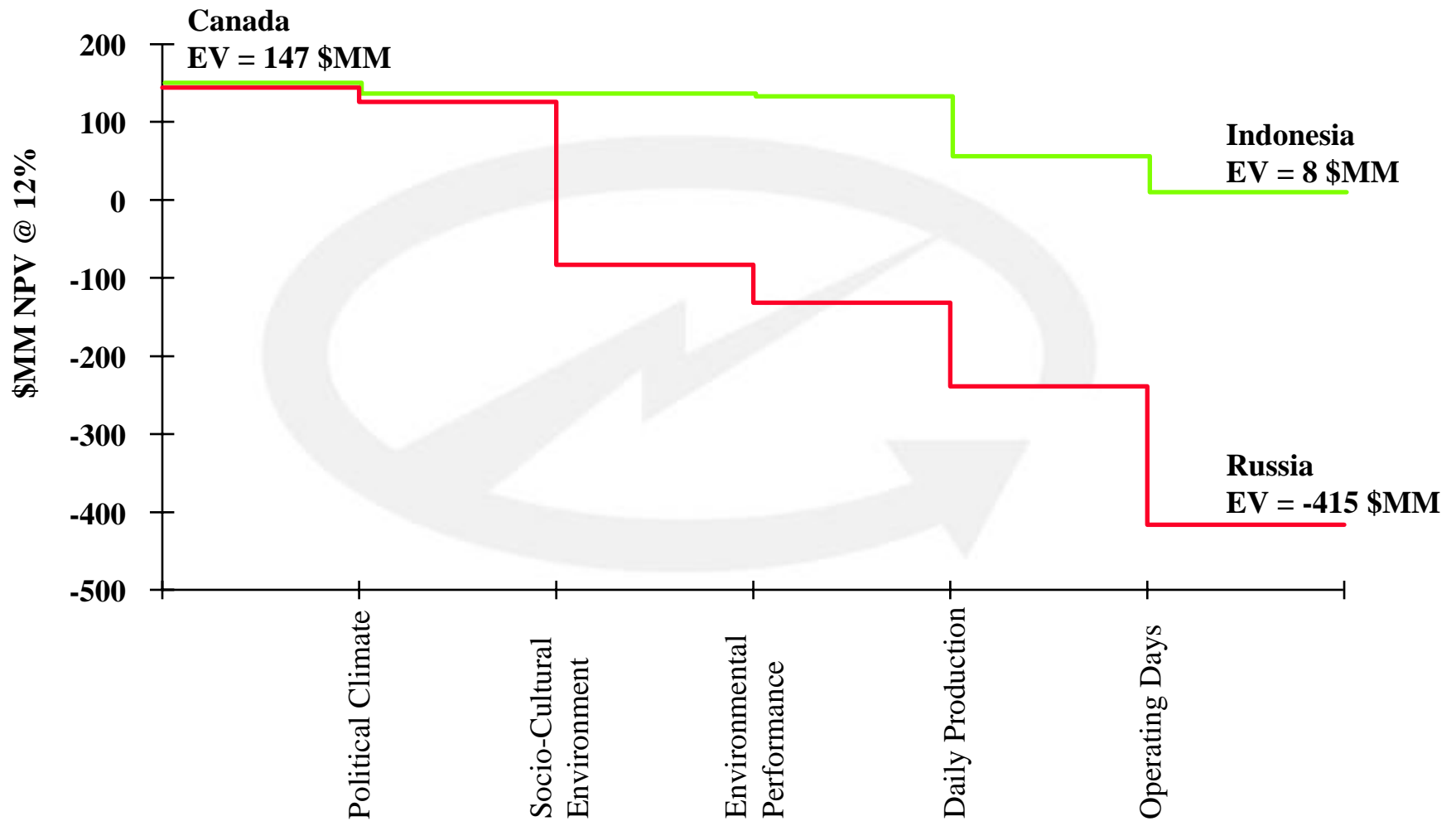


*The Tornado Diagram highlights the key drivers for the option & identifies areas to focus mitigation efforts to ensure success*

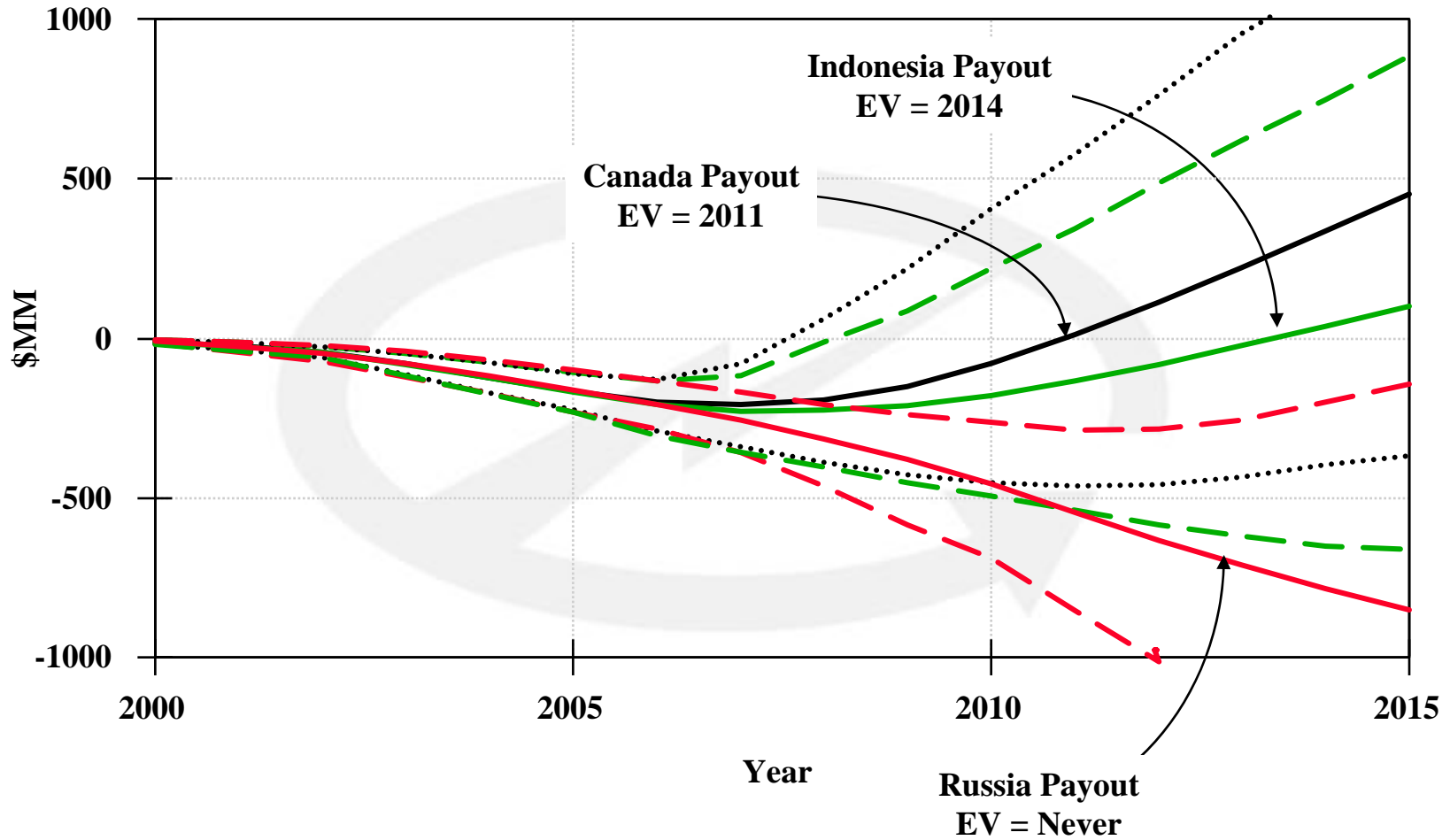


*NPV Canadian Case*

## The Step Diagram Identifies the Variances from the Base Plan



## Cumulative Cashflow



## ***A Risk & Decision Analysis should be conducted early in the project planning cycle because...***

- ***The process identifies opportunities and issues, and allows early identification and quantification of mitigated solutions.***
- ***The process tests the effectiveness of the project configuration and assumptions, and identifies areas which need attention. Early design changes are easier and less expensive to implement.***
- ***The process quantifies and compares all project options and eliminates non-feasible ones.***
- ***The analysis identifies the project base data and facilitates open information across the project team. It sets a baseline so that changes can be monitored and reconciled.***
- ***Potential risk mitigation actions are identified early enough to identify the R&D that may be needed to mitigate a downside risk or capture an upside opportunity.***



## *In each case, risk analysis has caused the project plans to improve:*

- **Sable Gas Project** developed a **proactive strategy** to mitigate a potential schedule delay from regulatory uncertainty. They updated the results five times to **monitor value** over the life of the project.
- **Syncrude** delayed upgrader expansion **plans** because of improved understanding between experts from the risk analysis. Adopted a strategic R&D program based on the long term **decision map**.
- **Corridor Pipeline and Shell** used the risk analysis to set **contingency levels** used in an incentive formula. Corridor planned the project using risk analysis to **mitigate a serious schedule concern** on the integrated start-up for the project.
- **Suncor and Syncrude** used the process to **negotiate realistic incentives** with Alliance partners on their major capital expansions.
- **Calgary Northwest LRT** team **avoided embarrassment** using a schedule mitigation plan developed from the risk analysis.
- **PanCanadian** at Weyburn shared the model with SEM and WIO for **consistency of analysis** by all stakeholders. **Rescheduled** Weyburn project to capture benefits of the fiscal terms analysis and negotiations. **Optimized facility sizes** to counter feedstock cost uncertainty.