

# Classifying extraction projects with UNFC-2009 Solutions to Classroom Exercises

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# UNFC 2009 Classification (Detailed)

	Extracted	Sales Production				
		Non-Sales Production				
		Class	Sub-class	Categories		
			E	F	G	
Total Commodity initially in place	Future recovery by commercial development projects or mining operations	Commercial Projects	On Production	1	1.1	1,2,3
			Approved for development	1	1.2	1,2,3
			Justified for development	1	1.3	1,2,3
	Potential future recovery by contingent development projects or mining operations	Potentially Commercial Projects	Development Pending	2	2.1	1,2,3
			Development on hold	2	2.2	1,2,3
	Potential future recovery by contingent development projects or mining operations	Non-Commercial Projects	Development Unclarified	3.2	2.3	1,2,3
			Development not Viable	3.3	2.3	1,2,3
	Additional quantities in place associated with known deposits			3.3	4	1,2,3
	Potential future recovery by successful exploration activities	Exploration Projects		3.2	3	4
	Additional quantities in place associated with potential deposits			3.3	4	4

# G refers to level of geological knowledge and confidence

Category	Definition
G 1	Quantities associated with a known deposit that can be estimated with a <b>high level of confidence</b> .
G 2	Quantities associated with a known deposit that can be estimated with a <b>moderate level of confidence</b> .
G 3	Quantities associated with a known deposit that can be estimated with a <b>low level of confidence</b> .
G 4	Estimated quantities associated with a potential deposit, based <b>primarily on indirect evidence</b> .

Specific requirements for “high”, “moderate” and “low” levels of are determined by the evaluator based on specifications and guidelines applicable for each mineral deposit/ commodity type.

# Project Feasibility

Category	Definition
F 1	Feasibility of extraction by a defined development project or mining operation has been <b>confirmed</b> .
F 2	Feasibility of extraction by a defined development project or mining operation is <b>subject to further evaluation</b> .
F 3	Feasibility of extraction by a defined development project or mining operation <b>cannot be evaluated due to limited technical data</b> .
F 4	<b>No development project or mining operation</b> has been identified.

# F – Sub-category

Category	Definition
F 1.1	Extraction is <b>currently taking place</b> .
F 1.2	Capital funds have been <b>committed</b> and implementation of the development project or mining operation is <b>underway</b> .
F 1.3	Sufficiently <b>detailed studies have been completed</b> to demonstrate the feasibility of extraction by implementing a defined development project or mining operation.
F 2.1	Project activities are <b>ongoing</b> to justify development in the foreseeable future.
F 2.2	Project activities are <b>on hold</b> and/or where justification as a commercial development may be <b>subject to significant delay</b> .
F 2.3	There are <b>no current plans</b> to develop or to acquire additional data at the time due to limited potential.

# E - Socio-economics

Category	Definition
E 1	Extraction and sale has been <b>confirmed</b> to be economically viable.
E 2	Extraction and sale is expected to become economically viable in the <b>foreseeable future</b> .
E 3	Extraction and sale is <b>not expected</b> to become economically viable in the foreseeable future or evaluation is at <b>too early</b> a stage to determine economic viability.

The phrase “economically viable” encompasses economic (in the narrow sense) plus other relevant “market conditions” and includes considerations such as prices, costs, legal/fiscal framework, environmental, social and all other non-technical factors that could directly impact the viability of a development project.

# E - Sub-categories

Sub -Category	Definition
E 1.1	Extraction and sale is <b>economic</b> on the basis of current market conditions and realistic assumptions of future market conditions.
E 1.2	Extraction and sale is not economic on the basis of current market conditions and realistic assumptions of future market conditions, but is made viable through <b>government subsidies and/or other considerations.</b>
E 2	
E 3.1	Quantities that are forecast to be extracted, but which will <b>not be available for sale.</b>
E 3.2	Economic viability of extraction <b>cannot yet be determined</b> due to insufficient information (e.g. during the exploration phase).
E 3.3	On the basis of realistic assumptions of future market conditions, it is currently considered that there are <b>not reasonable prospects</b> for economic extraction and sale in the foreseeable future.

Exploration Project's socio-economic viability is yet to be determined, feasibility studies need further data acquisition and estimation is based primarily on indirect evidence

Category	Definition <sup>b</sup>	Supporting Explanation <sup>c</sup>
E3	Extraction and sale is not expected to become economically viable in the foreseeable future or evaluation is at too early a stage to determine economic viability. <sup>d</sup>	On the basis of realistic assumptions of future market conditions, it is currently considered that there are not reasonable prospects for economic extraction and sale in the foreseeable future; or, economic viability of extraction cannot yet be determined due to insufficient information (e.g. during the exploration phase). Also included are quantities that are forecast to be extracted, but which will not be available for sale.
F3	Feasibility of extraction by a defined development project or mining operation cannot be evaluated due to limited technical data.	Very preliminary studies (e.g. during the exploration phase), which may be based on a defined (at least in conceptual terms) development project or mining operation, indicate the need for further data acquisition in order to confirm the existence of a deposit in such form, quality and quantity that the feasibility of extraction can be evaluated.
G4	Estimated quantities associated with a potential deposit, based primarily on indirect evidence.	Quantities that are estimated during the exploration phase are subject to a substantial range of uncertainty as well as a major risk that no development project or mining operation may subsequently be implemented to extract the estimated quantities. Where a single estimate is provided, it should be the expected outcome but, where possible, a full range of uncertainty in the size of the potential deposit should be documented (e.g. in the form of a probability distribution). In addition, it is recommended that the chance (probability) that the potential deposit will become a deposit of any commercial significance is also documented.



Non-Commercial Project has no reasonable prospect in foreseeable future, feasibility is defined or needs further work, and quantities are estimated with high, moderate or low levels of confidence

Category	Definition <sup>b</sup>	Supporting Explanation <sup>c</sup>
E3	Extraction and sale is not expected to become economically viable in the foreseeable future or evaluation is at too early a stage to determine economic viability. <sup>d</sup>	On the basis of realistic assumptions of future market conditions, it is currently considered that there are not reasonable prospects for economic extraction and sale in the foreseeable future; or, economic viability of extraction cannot yet be determined due to insufficient information (e.g. during the exploration phase). Also included are quantities that are forecast to be extracted, but which will not be available for sale.
F2	Feasibility of extraction by a defined development project or mining operation is subject to further evaluation.	Preliminary studies demonstrate the existence of a deposit in such form, quality and quantity that the feasibility of extraction by a defined (at least in broad terms) development project or mining operation can be evaluated. Further data acquisition and/or studies may be required to confirm the feasibility of extraction.
G1	Quantities associated with a known deposit that can be estimated with a high level of confidence.	For in situ (in-place) quantities, and for recoverable estimates of fossil energy and mineral resources that are extracted as solids, quantities are typically categorised discretely, where each discrete estimate reflects the level of geological knowledge and confidence associated with a specific part of the deposit. The estimates are categorised as G1, G2 and/or G3 as appropriate.  For recoverable estimates of fossil energy and mineral resources that are extracted as fluids, their mobile nature generally precludes assigning recoverable quantities to discrete parts of an accumulation. Recoverable quantities should be evaluated on the basis of the impact of the development scheme on the accumulation as a whole and are usually categorised on the basis of three scenarios or outcomes that are equivalent to G1, G1+G2 and G1+G2+G3.
G2	Quantities associated with a known deposit that can be estimated with a moderate level of confidence.	
G3	Quantities associated with a known deposit that can be estimated with a low level of confidence.	

Potentially Commercial Project has reasonable prospects in foreseeable future, preliminary feasibility studies are good and quantities are estimated with high, moderate or low levels of confidence

Category	Definition <sup>b</sup>	Supporting Explanation <sup>c</sup>
E2	Extraction and sale is expected to become economically viable in the foreseeable future. <sup>d</sup>	Extraction and sale has not yet been confirmed to be economic but, on the basis of realistic assumptions of future market conditions, there are reasonable prospects for economic extraction and sale in the foreseeable future.
F2	Feasibility of extraction by a defined development project or mining operation is subject to further evaluation.	Preliminary studies demonstrate the existence of a deposit in such form, quality and quantity that the feasibility of extraction by a defined (at least in broad terms) development project or mining operation can be evaluated. Further data acquisition and/or studies may be required to confirm the feasibility of extraction.
G1	Quantities associated with a known deposit that can be estimated with a high level of confidence.	For in situ (in-place) quantities, and for recoverable estimates of fossil energy and mineral resources that are extracted as solids, quantities are typically categorised discretely, where each discrete estimate reflects the level of geological knowledge and confidence associated with a specific part of the deposit. The estimates are categorised as G1, G2 and/or G3 as appropriate.  For recoverable estimates of fossil energy and mineral resources that are extracted as fluids, their mobile nature generally precludes assigning recoverable quantities to discrete parts of an accumulation. Recoverable quantities should be evaluated on the basis of the impact of the development scheme on the accumulation as a whole and are usually categorised on the basis of three scenarios or outcomes that are equivalent to G1, G1+G2 and G1+G2+G3.
G2	Quantities associated with a known deposit that can be estimated with a moderate level of confidence.	
G3	Quantities associated with a known deposit that can be estimated with a low level of confidence.	

# Commercial Project is economically viable, feasibility confirmed and quantities are estimated with high, moderate or low levels of confidence

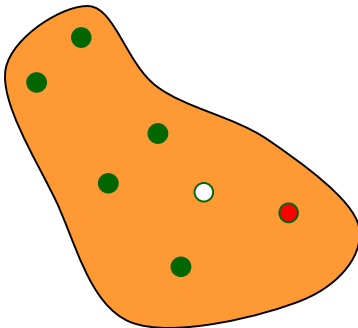
Category	Definition <sup>b</sup>	Supporting Explanation <sup>c</sup>
E1	Extraction and sale has been confirmed to be economically viable. <sup>d</sup>	Extraction and sale is <u>economic</u> on the basis of current market conditions and realistic assumptions of future market conditions. All necessary approvals/contracts have been confirmed or there are reasonable expectations that all such approvals/contracts will be obtained within a reasonable timeframe. Economic viability is not affected by short-term adverse market conditions provided that longer-term forecasts remain positive.
F1	Feasibility of extraction by a defined development project or mining operation has been confirmed.	Extraction is currently taking place; or, implementation of the development project or mining operation is underway; or, <u>sufficiently detailed studies</u> have been completed to demonstrate the feasibility of extraction by implementing a defined development project or mining operation.
G1	Quantities associated with a known deposit that can be estimated with a high level of confidence.	For in situ (in-place) quantities, and for recoverable estimates of fossil energy and mineral resources that are extracted as solids, quantities are typically categorised discretely, where each discrete estimate reflects the level of geological knowledge and confidence associated with a specific part of the deposit. The estimates are categorised as G1, G2 and/or G3 as appropriate.  For recoverable estimates of fossil energy and mineral resources that are extracted as fluids, their mobile nature generally precludes assigning recoverable quantities to discrete parts of an accumulation. Recoverable quantities should be evaluated on the basis of the impact of the development scheme on the accumulation as a whole and are usually categorised on the basis of three scenarios or outcomes that are equivalent to G1, G1+G2 and G1+G2+G3.
G2	Quantities associated with a known deposit that can be estimated with a moderate level of confidence.	
G3	Quantities associated with a known deposit that can be estimated with a low level of confidence.	

Additional Quantities in Place are not economically viable and in-situ quantities that will not be extracted and quantities are estimated with high, moderate or low levels of confidence

E3	Extraction and sale is not expected to become economically viable in the foreseeable future or evaluation is at too early a stage to determine economic viability. <sup>d</sup>	On the basis of realistic assumptions of future market conditions, it is currently considered that there are not reasonable prospects for economic extraction and sale in the foreseeable future; or, economic viability of extraction cannot yet be determined due to insufficient information (e.g. during the exploration phase). Also included are quantities that are forecast to be extracted, but which will not be available for sale.
F4	No development project or mining operation has been identified.	In situ (in-place) quantities that will not be extracted by any currently defined development project or mining operation.
G1	Quantities associated with a known deposit that can be estimated with a high level of confidence.	For in situ (in-place) quantities, and for recoverable estimates of fossil energy and mineral resources that are extracted as solids, quantities are typically categorised discretely, where each discrete estimate reflects the level of geological knowledge and confidence associated with a specific part of the deposit. The estimates are categorised as G1, G2 and/or G3 as appropriate.  For recoverable estimates of fossil energy and mineral resources that are extracted as fluids, their mobile nature generally precludes assigning recoverable quantities to discrete parts of an accumulation. Recoverable quantities should be evaluated on the basis of the impact of the development scheme on the accumulation as a whole and are usually categorised on the basis of three scenarios or outcomes that are equivalent to G1, G1+G2 and G1+G2+G3.
G2	Quantities associated with a known deposit that can be estimated with a moderate level of confidence.	
G3	Quantities associated with a known deposit that can be estimated with a low level of confidence.	

# Project 1 Background

- **Geology**
  - Well understood sandstone in a deepwater environment
  - in recovery is well understood, and all values given for estimates are best estimates
- **Feasibility**
  - 5 wells producing from 7 well programme (all 7 will contribute equal volumes)
  - 1 junked well – evaluating repair or sidetrack
  - 1 yet to be drilled
  - Injection facilities start-up delayed 1 year
  - Infill drilling being evaluated
  - An enhanced oil recovery project has been proposed, but has significant technical barriers
- **Socio – Economics**
  - All government contracts and approvals are in place
  - Existing production scheme is in place with no minimal environmental impact and good community support



Project	Volume
Primary Recovery	42
Waterflood Recovery	95
Infill Drilling	15
LoSal Waterflood EOR	15

# Project 1 Solution

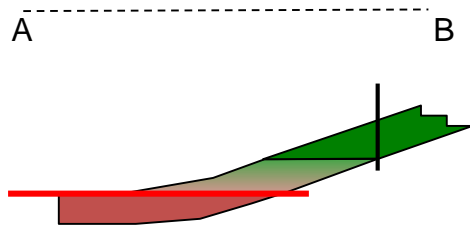
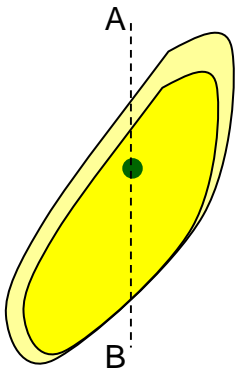
- Primary: What is split of developed by well?
  - $5/7 * 42 = 30$
- Primary: What is value of junked well? What is cost of repair? Is cost sanctioned?
  - $1/7 * 42 = 6$
- Primary: What is value of last well?
  - $1/7 * 42 = 6$
- Waterflood: Impact of junked well on WF?
  - 95
- Infill: is this Justified yet?
  - assume not:15
- LoSal: is this being progressed?
  - assume a barrier: 15

# Project 1 Solution

Project	E	F	G	Class / Sub-Class	Quantity in mmboe	PRMS
Primary 5 producing wells	1.1	1.1	1+2	On Production	30	On Production - Producing
Primary well repair	1.1	1.1	1+2	On Production	6	On Production – Not Producing
Primary undrilled well	1.1	1.2	1+2	Approved for Development	6	Approved for Development
Waterflood recovery	1.1	1.2	1+2	Approved for Development	95	Approved for Development
Infill Drilling	2	2.1	1+2	Development Pending	15	Development Pending
LoSal EOR	3.2	2.2	1+2	Development Unclarified	15	Development Unclarified or on Hold

# Project 2 Background

- **Geology**
  - New discovery in appraisal
  - Seismic indicates an anomaly flatspot consistent with the spill point of the structure
- **Feasibility**
  - One discovery well with an oil down-to
  - Pressures in well consistent with regional aquifer trend and contact at spill-point
- **Socio-Economics**
  - Long tie-back opportunity, WF doesn't work without government license renewal



Project	Volume
Primary Recovery above LKH	20
Waterflood Recovery above LKH	55
Primary Recovery below LKH	10
Waterflood Recovery below LKH	22



# Project 2 Solution

- Primary:
  - Above and Below the LKH E1.1, F2.1
  - Above the LKH G1
  - Below the LKH G2
  
- Waterflood
  - Above and Below the LKH E2, F2.2
  - Above the LKH G1
  - Below the LKH G2

# Project 2 Solution

Project	E	F	G	Class / Sub-Class	Quantity in mmboe	PRMS
Primary above LKH	1.1	2.1	1	Development Pending	20	Development Pending – C1
Primary below LKH	1.1	2.1	2	Development Pending	10	Development Pending – C2
WF above LKH	2	2.2	1	Development On Hold	55	Development unclarified or on hold – C2
WF below LKH	2	2.2	2	Development On Hold	22	Development unclarified or on hold – C2

# Project 3 Background

- **Geology**
  - Nickel-sulphide mineralization hosted by serpentines; nickel is contained both in nickel sulphides and in silicates such as antigorite, olivine and pyroxene.
  - Extensive core drilling in 3 phases
  - 573 000 tonnes of total Nickel estimated with 0.179% grade. Out of this only 329 000 tonnes is estimated as sulphide nickel with 0.103% grade. This has a medium levels of confidence and very low geological complexity.
  - 20 000 tonnes of total nickel estimated with 0.166% grade. Out of this 10 000 tonnes of nickel is estimated as sulphide nickel with 0.004% grade. This is low confidence quantities estimated based on extension of the ore body approximately 50 m down dip of the last drillhole intersection on the section line.
- **Feasibility**
  - Preliminary Economic Assessment (PEA); proposing to undertake a pre-feasibility study
  - Open pit mining
  - Total ~ **70% recovery** (10% Mining losses and 20% Processing Losses)
  - Infrastructure good
- **Socio-Economics**
  - Exploration permit and exploitation concessions currently held.
  - Markets well developed
  - Social acceptance poor due to lack of engagement

# Project 3 Solution

Project	E	F	G	Class / Sub-Class	Quantity t Ni	CRIRSCO
Project 3	2	2.1	2	Potentially Commercial Project / Development Pending	230 300	Indicated Resources
	2	2.1	3	Potentially Commercial Project / Development Pending	7 000	Inferred Resources
				Total	<b>237 300</b>	
				Additional Quantities in Place	254 000 10 000 98 700 3 000 <b>365 700</b>	(silicate Ni lost) (silicate Ni lost) (losses in G2) (losses in G3) <b>(Total losses)</b>

# Project 4 Background

- Geology
  - Sandstone type deposit
  - Uraninite accounts for 80% of mineralization
  - Borehole spacing 50 x 50 m - estimated 10 000 tU @ 0.040 % U (recoverable confirmed by DFS )
  - Borehole spacing 100 mx 100 m – estimated 20 000 tU @ 0.040 % U (recoverable confirmed by DFS)
  - Quantities estimated outside ore boundary – 15 000 tU @ 0.035 % U (not considered in DFS)

[Quantities estimated at 50 x 50 m and 100 x 100 m are generally found to have high and moderate levels of confidence]
- Feasibility
  - Detailed Feasibility Study (DFS) completed
  - Mining method – Open pit
  - Process – Heap leaching
  - Total recovery – 75 % (10% mining loss; 15% processing loss)
  - Cost \$120/KgU
- Socio - economics
  - Markets available
  - All approvals and licenses in place
  - Social acceptance confirmed through public hearing; CSR programme in place
  - Awaiting further investment decision

# Project 4 Solution

Project	E	F	G	Class / Sub-Class	Quantity in tU (%U)	CRIRSCO
Project 4 a	1.1	1.3	1	Commercial project / Justified for development	10 000 (0.040)	Proved Reserves
	1.1	1.3	2	Commercial project / Justified for development	20 000 (0.040)	Reserves
Project 4 b	2	2.1	3	Potentially Commercial Project / Development Pending	11 250 (0.035)	Inferred resources
	3	4	2,3	Additional quantities in place	11 250 (0.035)	Discovered Unrecoverable