Section Five

Project Justification and Alternatives

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5.1 Project Justification

5.1.1 Market Demand and Supply

A review of the current nuclear energy industry and its response to the events at the Fukushima-Daiichi nuclear power plant in Japan that occurred as a result of the March 2011 earthquake and tsunami is presented in Section 2.4. A discussion of market demand and supply of uranium is discussed below.

There are currently 433 nuclear reactors operating throughout the world with a combined electricity output of around 2,500 TWh per annum, consuming just under 68,000 tonnes per annum (tpa) of UOC (www.world-nuclear.org/info/reactors.html accessed July 2012).

As a result of the high capital costs and low operating costs of nuclear electricity generation, it is cost-effective to keep existing nuclear power stations operating at high capacities, with changes in load to meet local electricity demand largely being met by the fossil fuel electricity generators. Therefore, the demand for uranium is largely isolated from economic variations, and more dependent on installed capacity. There are currently 64 nuclear reactors under construction, 160 ordered or planned and 329 proposed (www.world-nuclear.org/info/reactors.html accessed July 2012). In the short-term, uranium demand is expected to increase by around 33% in the period 2010-2020, then 16% between 2020-2030 (World Nuclear Association, 2012).

Approximately 65% of the demand for uranium is supplied from mines with the remainder supplied from stockpiles or other secondary sources, including recycled uranium and plutonium from spent nuclear fuel; re-enriched uranium tails; and decommissioned weapons-grade uranium and plutonium.

Australia currently supplies around 15.7% of world uranium demand (World Nuclear Association, 2012), and has approximately 31% (1.7 Mt) of the world's known recoverable resources of uranium, which total around 5.4 Mt (Table 5-1).

Table 5-1: Known recoverable resources of uranium 2009

Country	Tonnes of Uranium	Percentage of World
Australia	1,673,000	31%
Kazakhstan	651,000	12%
Canada	485,000	9%
Russia	480,000	9%
South Africa	295,000	5%
Namibia	284,000	5%
Brazil	279,000	5%
Niger	272,000	5%
USA	207,000	4%
China	171,000	3%
Jordan	112,000	2%
Uzbekistan	111,000	2%
Ukraine	105,000	2%
India	80,000	1.5%
Mongolia	49,000	1%
Other	150,000	3%
World Total	5,404,000	100%

Note: Reasonably Assured Resources plus Inferred Resources, to US$ 130/kg U, 1/1/09, from OECD NEA & IAEA, Uranium 2009: Resources, Production and Demand.

Whilst the events of 2011 saw the reduction in global consumption of uranium, the industry also faced a number of production challenges (Section 2.4). Cameco estimates 2011 global production was 143 million pounds (64,860 tonnes), about 5% below the original estimate. By 2021, Cameco expects world uranium consumption to be about 230 million pounds (104,330 tonnes) per year, based on an average growth rate of about 3%.

5.1.2 Project Benefits

In addition to meeting a growing market need for uranium as fuel for electricity generation, the Project would provide economic, employment-related, infrastructure-related and broader environmental benefits, described in more detail in the following sections.

5.1.2.1 Economic Benefits

The Project would generate wealth for the local region, Western Australia and Australia through employment, the purchase of goods and services locally and through the export of UOC. Royalties from the sale of UOC would also be collected by the Western Australian Government. It is expected that the Indigenous Land Use Agreement negotiated with the Martuwill result in significant local economic benefit, including community and business development.

The Project would generate up to 400 direct jobs during the construction phase, and support up to 450 direct jobs during operations. A number of temporary (during the construction phase) and permanent (during operations) indirect jobs would also be created within Western Australia and Australia. Many of these jobs would provide economic benefit to local and regional communities. The Project would provide employment and development opportunities for the Martuin proximity to their existing communities, enabling participation in business and employment enterprises while continuing to live in local communities.

5.1.2.2 Infrastructure

The development of the Project would contribute to infrastructure development in the East Pilbara region. The construction of 90 km of road would provide an upgraded transport route through the region providing better access for local communities and making the area more accessible for mineral exploration and tourism.

5.1.2.3 Environmental

The UOC produced by the Project will be used in electricity generation overseas. The generation of electricity using uranium produces zero greenhouse gas emissions and could offset emissions that would otherwise occur should the same amount of electricity be generated using traditional fossil fuel energy mixes.

Globally, the nuclear energy industry is the only energy-producing industry which takes responsibility for managing all its wastes, as well as fully costing this into the production of nuclear-generated electricity. In all countries using nuclear energy there are well established procedures for storing, managing and transporting such wastes, funded from electricity tariffs. Wastes are contained and managed and are not released to the environment. Storage is safe and secure with long-term plans for eventual disposal (www.world-nuclear.org/reference/position_statements/waste.html accessed July 2012).

5.1.3 Consequences of Not Proceeding

The consequences of not proceeding with the Project at this time are the loss of the potential benefits listed above if it were cancelled indefinitely, or a delay in achieving the potential benefits should the Project be deferred.

5.2 Project Alternatives

In accordance with its corporate risk management standards and International Standards Organisation (ISO) risk management standards, Cameco followed a methodical approach to the investigation of alternatives that considered health, safety, environmental, social and economic factors, before determining a preferred alternative.

A summary of the major project alternatives considered is presented in Table 5-2 and the reasoning for selecting the preferred alternative and rejecting other options, is presented in the following sections.

5.2.1 Mining Method

Section 6.3 describes the proposed mining methodology in detail. The sections below outline the alternatives considered and the reasons for selecting the preferred methodology.

5.2.1.1 Underground Mining

The use of underground mining methods for the extraction of the ore from the deposit was not selected because of the shallow nature of parts of the orebody. Underground mining is not technically feasible for some of these near-surface deposits, and would, if employed for the slightly deeper deposits, result in partial sterilisation of these shallow sections of the orebody, reducing overall ore yields.

Underground mining may be considered in the future, as there are some parts of the orebody that extend beyond the depth of the proposed open pit. If these were to be mined using open pit techniques it would require the movement of large volumes of non-mineralised overburden. However, underground mining is not being considered as part

Table 5-2: Key project alternatives investigated

Note: Bold indicates preferred alternative

Element	Alternatives investigated
Mining	**Single open pit**
	Several open pits
	Underground
	In-situ recovery
Waste rock landform (WRL)	**Above-ground WRL with partial backfilling of pit**
	Single above-ground WRL
	Backfilling of waste rock to the pit
Management of mineralised overburden	**Separate stockpile with any remaining encapsulated at end of mine life**
	Disposal to WRL
Metallurgical processing	**Acid leach**
	Alkaline pressure leach
	Alkaline atmospheric leach
	Acid or alkaline heap leach
	Extraction of other minerals
Tailings disposal	**Above-ground slurried tailings to a paddock-style TMF integrated into the WRL**
	Above-ground dry stacks (with or without co-location)
	Above-ground co-disposed with waste rock
	In-pit disposal of dry or slurried tailings
	Above-ground slurry tailings (un-neutralised)
Energy supply	**Diesel-fired on-site electricity generation**
	On-site gas-fired electricity generation via a gas pipeline
	Access to an existing electricity transmission network
	Renewable electricity
Site access and general transport	**Access via the Telfer and Kintyre Roads**
	Access via the Talawana Track
	Use of the Marble Bar to Newman Road
UOC transport	**Export of UOC via the Port of Adelaide**
	Export of UOC via the Port of Darwin
	Export of UOC via Western Australian ports
Workforce	**Fly-in/fly-out workforce**
	Residential workforce
	Drive-in/drive-out workforce
Accommodation location	**New accommodation village**
	Expansion of the existing exploration accommodation

of this Project and approvals for the development of an underground mining operation would be sought separately if required.

5.2.1.2 Open Pit Mining with Separate Pits

As there are five distinct ore deposits, the option of mining them in a series of separate, isolated pits was investigated. This was ultimately rejected as reaching the deeper elements of the deposits would require that the pits overlap each other. This would present difficulties in mine planning and operation that would lead to the sterilisation of a larger proportion of the ore, making this option less economically attractive.

5.2.1.3 In-situ Leach

In-situ recovery extraction methods were initially investigated. However, unfavourable geochemical and geological factors, such as the stratigraphic placement of the ore body that make containment and recovery of leach solutions difficult, render this methodology technically unfeasible.

5.2.1.4 Preferred Method: Single Open Pit

A single open pit was selected predominantly to maximise the economic return for the Project by maximising uranium-bearing ore recovery.

As the open pit progresses from west to east, the orebody will become deeper, and the volume of non-mineralised overburden requiring removal increases significantly. Selective mining techniques have been adopted to minimise the dilution of ore and the potential to mix non-mineralised overburden with uranium-bearing material. This will result in improved mining efficiencies, less mineralised overburden requiring disposal and smaller environmental impacts associated with the development of the Waste Rock Landform and the integrated TMF.

5.2.2 Waste Rock Landform

Section 6.3.4 describes the proposed WRL construction and operation. The sections below outline the alternatives considered and the reasons why this methodology is preferred over other potential disposal methods.

5.2.2.1 Backfill of Waste Rock to Open Pit

The backfilling of non-mineralised overburden to the pit was considered. Progressive backfilling of the whole pit was not pursued as this would result in significant logistical and mine-planning issues associated with the excavation of material from the pit, resulting in the need for a temporary above-ground storage facility. Backfilling the pit from this temporary stockpile would necessitate significant re-handling. Additionally, the backfilling of the whole open pit would result in the sterilisation of a potential future resource by removing future opportunities to extend the mine-life through either open cut or underground mining expansion.

5.2.2.2 Preferred Method: Above-ground WRL with Partial Backfilling of Pit

Partial backfilling of the pit with 23 Mt of non-mineralised overburden is proposed in a manner which will not sterilise future resources, constrain pit development during operations or require significant rehandling of the material. The remaining overburden will be placed in an engineered above-ground WRL. The WRL would ultimately store around 119 Mt of non-mineralised material over the life-of-mine and as far as practicable, be designed to blend into the surrounding landscape.

5.2.3 Mineralised Overburden Management

Section 6.3 describes the proposed management strategy for mineralised overburden. The sections below outline the alternatives considered and the reasons why this methodology is preferred over other management methods.

5.2.3.1 Disposal of Mineralised Overburden

The disposal of mineralised overburden to the WRL was considered. However, dependent on market economics it may become viable to process this material in the future. This material could also be used to blend with high grade ore to achieve consistent mineral grade fed to the process plant.

5.2.3.2 Preferred Method: Separate Stockpile

The preferred management strategy for mineralised overburden is to develop an engineered separate stockpile suitable for the storage of up to 6 Mt of material with an average uranium grade of 500 ppm U_3O_8. This material would be selectively extracted during the excavation of ore, and would be directed to the mineralised overburden stockpile, should the truck radiometric analyser suggest that it is below ore-grade material.

The mineralised overburden stockpile would have controls appropriate to manage the environmental risk associated with dust generation, rainfall infiltration and run off and seepage. This material may be fed through the mill on an opportunistic basis during the life-of-mine, or blended with high grade ore as necessary to maintain a suitable uranium grade to the mill. At the end of the life-of-mine any remaining mineralised overburden that was not considered economically viable to process, would be encapsulated within the WRL prior to rehabilitation.

5.2.4 Metallurgical Processing

Section 6.4 describes the proposed metallurgical process in detail. The alternatives considered and the selected methodologies are discussed below.

5.2.4.1 Alkaline Pressure Leaching

Two proven metallurgical processes, alkaline pressure leaching and acid leaching, were considered in significant detail by Cameco. With similar capital and operating costs, both methods were considered economically viable. Alkaline pressure leaching is not the preferred option as it ultimately delivers lower uranium recoveries and uses less conventional extraction technologies that represent a greater business risk to the Project. The process also requires approximately 25% more power than the acid leach option. The alkaline pressure leaching process is more complex, resulting in potential issues associated with maintainability and operability and the potential for lower plant availability.

5.2.4.2 Atmospheric Leaching

Atmospheric alkaline leaching was dismissed as a feasible method for uranium extraction due to its higher capital cost and lower uranium recoveries.

5.2.4.3 Heap Leach

Heap leaching of the whole-of-ore would deliver significantly lower recoveries than acid or alkaline leaching, and therefore wasn't considered economically viable. The heap leaching of mineralised overburden may represent an opportunity to enhance the value of the operation in later years, and this option would be reviewed in the future. However, heap leaching is not being considered as part of this Project and approvals would be sought separately should Cameco decide to pursue this option.

5.2.4.4 Extraction of Other Minerals

Uranium mineralisation occurs predominantly as massive and finely disseminated uraninite and coffinite. The mineralogy of the tailings is dominated by quartz and chlorite, and the quantity of elements such as gold and rare earths are not sufficient to justify consideration as by-products.

5.2.4.5 Preferred Method: Acid Leach

A conventional acid leaching and solvent extraction circuit is proposed to be used to treat the ore extracted from the open pit mine. This methodology delivers greater uranium recoveries at lower overall cost and technological risk to the Project.

5.2.5 Tailings Disposal

Section 6.4.4 describes the proposed tailings storage methodology in detail. The options for tailings disposal considered include various combinations of co-location, co-disposal and dry stack processes. The Integrated Waste Landform-Tailings Management Facility (IWL-TMF) refers to building the tailings containment within the waste rock landform. Co-disposal of tailings refers to the disposal of tailings with waste rock to a facility with a single common footprint, using tailings to fill the pore spaces in the WRL. Dry stack tailings are produced by filtering tailings slurry to extract liquor and yield tailings which can be disposed of in a solid form. This section describes why the IWL-TMF above-ground neutralised slurried tailings disposal is preferred over other potential disposal and storage methods.

5.2.5.1 Above-ground Dry-stacked, with and without Co-location

Dry stacked tailings were not preferred for acid process tails as the particle size of ground material is not conducive to this form of engineered control. It is also considered to represent an increased radiation exposure risk from dust when compared to slurried tailings where a wet cover can be maintained to reduce radon emanation.

5.2.5.2 Above-ground Co-disposal with Waste Rock

Above-ground co-disposal presented operational issues with regards to the blending or placement of tailings on an active waste rock stockpile face, resulting in potential geotechnical issues related to stockpile stability and an increase in environmental risk associated with dust generation and surface water management.

5.2.5.3 In-pit Disposal of Dry or Slurry Tailings

The backfilling of dry or slurry tailings to the pit was considered. This option was not progressed, primarily because the progressive backfilling of material to the pit would result in significant logistical and mine-planning issues and sterilise a potential future resource. Handling of dry tailings could also result in additional dust generation and radon emissions.

5.2.5.4 Above-ground Slurried Tailings (Not Neutralised)

The disposal of non-neutralised (acidic) tailings was not considered due to the potential for increased environmental impact through interaction with acidic liquor.

5.2.5.5 Preferred Method: Above-ground Neutralised Slurried Tailings

The preferred tailings disposal method is to dispose of neutralised slurried tailings to a double-lined above-ground facility with a seepage collection system. Non-mineralised overburden would be used to construct the IWL-TMF and act as a structural shell for the facility. The IWL-TMF would be constructed and operated, with the tailings surface kept moist to minimise radon emanation and dust generation. This IWL-TMF tailings disposal methodology is commonly used and understood, representing less technological and operability risk. It provides benefits including, reductions in waste handling, enhanced aesthetics and amenity and the benefit of long term stability post closure by storing often erosive tailings material within a waste landform.

5.2.6 Electricity Supply

Section 6.6 describes the proposed electricity supply in detail. The sections below outline the alternatives that were considered and why the preferred option was selected.

5.2.6.1 On-site Gas-fired Generation via a Gas Supply Pipeline from Telfer or Newman

On-site gas-fired electricity generation was discounted because of the lack of certainty surrounding the availability of gas within the existing gas supply network. Currently most of the capacity of the Telfer Gas Pipeline is used by foundation customers under long-term contracts, with demand amongst these customers likely to increase in future. Discussions with relevant stakeholders regarding access to gas have not sufficiently progressed to present this as a viable option in this ERMP. At this stage the option appears also to be economically unviable for the current mine life.

Dual-fired generators (capable of operation on either diesel or gas) may be installed and should a secure and economically viable gas supply become available in the future, gas-fired generation may be reconsidered.

5.2.6.2 Connection to an Existing Electricity Network

Network-based electricity is available in the Pilbara via the Horizon Power North West Interconnected System (NWIS). Alinta operates a private electricity generation station in Newman (260 km south west), with distribution to customers managed via BHP Billiton. However, the nearest connection point would be too distant, and the electricity demand of the proposed operation too low for it to be economically viable to construct transmission lines to service the Project. Additionally, the installation of these transmission line corridors would necessitate a significant increase in disturbance footprint.

5.2.6.3 Renewable Electricity

Renewable energy in the form of solar-generated electricity was considered during the development of the pre-feasibility study. This was ultimately discounted as a primary power supply due to the need to have back-up electricity in the event that insufficient solar-generated electricity was available (e.g. on overcast days or during night time hours) and thus was not economically viable. Small scale solar installations may be used for the provision of hot water and to meet smaller or more isolated electrical demands including production wells and at the proposed airport. The current air quality monitoring network is solar powered.

5.2.6.4 Preferred Method: Diesel-fired On-site Electricity Generation

The demand of around 8 MW, equating to a consumption of around 70,000 MWh per annum, would be met through on-site generators, with a local supply network established to provide electricity to the processing plant, groundwater abstraction wells and the accommodation village. This will require the transport of diesel to site and storage of diesel on-site. Cameco will have appropriate management measures in place to minimise the risk of spills as outlined in the Chemical and Fuel Storage Management Plan (Appendix D1).

5.2.7 Road Access and General Transport

A number of options for site access and general transport to and from site were considered for the Project and are discussed below.

Access to the site from Newman in the south via the Talawana Track through the Karlamilyi National Park was considered as an option for permanent access to the site (Figure 2-1). It was determined that the route would require significant upgrading and the option was dismissed following consultation with the DPaW. DPaW indicated it would prefer to retain a less developed track through Karlamilyi National Park to minimise the potential impacts on the park. As a result, this route is considered unsuitable for heavy haulage. However, Cameco will work co-operatively with DPaW to maintain the National Park road for light vehicle access only (e.g. for personnel transport). Any changes to the track through the National Park will be managed by the DPaW and is not part of this Project.

5.2.7.1 Use of the Marble Bar to Newman Road

The use of the Marble Bar to Newman Road was considered as it is more direct than the route via Port Hedland to Newman. However, this section of the road is unsealed and therefore may restrict access to the site during unfavourable weather. Should the Marble Bar to Newman Road be upgraded before Cameco commences production, this route may be considered further. Similarly, should a new road from Wiluna to the Meekatharra to Newman Road be constructed, this may also be considered as an alternative to the current proposed route.

5.2.7.2 Preferred Route: Great Northern Highway via Port Hedland, then via Marble Bar and Telfer

General transport of materials to and from site would be along the heavy haulage route via Port Hedland and the Great Northern Highway. Site access would be provided through the existing Telfer Road from Marble Bar to Telfer, and the upgraded Kintyre Road between Telfer and the Project site.

Several alternative routes for the section of the access road between Telfer and Kintyre were considered and the preferred route was selected to avoid mining leases around Telfer and environmental, cultural and engineering constraints.

5.2.8 Uranium Oxide Concentrate Transport

Section 6.9.3 describes the proposed UOC transport arrangements in detail. The sections below outline the alternatives considered and justification for selection of the preferred route.

5.2.8.1 Export of UOC through Darwin

The transport of UOC by road via Port Hedland and Kununurra to Darwin for export via the Port of Darwin was considered. However, Cameco believes that the frequency of export vessels and lack of established infrastructure makes this port less favourable. Additionally, many of the roads in the Kimberley region and Northern Territory become impassable during the wet season, potentially limiting the ability to deliver product to the export port. Cameco will maintain awareness of shipping schedules and infrastructure in Darwin and would seek additional approvals for export via Darwin if this option became more viable.

5.2.8.2 Export of UOC through Western Australian Ports

The export of UOC from Western Australian ports is currently prohibited by the Western Australian Government.

5.2.8.3 Preferred Route: Port of Adelaide via Port Hedland and Kalgoorlie

UOC would be transported by road from the Kintyre site to Kalgoorlie, then via road to Adelaide for export from the Port of Adelaide as described in Section 6.9.3. The option to transport UOC by rail from Kalgoorlie was considered but is currently restricted by the lack of a suitable intermodal facility at Kalgoorlie to handle UOC containers. Should such a facility be developed near Kalgoorlie, then rail transport from Kalgoorlie may be considered as an option in the future.

Figure 5-1: Transport options considered for the Project

5.2.9 Workforce

5.2.9.1 Residential Workforce

The establishment of a residential community at Kintyre would be prohibitively expensive given the relatively short mine life, and the remote location would mean that the provision of basic permanent services would be challenging.

5.2.9.2 Drive-in-drive-out Workforce

Establishing a drive-in-drive-out workforce was discounted due to the remoteness of the site and size of the proposed workforce. It is unlikely that sufficient skilled personnel would be available in the nearest towns (Newman and Port Hedland) and local communities. The workforce would, however, have a partial drive-in-drive-out component from these towns and Aboriginal communities within a reasonable driving distance of the Project.

5.2.9.3 Preferred Alternative: Predominantly fly-in-fly-out Workforce

The proposed workforce would predominantly be fly-in-fly-out from Perth with some drive-in-drive-out from nearby regional centres. The workforce would be accommodated on-site during their roster.

5.2.10 Infrastructure location

5.2.10.1 Expansion of Existing Exploration Camp

The existing exploration camp location is considered unsuitable for the long-term accommodation of the workforce due to its proximity to the proposed mining and processing operations. This camp would, however, be maintained in a serviceable condition and would be used as overflow accommodation for periods of high workforce demand such as during construction and plant shutdowns.

5.2.10.2 Preferred Option: Establishment of a New Accommodation Village

A new accommodation village of around 250 rooms would be established to the south of the operation, and would include a mess, wet mess, ablution, recreation, laundry and medical facilities.

5.3 Customers

The uranium that Cameco produces is used exclusively to produce fuel for the generation of electricity at nuclear power stations. Cameco currently exports 49% of its product to utilities in the Americas (US, Canada and Latin America), 30% to European customers and 21% to utilities in the Far East.

Exports of UOC from Kintyre would be subject to the terms of Australia’s international agreements and export controls including the safeguards and verification measures of the International Atomic Energy Agency. UOC from Kintyre would be shipped outside the country for processing to nuclear fuel at permissible facilities of the customer’s choice.