CAMECO CORP
Form 6-K
March 24, 2017
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UNITED STATES

SECURITIES AND EXCHANGE COMMISSION

Washington, DC 20549

FORM 6-K

Report of Foreign Private Issuer

Pursuant to Rule 13a-16 or 15d-16

Under the Securities Exchange Act of 1934

For the month of March, 2017

Cameco Corporation

(Commission file No. 1-14228)

2121-11th Street West

Saskatoon, Saskatchewan, Canada S7M 1J3

(Address of Principal Executive Offices)

Indicate by check mark whether the registrant files or will file annual reports under cover Form 20-F or Form 40-F.

Form 20-F Form 40-F

Indicate by check mark whether the registrant by furnishing the information contained in this Form is also thereby furnishing the information to the Commission pursuant to Rule 12g3-2(b) under the Securities Exchange Act of 1934.

Yes No

If Yes is marked, indicate below the file number assigned to the registrant in connection with Rule 12g3-2(b):

Exhibit Index

Exhibit No.	Description	Page No.
1.	Press Release dated March 23, 2017	
2.	Inkai Technical Report dated March 23, 2017	

SIGNATURE

Pursuant to the requirements of the Securities Exchange Act of 1934, the registrant has duly caused this report to be signed on its behalf by the undersigned, thereunto duly authorized.

Date: March 24, 2017

Cameco Corporation

By:

Sean A. Quinn

Sean A. Quinn
Senior Vice-President, Chief Legal Officer and

Corporate Secretary

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TSX: CCO **website:** cameco.com

NYSE: CCJ **currency:** Cdn (unless noted)

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Cameco Reports Document Filings

Saskatoon, Saskatchewan, Canada, March 23, 2017 . . . .

Cameco (TSX: CCO; NYSE: CCJ) reported today that it filed its annual report on Form 40-F with the US Securities and Exchange Commission. The document includes Cameco s audited annual financial statements for the year ended December 31, 2016, its management s discussion and analysis (MD&A), and its Canadian annual information form (AIF).

In addition, Cameco filed with Canadian securities regulatory authorities its AIF. Its audited annual financial statements for the year ended December 31, 2016, and its MD&A were filed with Canadian securities regulatory authorities in February 2017.

Cameco also filed a technical report for the Inkai operation under Canadian Securities Administrators National Instrument 43-101.

All of these documents are posted on our website. Shareholders may obtain hard copies of these documents, including the financial statements, free of charge by contacting:

Cameco Investor Relations

2121 11th Street West

Saskatoon, SK S7M 1J3

Phone: (306) 956-6340

On April 7, 2017, Cameco plans to post on its website the management proxy circular that is being distributed to shareholders of record as of March 14, 2017 for its annual meeting of shareholders on May 11, 2017.

Profile

Cameco is one of the world s largest uranium producers, a significant supplier of conversion services and one of two CANDU fuel manufacturers in Canada. Our competitive position is based on our controlling ownership of the world s largest high-grade mineral reserves and low-cost operations. Our uranium products are used to generate clean electricity in nuclear power plants around the world. We also explore for uranium in the Americas, Australia and Asia. Our shares trade on the Toronto and New York stock exchanges. Our head office is in Saskatoon, Saskatchewan.

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Inkai Operation

South Kazakhstan Oblast,

Republic of Kazakhstan

National Instrument 43-101

Technical Report

Effective Date: December 31, 2016

Date of Technical Report: March 23, 2017

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Units of Measure and Abbreviations

°C	Degrees Celsius
$	Canadian dollars
>	Greater than
<	Less than
%	Percent
a	Annum (year)
d	Day
g	Grams
GT	Grade multiplied by Thickness
h	Hour(s)
K	Thousand
km^2	Square kilometres
L	Litre
Lbs	Pounds
M	Million
m	Metres
$m\%U_3O_8$	Metres times percent uranium oxide
m/d	Metres per Day
mm	Millimetres
t	Tonnes (metric)
U	Uranium (1 tonne U = 2,599.8 Lbs U_3O_8)
%U	Percent uranium (%U x 1.179 = % U_3O_8)
U_3O_8	Uranium oxide (yellowcake)
$\%U_3O_8$	Percent uranium oxide ($\%U_3O_8$ x 0.848 = %U)
UF_6	Uranium hexafluoride

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1 Summary

Inkai is a material property for Cameco Corporation (Cameco) under Canadian securities laws.

This technical report has been prepared for Cameco by internal Qualified Persons (QP) in support of the disclosure of scientific and technical information relating to Inkai contained in Cameco s annual Management s Discussion and Analysis for the year ended December 31, 2016 filed with Canadian securities regulators on February 9, 2017, and Cameco s Annual Information Form and Form 40-F for the year ended December 31, 2016.

All monetary references in this technical report are expressed in Canadian dollars, unless otherwise indicated.

1.1 Operation overview

Inkai is an in-situ recovery (ISR) producing mine in the Central Asian Republic of Kazakhstan, made up of three contiguous licence blocks:

- Block 1 16.6 square kilometres
- Block 2 230 square kilometres
- Block 3 240 square kilometres

Inkai is owned and operated by Joint Venture Inkai Limited Liability Partnership (JV Inkai), an entity which is owned by Cameco (60%) and Joint Stock Company National Atomic Company Kazatomprom (Kazatomprom) (40%). The Republic of Kazakhstan owns Joint Stock Company Sovereign Wealth Fund Samruk-Kazyna , who is the sole shareholder of Kazatomprom.

Inkai s mineral reserves and resources reported by Cameco are located at Blocks 1 and 2. An ISR test is currently in progress at Block 3 in order to demonstrate Block 3 s technical and economic viability. Total packaged production from Blocks 1 and 2 from 2009 to the end of 2016 is 36.7 million pounds of U_3O_8 (Cameco s share 21.5 million pounds).

1.2 2016 Implementation agreement

Cameco, Kazatomprom and JV Inkai signed an agreement (Implementation Agreement) dated May 27, 2016, to restructure and enhance Inkai. Subject to closing, the Implementation Agreement provides as follows:

- JV Inkai will have the right to produce 4,000 tonnes of uranium (tU) (10.4 million pounds of U_3O_8) per year (Cameco s share 4.2 million pounds), an increase from the current 5.2 million pounds (Cameco s share 3.0 million pounds)

JV Inkai will have the right to produce from Blocks 1, 2 and 3 until 2045 (currently, the licence terms are to 2024 for Block 1 and to 2030 for Blocks 2 and 3)

subject to further adjustments tied to the construction of a refinery as described below, Cameco s ownership interest in JV Inkai will be adjusted to 40%, and Kazatomprom s ownership interest in JV Inkai will be adjusted to 60%. However the Implementation Agreement ensures that during production ramp up, Cameco s share of annual production remains at 57.5% on the first 5.2 million pounds of U_3O_8. As annual production increases above 5.2 million pounds, Cameco will be entitled to 22.5% of any incremental production, to the maximum annual share of 4.2 million pounds of U_3O_8. Once the ramp up to 10.4 million pounds of U_3O_8 annually is complete, Cameco s interest in production will be adjusted to match its ownership interest at 40%.

a governance framework that provides protection for Cameco as a minority owner of JV Inkai

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- the current boundaries of Blocks 1, 2 and 3 will be adjusted to match the agreed production profile for Inkai to 2045

- the loan made by a Cameco subsidiary to JV Inkai to fund exploration and evaluation of Block 3 will be paid on a priority basis

The Implementation Agreement is subject to obtaining all required government approvals, including certain amendments to JV Inkai s Resource Use Contract. In February 2017, Cameco estimated it would take 10 to 18 months to obtain the required approvals. The agreement provides for annual production at Inkai to be ramped up to 10.4 million pounds of U_3O_8 over three years following receipt of the required approvals.

The Implementation Agreement also provides that Cameco and Kazatomprom will complete a feasibility study for the purpose of evaluating the design, construction and operation of a uranium refinery in Kazakhstan. If Cameco and Kazatomprom decide to build the refinery, the agreement also provides that Cameco s ownership interest in JV Inkai will be increased to 42.5% upon commissioning of the refinery and, depending on the level of commercial support Cameco provides, may be increased further to 44%. The agreement also grants Kazatomprom a five-year option to license Cameco s proprietary uranium conversion technology for purposes of constructing and operating a UF_6 conversion facility in Kazakhstan, if Cameco and Kazatomprom decide to build the refinery.

For more information, see Section 24.3 *2016 Implementation Agreement.*

The technical and scientific information in this technical report does not reflect the material changes that would result upon closing of the Implementation Agreement since it is still subject to obtaining all required government approvals. If the Implementation Agreement closes, the estimated mineral resources and mineral reserves of Inkai and Cameco s share will change materially.

1.3 Property tenure

In April 1999, the government of Kazakhstan granted JV Inkai a mining licence for Block 1 and an exploration with subsequent mining licence for Blocks 2 and 3. The associated subsoil use contract (Resource Use Contract), covering both licences, was signed by the Republic of Kazakhstan and JV Inkai in July, 2000. The Block 1 licence expires in 2024 and the Blocks 2 and 3 licence expires in 2030 (Licences).

JV Inkai also has obligations under the Licences and the Resource Use Contract which it must comply with in order to maintain its rights to Blocks 1, 2 and 3. There have been five amendments to the Resource Use Contract. The most recent amendment was in November 2016 to extend the exploration period at Block 3 until July 13, 2018.

In addition to complying with its obligations under the Licences and the Resource Use Contract, JV Inkai, like all subsoil users, is required to abide by the work program appended to its Resource Use Contract, which relates to its mining operations.

Under Kazakhstan law, subsoil and mineral resources belong to the state. Currently, the state provides access to subsoil and mineral resources under a resource use contract. Minerals extracted from subsoil by a subsoil user under a resource use contract are the property of the subsoil user unless the Law on the Subsoil and Subsoil Use, dated June 24, 2010, as amended (Subsoil Law) or a resource use contract provides otherwise.

Under the Resource Use Contract and the Licences, JV Inkai has the rights to explore for and to extract uranium from the subsoil. JV Inkai owns uranium extracted from the subsoil, and has the right to use the surface of the lands.

A subsoil use contract gives the contractor a right to use the surface of the property while exploring, mining and reclaiming the land. However, this right must be set forth in a surface lease agreement with the applicable local administrative authorities.

On a regular basis, JV Inkai obtains from local authorities the necessary surface lease agreements for new

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buildings and infrastructure. JV Inkai does not hold surface leases for the entire area that is subject to the Licences. JV Inkai obtains surface leases gradually only for surface area required for exploration, mining or construction of new infrastructure.

For more information, see Sections 4.1 to 4.5.

1.4 Location and existing infrastructure

Inkai is located in the Suzak District of South-Kazakhstan Oblast, Kazakhstan, near the town of Taikonur. It is approximately 350 kilometres northwest of the city of Shymkent and approximately 155 kilometres east of the city of Kyzl-Orda. Inkai is accessible by road from Shymkent (470 kilometres) and from Kyzl-Orda (290 kilometres). JV Inkai s corporate office is located in Shymkent.

There are three surface processing facilities at Inkai:

- main processing plant (MPP) located on Block 1
- satellite 1 (Sat1) located on Block 2
- test leach facility (TLF) located on Block 3

The MPP has an ion exchange (IX) capacity of 2.7 million pounds of U_3O_8 per year and a product recovery drying and packaging capacity of 8.1 million pounds of U_3O_8 per year. Sat1 has an IX capacity of 6.3 million pounds of U_3O_8 per year. The TLF is currently operated as part of a test campaign to assess the commercial viability of Block 3.

The following are located at Block 1: an administrative office, shops, garage, holding ponds, laboratory and emergency response building, enclosures for low-level radioactive waste and domestic waste, reagent storage tanks, food services facilities, engineering and construction offices, wellfield pipelines, header houses, roads, and powerlines. At Block 2, there is an office, shops, holding ponds, reagents storage tanks, a food services facility, wellfield pipelines, header houses, roads, and powerlines. At Block 3, there is an office, shops, holding ponds, reagent storage tanks, a food services facility, wellfield pipelines, header houses, roads, and powerlines. At Taikonur, JV Inkai has a camp for 429 employees with catering and leisure facilities.

1.5 Geology and mineralization

South-central Kazakhstan geology is comprised of a large relatively flat basin of Cretaceous to Quaternary age continental clastic sedimentary rocks. The Chu-Sarysu Basin extends for more than 1,000 kilometres from the foothills of the Tien Shan Mountains located on south and southeast sides of the basin, and merges into the flats of the Aral Sea depression to the northwest. The basin is up to 250 kilometres wide, bordered by the Karatau Mountains on the southwest and the Kazakh Uplands on the northeast. The basin is composed of gently dipping to nearly flat lying fluvial-derived unconsolidated sediments composed of inter-bedded sand, silt and local clay horizons.

The Cretaceous and Paleogene sediments contain several stacked and relatively continuous, sinuous roll-fronts or oxidation-reduction (redox) fronts hosted in the more porous and permeable sand and silt units. Several uranium deposits and active ISR uranium mines are located at these regional oxidation roll-fronts, developed along a regional system of superimposed mineralization fronts. The overall stratigraphic horizon of interest in the basin is approximately 200 to 250 metres in vertical section.

The Inkai deposit is one of these roll-front deposits. It is hosted within the Inkuduk and Mynkuduk Formations which comprise fine, medium and coarse-grain sands, gravels and clays. The redox boundary can be readily recognised in core by a distinct colour change from grey and greenish-grey on the reduced side to light-grey with yellowish stains on the oxidized side, stemming from the oxidation of pyrite to limonite.

The sands have high horizontal hydraulic conductivities. Hydrogeological parameters of the deposit play a key role in ISR mining. Studies and mining results indicate Inkai has favourable hydrogeological conditions for ISR mining.

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Ten mineralized zones have been identified in Blocks 1, 2 and 3. These include four zones in the Mynkuduk horizon and six zones in the Inkuduk horizon. The bulk of the uranium mineralization in Block 1 is contained in the Mynkuduk horizon which extends over more than 10 kilometres. This horizon is at an average depth of about 490 metres. Mineralization in Block 2 is contained primarily in the Lower and Middle Inkuduk horizons at average depths of 390 and 340 metres below surface. It extends over more than 35 kilometres. The bulk of the mineralization in Block 3 is contained in the Lower and Middle Inkuduk horizons extending over more than 25 kilometres at average depths of 360 and 330 metres below surface.

Mineralization comprises sooty pitchblende (85%) and coffinite (15%). The pitchblende occurs as micron-sized globules and spherical aggregates, while the coffinite forms tiny crystals. Both uranium minerals occur in pores on interstitial materials such as clay minerals, as films around and in cracks within sand grains, and as replacements of rare organic matter, and are commonly associated with pyrite.

1.6 Exploration and delineation

Exploration at Inkai began in the 1970s and progressed until 1996. Since 2006 exploration and delineation drilling has been conducted by JV Inkai.

Blocks 1 and 2 exploration and delineation programs

No exploration activity was conducted by JV Inkai at Blocks 1 and 2 before 2013. From 2013 to 2016, delineation drilling was conducted at Block 1 (67 drillholes) and Block 2 (280 drillholes) to better establish the mineralization distribution and to support further development and wellfield design.

Block 3 exploration and delineation programs

Exploration and delineation work was completed at the northern flank (Block 3) of the Inkai deposit by JV Inkai from 2006 to 2016.

During the period from 2006 to 2013, an extensive exploration-delineation drilling program was carried out at Block 3, consisting of 3,640 drillholes. This was in addition to the historic 489 holes drilled prior to JV Inkai obtaining it licenses for Inkai.

The first phase of the drilling program, from 2006 through 2009, was focused on drilling on an 800 x 50-metre grid pattern in the southwestern part of Block 3. The mineralization trends were also followed along the northwestern border using sparser (800 to 1,600 x 100 to 200-metre) drilling patterns. It resulted in the identification of extensive uranium mineralization hosted by several units, and traced along approximately 25 kilometres from Block 2 in the southwest through to the northeastern border of Block 3.

The second phase of the drilling program, from 2010 to May 2011, was aimed at developing an 800 x 50-metre infill drilling grid pattern throughout the mineralized trend identified along the northwestern border, as well as the trend developed along the southern border. In addition, the 200 x 50-metre drilling grids patterns started to be developed in the southwestern part of Block 3 with the goal of identifying sites and designing test wellfields in the Lower Inkuduk and Lower Mynkuduk horizons.

The third phase of drilling started in June 2011 and continued until the end of 2013. Progressively tightening drilling grids (from 800 x 50-metre to 400 x 50-metre to 200 x 50-metre) were used to delineate mineralization in the southwestern, western and northern parts of Block 3.

In the fourth phase of drilling, during the second half of 2016, 69 infill delineation holes were drilled on a 100 x 50-metre grid on a selected site focusing on the Mynkuduk mineralization to confirm the continuity of the mineralization and its categorization. Thirty-nine drillholes were drilled at the test leach wellfields to study the recovery process.

1.7 Block 3 appraisal program

Exploration work on Block 3 has identified extensive mineralization hosted by several horizons and traced along 25 kilometres. This discovery requires further assessment of its commercial viability. A Cameco subsidiary funded JV Inkai s Block 3 exploration work. JV Inkai is operating a test mine at Block 3.

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Approvals

Since 2009, JV Inkai has received a number of approvals extending the exploration period at Block 3. The latest one in November 2016, extended the exploration period until July 13, 2018.

In 2011, JV Inkai obtained government approval to carry out delineation drilling, uranium resource estimation, construction and operation of a TLF and completion of a pre-feasibility study.

In February 2017, JV Inkai submitted an updated estimate of in-situ uranium mineralization and a study, similar to a pre-feasibility study, to the Kazakh State Reserve Commission (SRC) for their approval.

Appraisal Work

Extensive exploration and delineation drilling was completed at Block 3 by JV Inkai from 2006 to 2016.

In 2011, JV Inkai began infrastructure development and completed engineering for a TLF for the Block 3 assessment program. In addition, a preliminary estimate of the mineralization on the southwestern corner of Block 3 was prepared, which was reviewed and approved by the SRC.

In 2012, JV Inkai started drilling the test wellfields and started construction of the TLF.

In 2014, an interim report on exploration results and estimate of the mineralization at Block 3 was reviewed and conditionally approved by the SRC.

In 2015, JV Inkai completed construction of the TLF and began pilot production from test wellfields. At December 31, 2016, total production from test mining at Block 3 was 865,000 pounds of U_3O_8.

In 2017, JV Inkai plans to continue with pilot production from the TLF.

1.8 Blocks 1 and 2 development

A pilot test, using the ISR mining method, was performed in the northeast area of Block 1 starting in December 1988. The pilot leach test in the north area of Block 2 was initiated in 2002.

In September 2005, JV Inkai decided to proceed with the main processing plant to be located at Block 1, and construction began soon after. In 2009, construction of the main processing plant was completed and the processing of solutions from Block 1 commenced. In February 2010, regulatory approval was received, allowing full processing of uranium concentrate on site.

Also in 2009, JV Inkai constructed and began commissioning a satellite plant to process solution recovered from Block 2. In 2011, JV Inkai received regulatory approval for processing at this satellite plant.

1.9 Mineral resources and mineral reserves

The estimated mineral resources and reserves at Inkai are located in Block 1 and Block 2. The preparation of the resource models followed the SRC guidelines. They were created by Volkovgeology Joint Stock Company (Volkovgeology), using the Grade-Thickness (GT) estimation method on 2-dimensional blocks in plan. Volkovgeology is a subsidiary of Kazatomprom and is responsible for prospecting, exploration and development of uranium deposits in Kazakhstan.

In 2003, Cameco performed a validation of the Kazakh reserve estimate for Block 1 and confirmed the estimated pounds of uranium to within 2.5% of the Kazakh reserve estimate. The same Kazakh reserve estimate was validated by an independent consulting firm in 2005. In 2007, Cameco and an independent consulting firm verified the Kazakh reserves estimate for Block 2 and obtained results in agreement with the Kazakh reserve estimate. In 2016, Cameco reviewed the criteria to align the Kazakh mineral resources and mineral reserves classification system with the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards - For Mineral Resources and Mineral Reserves (Definition Standards). Where previously the Kazakh categories C2 and C1 were directly reconciled to Inferred and Indicated respectively, now C2 can be in the Inferred and Indicated categories and C1 in the Indicated and Measured categories.

The Block 1 mineral resources and reserves estimates are based on 991 surface drillholes. The Block 2

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mineral resources and reserves estimates are based upon 1,441 drillholes. No mineral resources or reserves are reported for Block 3 until approved by the SRC and the Implementation Agreement closes.

Summaries of the estimated mineral resources and mineral reserves for Inkai with an effective date of December 31, 2016 are shown in *Table 1-1* and *Table 1-2*. Cameco s share of uranium in the mineral resources is based on its interest in potential production (57.5%), which differs from its ownership interest in JV Inkai (60%). Cameco s share of uranium in the mineral reserves is based on its interest in planned production (57.5%) assuming an annual production rate of 5.2 million pounds of U_3O_8, which differs from its ownership interest in JV Inkai (60%).

TABLE 1-1: SUMMARY OF MINERAL RESOURCES DECEMBER 31, 2016

Category	**Area**	**Total tonnes (x 1,000)**	**Grade % U_3O_8**	**Total M Lbs U_3O_8**	**Cameco s share M Lbs U_3O_8**
MEASURED	Block 1	24,650	0.076	41.5	23.8
	Block 2	10,205	0.061	13.8	8.0
	Total Measured	**34,855**	**0.072**	**55.3**	**31.8**
INDICATED	Block 1	15,561	0.069	23.7	13.6
	Block 2	62,354	0.045	62.3	35.9
	Total Indicated	**77,915**	**0.050**	**86.0**	**49.5**
Total Measured and Indicated		**112,770**	**0.057**	**141.3**	**81.3**
INFERRED	Block 1	2,038	0.062	2.8	1.6
	Block 2	149,546	0.045	147.1	84.6
	Total Inferred	**151,583**	**0.045**	**149.9**	**86.2**

Notes: (1) Reported mineral resources do not include amounts identified as mineral reserves. Totals may not add up due to rounding.
(2) Cameco s share is 57.5% of total mineral resources.
(3) Inferred mineral resources are estimated on the basis of limited geological evidence and sampling, sufficient to imply but not verify geological grade and continuity. They have a lower level of confidence than that applied to an Indicated mineral resource and cannot be directly converted to a mineral reserve.
(4) Mineral resources have been estimated at a minimum grade-thickness cut-off per hole of 0.071 & 0.047 m%U_3O_8 for Blocks 1 and 2, respectively.
(5) The geological model used for Inkai involves geological interpretations on section and plan derived from surface drillhole information.
(6) Mineral resources have been estimated on the assumption of using the ISR extraction method.
(7) Mineral resources have been estimated with the grade-thickness method using 2-dimensional block models.
(8) There are no known environmental, permitting, legal, title, taxation, socio-economic, political, marketing or other relevant factors that could materially affect the above estimate of mineral resources other than changes resulting from closing of the Implementation Agreement.

(9) Mineral resources that are not mineral reserves have no demonstrated economic viability and do not meet all relevant modifying factors.

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TABLE 1-2: SUMMARY OF MINERAL RESERVES DECEMBER 31, 2016

Category	Area	Total tonnes (x 1,000)	Grade % U_3O_8	Total M Lbs U_3O_8	Cameco s share M Lbs U_3O_8
PROVEN	Block 1	11,170	0.076	18.8	10.8
	Block 2	22,023	0.061	29.8	17.1
	Total Proven	**33,193**	**0.066**	**48.6**	**28.0**
PROBABLE	Block 1	2,425	0.069	3.7	2.1
	Block 2	28,292	0.045	28.3	16.3
	Total Probable	**30,717**	**0.047**	**32.0**	**18.4**
TOTAL RESERVES	**Inkai**	**63,910**	**0.057**	**80.6**	**46.3**

Notes: (1) Cameco reports mineral reserves and mineral resources separately. Totals may not add up due to rounding.

(2) Total pounds U_3O_8 are those contained in mineral reserves and are not adjusted for the estimated metallurgical recovery of 85%.

(3) Cameco s share is 57.5% of total mineral reserves.

(4) Mineral reserves have been estimated at a grade-thickness cut-off of 0.13 m%U_3O_8.

(5) The geological model used for Inkai involves geological interpretations on section and plan derived from surface drillhole information.

(6) Mineral reserves have been estimated with no allowance for dilution, as this is not applicable for ISR mining.

(7) Mineral reserves have been estimated based on the use of the ISR extraction method. The production rate is planned for 5.4 million pounds of U_3O_8 for 2017, then 5.2 million pounds per year for 2018 to 2028 and then decreasing till 2030.

(8) Mineral reserves have been estimated with the grade-thickness method using two-dimensional block models.

(9) An average price of $51 (US) per pound of U_3O_8 was used to estimate the mineral reserves with exchange rates of $1.00 US=$1.20 to $1.25 Cdn and 245 Kazakhstan Tenge to $1.00 Cdn.

(10) There are no known mining, metallurgical, infrastructure, permitting or other relevant factors that could materially affect the above estimate of mineral reserves other than closing of the Implementation Agreement.

1.10 Mining

Mining at Inkai is based upon a conventional and well-established ISR process. ISR mining of uranium is defined by the International Atomic Energy Agency as:

The extraction of ore from a host sandstone by chemical solutions and the recovery of uranium at the surface. ISR extraction is conducted by injecting a suitable leach solution into the ore zone below the water table; oxidizing, complexing and mobilizing the uranium; recovering the pregnant solutions through production wells; and finally, pumping the uranium bearing solution to the surface for further processing.

ISR mining at Inkai is comprised of the following components to produce a uranium-bearing lixiviant (an aqueous solution which includes sulphuric acid), which goes to settling ponds and then to the processing

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plants for production of uranium as yellowcake.

- Determination of the GT cut-off for the initial design and the operating period. The design cut-off sets a lower limit to the pounds per pattern required to warrant installation of a pattern before funds are committed, and the operating cut-off applies to individual producer wells and dictates the lower limit of operation once a well has entered production.

- Preparation of a production sequence which will deliver the uranium-bearing lixiviant to meet production requirements, considering the rate of wellfield uranium recovery, lixiviant uranium head grades, and wellfield flow rates.

- Wellfield development practices using an optimal pattern design to distribute barren lixiviant to the wellfield injectors, and to then collect lixiviant, which carries the dissolved uranium, back to the main processing plant or satellite plant, as the case may be.

The above factors are used to estimate the number of operating wellfields, wellfield patterns and header houses over the production life. They also determine the unit cost of each of the mining components required to achieve the production schedule, including drilling, wellfield installation and wellfield operation.

There is ongoing wellfield development in both Blocks 1 and 2 to support the current production plan.

1.11 Processing

As a result of extensive test work and operational experience, a very efficient process of uranium recovery has been established. The process consists of the following major steps:

- uranium in-situ leaching with a lixiviant

- uranium adsorption from solution with IX resin

- elution of uranium from resin with ammonium nitrate

- precipitation of uranium as yellowcake with hydrogen peroxide and ammonia

- yellowcake thickening, dewatering, and drying

- packaging of dry yellowcake product in containers

All plants load and elute uranium from resin while the resulting eluate is converted to yellowcake at the main processing plant. Inkai is designed to produce a dry uranium product that meets the quality specifications of uranium refining and conversion facilities.

1.12 Environmental assessment and licensing

In the Resource Use Contract, JV Inkai committed to conducting its operations according to good international mining practices. It complies with the environmental requirements of Kazakhstan legislation and regulations, and, as an industrial company, it must also reduce, control or eliminate various kinds of pollution and protect natural resources. JV Inkai is required to submit annual reports on pollution levels to the Republic of Kazakhstan environmental, tax and statistics authorities. Regulatory authorities have the power to issue an order reducing or halting production at a facility that violated environmental standards.

Environmental protection legislation in Kazakhstan has evolved rapidly, especially in recent years. As the subsoil use sector has evolved, there has been a trend towards greater regulation, heightened enforcement and greater liability for non-compliance. The most significant development was the adoption of the Ecological Code in 2007. This code replaced the three main laws related to environmental protection. Amendments were made to the code in 2011 that include more stringent environmental protection regulations, particularly relating to the control of greenhouse gas emissions, obtaining environmental permits, state monitoring requirements and other similar matters.

JV Inkai is required to comply with environmental requirements during all stages of operation, and develop an

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environmental impact assessment for examination by a state environmental expert before making any legal, organizational or economic decisions that could have an effect on the environment and public health.

Under the Ecological Code, JV Inkai needs an environmental permit to operate. The permit certifies the holder s right to discharge emissions into the environment, provided that it complies with the requirements of the permit and the Ecological Code. JV Inkai has a permit for environmental emissions and discharges for the operation that is valid until December 31, 2022. JV Inkai also holds the required permits under the Water Code which have various expiry dates.

As Inkai is a nuclear facility, JV Inkai is required to and currently holds the following additional material licences relating to its mining activities:

- Licence for radioactive substances handling valid till January 23, 2020
- Licence for operation of mining production and mineral raw material processing with indefinite term
- Licence for transportation of radioactive substances within the territory of the Republic of Kazakhstan valid till January 23, 2020
- Licence for radioactive waste handling valid till January 23, 2020.

In accordance with applicable legislation regulating permits and licences, JV Inkai is required to submit annual reports to relevant state authorities. As is typical with any mineral extraction site, construction, operation, and reclamation are subject to an ongoing process during which permits, licences, and approvals are requested, monitored and reported on, expire, and are amended or renewed.

JV Inkai received a mining licence for Block 1 and an exploration with subsequent mining licence for Blocks 2 and 3 from the government of Kazakhstan in April 1999. (See Section 4.2, *Exploration and mining licences,* for more information.)

The ISR mining method at Inkai uses acid in the mining solution to extract uranium from underground non-potable aquifers. The injection and recovery system is engineered to prevent the mining solution from migrating to the aquifer above the orebody, which has water with higher purity.

Kazakhstan does not require active restoration of post-mining groundwater. After a number of decommissioning steps are taken, natural attenuation of the residual acid in the mined out horizon, as a passive form of groundwater restoration, has been accepted. Attenuation is a combination of neutralization of the groundwater residual acid content by interaction with the host rock minerals and other chemical reactions which immobilize residual groundwater contaminants in the mined-out subsoil horizon. This approach is considered acceptable because it results in water quality similar to the pre-mining baseline status.

JV Inkai s decommissioning obligations are largely defined by the Resource Use Contract. It has deposited the required contributions into a separate bank account as security to ensure it will meet its obligations. Contributions are capped at $500,000 (US). JV Inkai has funded the full amount.

Under the Resource Use Contract, JV Inkai must submit a plan for decommissioning the property to the government six months before mining activities are complete. It developed a preliminary decommissioning plan to estimate total decommissioning costs, and updates the plan every five years, or when there is a significant change at the operation that could affect decommissioning estimates. The plan was most recently revised in 2016. The preliminary decommissioning estimate is $10 million (US).

JV Inkai has environmental insurance, as required by the Ecological Code and the Resource Use Contract as well as the required civil liability insurance.

1.13 Production plan and mine life

The production plan presented in this technical report is based on Inkai mineral reserves from which the production of 68.5 million pounds of U_3O_8 is forecast. The projected remaining mine life is 13.3 years.

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Inkai s production plan over its mine life is presented on *Figure 1-1.*

FIGURE 1-1: ANNUAL PRODUCTION PLAN - 100% BASIS

1.14 Capital and operating cost estimates

Capital costs for Inkai are estimated to be $296.9 million over the remaining life of the current mineral reserves. The remaining capital costs, as of January 1, 2017, includes $217.3 million for wellfield development, $55.5 million for construction and $24.1 million for sustaining capital. The cost estimates are on a 100% basis with a currency exchange rate assumption of 245 Kazakhstan Tenge to $1.00 Cdn. All cost projections are stated in constant 2017 Canadian dollars and assume the throughput from the production schedule outlined on *Figure 1-1.*

Construction capital is heavily weighted to the first three years due to the major repairs and modernization planned for facilities at both Block 1 and Block 2. Pending closing of the Implementation Agreement, there are no other major construction projects anticipated.

Operating expenditures for ISR mining, surface processing, site administration and corporate overhead are estimated to be $12.71 per pound of U_3O_8 over the remaining life of the current mineral reserves. The operating costs have decreased from the March 31, 2010 technical report as a result of the optimization in the consumption of sulphuric acid and other reagents, as well as the devaluation of the Kazakhstan Tenge.

1.15 Regulatory risks

The identified regulatory risks are compliance with the requirements of the Resource Use Contract, Licences, permits, laws and regulations of Kazakhstan, uncertainty in and changes to Kazakhstan laws and regulations, the proposed new Subsoil Code not addressing the status of resource use contracts executed and licences issued prior to its enactment, political risk, Implementation Agreement regulatory approvals, and the extension of the Block 3 exploration period. Cameco believes that these risks are manageable. More information on these risks are included in Section 24.5 *Regulatory Risks.*

1.16 Conclusions and recommendations

Based on the rigorous procedures and experience demonstrated by Volkovgeology, JV Inkai and Cameco personnel, Cameco s review of the reliability, quality and density of data available, the thorough geological interpretative work, and the different validation tests performed over the years, the QPs responsible for the mineral resource and mineral reserve estimates consider that the current estimates of mineral resources and reserves are relevant and reliable.

From 2009 till end of 2016, JV Inkai produced 36.7 million pounds of U_3O_8 (Cameco s share 21.5 million) from Blocks 1 and 2. Cameco believes that Blocks 1 and 2 have the potential to sustain production levels, as outlined in this technical report. The current mine plan represents an operating mine life of 13.3 years, during which Inkai is forecast to produce an estimated 68.5 million pounds of U_3O_8.

Based on exploration and development to date, Cameco and the authors of this report are of the opinion that Block 3 has the potential to support a commercial operation.

Given that Inkai is in production, that it has sufficient mineral reserves to produce at the current licensed production rate, and that leach tests on Block 3 are in progress, the authors of this technical report consider that it is not necessary to recommend further exploration activities. In areas of probable mineral reserves where the confidence on some characteristics of the mineralization, such as grade continuity and hydrological conditions, can be increased, additional delineation drilling is recommended.

Over the life of the operation and at higher production rates, the accumulation of specific ionic species in the holding ponds could reduce surface equipment performance. It is recommended that the concentration of ionic species be monitored.

The Implementation Agreement provides for annual production at Inkai to be ramped up to 10.4 million pounds of U_3O_8 over three years following receipt of the required approvals. It is recommended that technical studies related to the production ramp-up be completed and submitted in a timely manner.

If the Implementation Agreement closes, the estimated mineral resources and mineral reserves of Inkai, and

Cameco s share of them, will change materially.

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2 Introduction

2.1 Introduction and purpose

Inkai is a material property for Cameco under Canadian securities laws.

This technical report has been prepared for Cameco by internal QPs in support of the disclosure of scientific and technical information relating to Inkai contained in Cameco s annual Management s Discussion and Analysis for the year ended December 31, 2016 filed with Canadian securities regulators on February 9, 2017, and Cameco s Annual Information Form and Form 40-F for the year ended December 31, 2016.

The report has an effective date of December 31, 2016, and has been prepared in accordance with NI 43-101 by the following individuals:

Darryl Clark, PhD, P. Geo., Managing Director, Cameco Kazakhstan LLP

Alain G. Mainville, P. Geo., Director, Mineral Resources Management, Cameco Corporation

Stuart B. Soliz, P. Geo., Principal Geologist, Power Resources, Inc. (operating as Cameco Resources)

Robert J. Sumner, PhD, P. Eng., Principal Metallurgist, Technical Services, Cameco Corporation.

These individuals are the qualified persons responsible for the content of this technical report. All four have visited Inkai.

Alain G. Mainville has visited the Inkai site and JV Inkai s head office on four occasions in the last three years, the latest being on November 20-22, 2016. The scope of his personal visits included meetings with JV Inkai, Kazatomprom and Volkovgeology personnel and field inspections of drilling, sampling, core logging, sample preparation and assaying, radiometric downhole surveys, geological modelling, mineral resources and mineral reserves estimation, production reconciliation and mine plans. Mr. Mainville has been involved with Inkai since 2002.

Darryl Clark is based in Astana, Kazakhstan. He routinely visits the Inkai site and JV Inkai s office in Shymkent to meet with JV Inkai management and personnel to review aspects of the operation, including exploration, operations and mine development. Mr. Clark has been involved with Inkai since 2014, as General Director till the end of 2016.

Stuart B. Soliz has visited the Inkai site on eight occasions, the latest occurring March 1-8 2017. The scope of his last personal visit to the Inkai site included meetings with JV Inkai personnel to review the development status of technical documents related to the Implementation Agreement, including the Life of Mine plan. Mr. Soliz has been involved with Inkai since 2014.

Robert Sumner has visited the Inkai site on one occasion on February 3-6, 2016. The scope of the visit included meetings with JV Inkai personnel to review the surface processing facilities. Mr. Sumner has been involved with Inkai since 2015.

2.2 Report basis

This technical report has been prepared with available internal Cameco and JV Inkai data and information, as well as data and information prepared for Inkai. The principal technical documents and files relating to Inkai that were used in preparation of this technical report are listed in Section 27 *References.*

All monetary references in this technical report are expressed in Canadian dollars, unless otherwise indicated. Illustrations (Figures) in this technical report are from Cameco, Kazatomprom and JV Inkai, and are dated December 31, 2016, unless otherwise specified.

The technical and scientific information in this technical report does not reflect the material changes that

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would result upon closing of the Implementation Agreement since it is still subject to obtaining all required government approvals. If the Implementation Agreement closes, the estimated mineral resources and mineral reserves of Inkai and Cameco s share will change materially.

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3 Reliance on other experts

The authors have relied, and believe they have a reasonable basis to rely, upon the following individuals who have contributed the legal and taxation information stated in this technical report, as noted in *Table 3-1* below.

TABLE 3-1: RELIANCE ON OTHER EXPERTS

Name	**Title**	**Section # (description)**
Larry Korchinski, LLB	Director Legal Services and General Counsel, Cameco	1.2 (description of 2016 Implementation Agreement)
		1.3 (description of Property Tenure)
		4.2 (description of Exploration and Mining Licences)
		4.3 (description of Surface Tenure)
		4.4 (description of Resource Use Contract)
		4.5 (description of Subsoil Law)
		4.6 (description of Draft Subsoil Code)
		4.7 (description of Strategic Object)
		6.1 (description of Ownership)
		19.2 (description of Uranium Sales Contracts)
		19.3 (description of Material Contracts)
		24.2 (description of Cameco Funding of Block 3 Appraisal Program)
		24.3 (description of 2016 Implementation Agreement)
		24.4 (description of Currency Control Regulations)
		24.5 (description of Regulatory Risks)
Jill Johnson, MPAcc, CPA, CA	Manager, Tax Planning, Cameco	4.8 (description of Taxes and Royalties)

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4 Property description and location

4.1 Location

The Inkai operation is located in the Suzak District of South Kazakhstan Oblast, Republic of Kazakhstan. The geographic coordinates are at approximately 45º 20 north latitude and 67º 30 east longitude (Figure *4-1)*.

JV Inkai received a licence for mineral resource use and a licence for geological exploration in the Republic of Kazakhstan. Licence Series AY 1370D, dated April 20, 1999, is for extraction of uranium in the area defined as Block 1 near the town of Taikonur. Licence Series AY 1371D, dated April 20, 1999, is for exploration and further mining in the areas designated as Blocks 2 and 3, also near the town of Taikonur.

The associated resource use contract (Resource Use Contract), covering both licences, was signed by the Republic of Kazakhstan and JV Inkai in July 2000.

FIGURE 4-1: LOCATION MAP

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4.2 Exploration and mining licences

JV Inkai holds two licences issued on April 20, 1999: Licence AY 1370D and Licence AY 1371D (Licences).

Licence Series AY 1370D allows for the mining of uranium in a 16.58 square-kilometre area, designated as Block 1 in the Suzak District of the Republic of Kazakhstan. Mining is to be conducted in the Inkuduk and Mynkuduk horizons, which are at depths ranging from 300 to 520 metres from the surface. Licence AY 1370D includes Appendix 1 (mining allotment) and Appendix 2, which provides a list of geographical co-ordinates of 14 points defining the licence area. The term of the licence is 25 years from the licence issue date.

Licence Series AY 1371D allows for the exploration and further mining of uranium in a 470 square-kilometre area, designated as Block 2 (about 230 square kilometres) and Block 3 (about 240 square kilometres) in the Suzak District of the Republic of Kazakhstan. Licence Series AY 1371D includes Appendix 1 (exploration allotment) and Appendix 2, which provides a list of geographic coordinates- of 21 points. The term of the licence is 31 years from the licence issue date.

In 2008, JV Inkai received initial approval for mining for Block 2. In December 2008, JV Inkai was issued a new mining allotment. It consists of both the original mining allotment for Block 1 and the newly added area of the mining allotment for Block 2. This mining allotment contains two tables with geographic co-ordinates of the corner points. The Block 1 mining area is 16.58 square kilometres, and the depth of mining from 300 to 540 metres. The table for Block 1 contains the same 14 points as was in the original mining allotment. The table for Block 2 contains 20 points. The Block 2 mining area is 164.0 square kilometres, and the depth of mining is down to 520 metres.

The mining licence for Block 2 expires in April 2030. The mining licence for Block 1 expires in April 2024.

The Licences themselves do not grant subsoil use rights in Kazakhstan, rather, the right arises on the basis of both the Licences and the Resource Use Contract. Please refer to Section 4.4 *Resource Use Contract* for the discussion of the Resource Use Contract.

The exploration period for Block 3 has been extended to July 13, 2018 by amendments to the Resource Use Contract. See Section 4.4 *Resource Use Contract* for more information.

4.3 Surface tenure

Under Kazakhstan law, subsoil and mineral resources belong to the Republic of Kazakhstan. Currently, the Republic of Kazakhstan provides access to subsoil and mineral resources under a resource use contract. Minerals extracted from subsoil by a subsoil user under a resource use contract are the property of the subsoil user unless the Subsoil Law or a resource use contract provides otherwise.

Under the Resource Use Contract and the Licences, JV Inkai has the rights to explore for and to extract uranium from the subsoil and JV Inkai owns uranium extracted from the subsoil.

A subsoil use contract gives the contractor a right to use the surface of the property while exploring, mining and reclaiming the land. However, this right must be set forth in a surface lease agreement with the applicable local administrative authorities.

On a regular basis, JV Inkai obtains from local authorities the necessary surface lease agreements for new buildings and infrastructure. JV Inkai does not hold surface leases for the entire area that is subject to the Licences. It obtains them gradually only for surface area required for exploration, mining or construction of new infrastructure.

For more information on subsoil use rights, terms, and termination of the Licences and the Resource Use Contract, please refer to Sections 4.2, 4.4, and 4.5.

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4.4 Resource Use Contract

The Resource Use Contract was signed by the Republic of Kazakhstan and JV Inkai in July 2000. Under the Subsoil Law, JV Inkai holds its rights to Blocks 1, 2 and 3, on the basis of the Licences it received for those blocks and the Resource Use Contract. JV Inkai also has obligations under the Licences and the Resource Use Contract with which it must comply in order to maintain its rights to Blocks 1, 2 and 3.

In 2007, Amendment No. 1 to the Resource Use Contract was signed to extend the exploration period at Blocks 2 and 3.

In 2009, Amendment No. 2 to the Resource Use Contract was signed to:

- extend the exploration period for Block 3 until July 13, 2010
- provide final approval for mining at Block 2
- combine Blocks 1 and 2 for mining and reporting purposes
- adopt the new Tax Code of the Republic of Kazakhstan (Tax Code) that took effect January 1, 2009
- reflect current Kazakhstan legal and policy requirements for subsoil users, like JV Inkai, to procure goods, works and services under certain prescribed procedures and foster greater local content. As a result, at least 40% of the cost of equipment and materials purchased must be for equipment and materials of Kazakhstan origin and 90% of the contract work must be of Kazakhstan origin
- require a certain level of Kazakhstan employment by JV Inkai: 100% of workers; at least 70% of technical and engineering staff; and at least 60% of the management staff. All of these percentages are measured over the life of the Resource Use Contract.

In 2011, Amendment No. 3 to the Resource Use Contract was signed to:

- increase annual production from Blocks 1 and 2 to 3.9 million pounds of U_3O_8
- carry out a five-year assessment program (to July 2015) at Block 3 that includes delineation drilling, uranium resource estimation, construction and operation of a TLF and completion of a feasibility study.

In 2013, Amendment No. 4 to the Resource Use Contract was signed to increase annual production from Blocks 1 and 2 to 5.2 million pounds of U_3O_8.

In November 2016, Amendment No.5 to the Resource Use Contract was signed, extending the exploration period at Block 3 to July 13, 2018.

The Implementation Agreement contemplates certain amendments to the Resource Use Contract. For more information, see Section 24.3 *2016 Implementation Agreement*

In addition to complying with its obligations under the Licences and the Resource Use Contract, JV Inkai, like all subsoil users, is required to abide by the work program appended to its Resource Use Contract, which relates to its mining operations. See Section 4.5.5 *Work programs and project documentation for* more information.

4.5 Subsoil Law

The principal legislation governing subsoil exploration and mining activity in Kazakhstan is the Law on the Subsoil and Subsoil Use, dated June 24, 2010, as amended (Subsoil Law) which superseded the previous law on subsoil and subsoil use dated January 27, 1996, as amended (Old Subsoil Law). In general, the Licences held by JV Inkai are governed by the version of the Old Subsoil Law in effect at the time of their issuance in April, 1999 and the current Subsoil Law applies only if it does not worsen JV Inkai s position.

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The Subsoil Law defines the framework and the procedures connected with the granting of subsoil rights and the regulation of the activities of subsoil users. The subsoil, including mineral resources in their underground state, are Kazakhstan state property, while resources brought to the surface belong to the subsoil user, unless otherwise provided by contract or laws of the Republic of Kazakhstan.

In order to develop mineral resources, the appropriate state agency (Competent Authority), grants exploration and production rights to third parties. Subsoil rights are granted for a specific period, but may be extended prior to the expiration of the applicable contract or licence. Currently, the Ministry of Energy of the Republic of Kazakhstan is the Competent Authority

Subsoil rights become effective upon execution of a contract with the Competent Authority. Pursuant to the Subsoil Law, a subsoil user is accorded, inter alia, the exclusive right to conduct mining operations, to erect production facilities, to freely dispose of its share of production and to conduct negotiations for extension of the contract, subject to restrictions and requirements set out in the Subsoil Law.

Until amendments to the Old Subsoil Law in August 1999, both a licence and a contract were required for exploration and production. Combined licences (both exploration and production) were granted for a period that included exploration and production licence periods (up to six and 25 years respectively), including any permitted extensions. Both exploration and production licences were required to contain, among other things, information concerning the licensee, the boundaries of the contract area, the term of the licence and the date of commencement of work, the type of contract (exploration or production), the minimum work program, environmental and safety obligations and conditions for extending the licence term.

In August 1999, the Kazakhstan government abolished the licence regime for subsoil use rights granted after September 1999. Thus, from September 1999 onward, subsoil use rights have been granted on the basis of a resource use contract alone. However, all licences previously issued remain valid. An entity which obtained its subsoil use right prior to August 1999 holds such rights on the basis of a subsoil use licence and a resource use contract. An entity which obtained a subsoil use right after August 1999 holds its rights on the basis of a resource use contract alone.

The subsoil use rights held by JV Inkai came into effect upon the issuance of its Licences (April 1999), the execution of its Resource Use Contract (July 2000), and approval of the Resource Use Contract by applicable state entities.

In accordance with the August 1999 amendments to the Old Subsoil Law and the current Subsoil Law, Cameco believes the Licences held by JV Inkai are governed by the version of the Old Subsoil Law in effect at the time of their issuance in April, 1999.

To date, the Subsoil Law has not had a significant impact upon JV Inkai; however, Cameco continues to assess the impact. Some of the general impact is described below in the remaining parts of this Section 4.5 *Subsoil Law*

4.5.1 Stabilization clause

The general stabilization provision has been changed in the Subsoil Law. Under the Old Subsoil Law, changes in legislation that worsened the position of the subsoil user did not apply to resource use contracts signed or licences granted before the changes were adopted.

While the Subsoil Law still contains the above guarantees, it expands the list of exceptions such as national defence or security, ecological safety, public health, taxation, and customs. The Republic of Kazakhstan has gradually weakened the stabilization guarantee, particularly in relation to the new projects, and the national security exception is applied broadly to encompass security over strategic national resources.

Amendment No. 2 to the Resource Use Contract eliminated the tax stabilization provision that applied to JV Inkai.

4.5.2 Transfer of subsoil use rights and pre-emptive rights

Amendments to the Old Subsoil Law of December 2004 and October 2005, provide the Republic of

Kazakhstan with a pre-emptive right to acquire subsurface use rights and equity interests in entities holding subsoil use rights and in any entity which may directly or indirectly determine or exert influence on decisions made by a subsoil user, if the main activity of such entity is related to subsoil use in Kazakhstan, when such entity wishes to transfer such rights or interests. This pre-emptive right is also provided by the Subsoil Law and it permits the Republic of Kazakhstan to purchase any subsoil use rights or equity interests being offered for transfer on terms no less favourable than those offered by other purchasers. The pre-emptive right has been recently limited to the deposits of strategic importance; however, Inkai is a deposit of strategic importance and therefore still subject to the pre-emptive right of the state.

The Competent Authority has the right to terminate a subsoil contract if a transaction takes place in breach of this law. According to the Subsoil Law requirements, these provisions apply both to Kazakhstan and overseas entities, including publicly traded companies.

The Subsoil Law provides that assignments and transfers of subsoil use rights may be made only with the prior consent of the Competent Authority. During its tenure as the Competent Authority, the Ministry of Energy of the Republic of Kazakhstan customarily interpreted this requirement widely to include any alienation of rights, including, for example, in bankruptcy or by merger or amalgamation. Transactions entered into and implemented without such consent as well as those implemented six months after the consent is granted are invalid.

The Subsoil Law also provides that once the approved transaction is completed, the Competent Authority must be informed within five business days. Failure to notify the Competent Authority in time is grounds for invalidation of the transaction.

See Section 4.7 *Strategic object* for information on additional requirements to dispose of an interest in JV Inkai.

4.5.3 Dispute resolution

The dispute resolution procedure in the Subsoil Law does not specifically disallow international arbitration. Instead it states that if a dispute related to a resource use contract cannot be resolved by negotiation, the parties can resolve the dispute according to the laws of Kazakhstan and international treaties ratified by the Republic of Kazakhstan.

The Resource Use Contract allows for international arbitration. Cameco believes the Subsoil Law does not affect this right.

4.5.4 Contract termination

Under the Subsoil Law, the Competent Authority can unilaterally terminate a contract before it expires if:

- a subsoil user does not fix more than two breaches of its obligations provided by the resource use contract specified in a notice by the Competent Authority within a specific period (non-compliance with project documents are excluded from the grounds for termination)

- subsoil rights or an object connected with the subsoil use rights (direct and indirect ownership interests in a subsoil user) are transferred without consent of the Competent Authority if such consent was required less than 30% of the financial obligations under a contract are fulfilled during two consecutive years

activities of a subsoil user exploring or developing a strategic deposit entails such changes in the economic interests of the state that it poses a threat to national security and the subsoil user does not satisfy the Competent Authority s request to amend the resource use contract in this regard.

Under the Resource Use Contract, if JV Inkai breaches its obligations, the Competent Authority has to notify JV Inkai of the breach and provide a reasonable period for JV Inkai to fix the breach before it can terminate the contract. Cameco believes that the terms of the Resource Use Contract should continue to apply unless the state seeks to apply the national security or environmental protection exception to the guarantee of legal stability.

4.5.5 Work programs and project documentation

In addition to following its obligations under its Licences and the Resource Use Contract, JV Inkai, like all subsoil users, is required to abide by the work program, which is a mandatory part of the Resource Use Contract, and which relates to its operations over the life of the mine.

Work programs must be developed in accordance with project documents. The Subsoil Law establishes three types of project documents, depending on the type and stage of the work:

- exploration project: none for JV Inkai
- appraisal project: Block 3
- mining project documents: Block 1 and Block 2.

The project documents are developed and undergo a review and approval process. All work must be in compliance with the project documents, and conducting any work without an approved project document, or in non-compliance with it, is not permitted. Since January 2015, subsoil users are allowed to produce within 20% (above or below) their licensed capacity in a year without triggering a requirement to redo the project document for the work program. Any other changes in the work program require application to the Competent Authority.

Subsoil users who received subsoil rights before the Subsoil Law was introduced were required to:

- develop new project documentation to be approved by July 7, 2011
- develop a new work program in accordance with the project documentation to be approved by January 7, 2012.

JV Inkai submitted the required documentation and received approval of the new work program as part of the April 2011 approval of Amendment No. 3 to the Resource Use Contract. An updated work program, to increase the annual production rate to 5.2 million pounds of U_3O_8 (100% basis), was submitted to the Competent Authority in 2012 and was approved in December 2013 in connection with Amendment No. 4 to the Resource Use Contract. An updated work program for the Block 3 appraisal project was submitted and approved in connection with the November 2016 Amendment No. 5 to the Resource Use Contract.

The Subsoil Law repealed the previous requirement for annual work plans. Instead, expected exploration and production for each year are now set out in one work program.

4.5.6 Procurement requirements

Under Subsoil law, all subsoil users, including JV Inkai, must procure goods, works and services for subsoil use operations under prescribed statutory procedures.

Kazakhstan law unifies the procurement process and now requires procurements from open tender, single source, price request and digital procurement to be conducted with mandatory use of the register of goods, works and services (the register of potential suppliers) or other digital procurement systems which is synchronized with this register. Subsoil users are also required to develop annual, mid-term and long-term procurement programs based on the work program and respective budget.

JV Inkai currently procures goods, works and services according to Kazakhstan law and the Resource Use Contract, following the annual approval of its procurement plan.

4.5.7 Local content requirements

Since 2002, Kazakhstan has implemented a policy aimed at replacing imports, and fostering greater involvement, support and stimulation of local producers and local employees. Under this policy, subsoil users are obliged to purchase local works and services and hire local personnel in such percentages as may be specified in their resource use contracts.

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In 2012 Kazakhstan amended the Subsoil Law to retroactively mandate all subsoil users to use unified terminology and to report on local content pursuant to a newly introduced unified methodology. However, since accession to the World Trade Organization, Kazakhstan amended its local content requirements, abolishing the local content requirements for goods. If this requirement remains in resource use contracts entered into prior to January 1, 2015, it must be removed if the term of the contract is amended; otherwise it would have been automatically abolished on January 1, 2012. Nonetheless, the Subsoil Law still imposes local content requirements for works, services and employees.

The Resource Use Contract imposes local content requirements on JV Inkai with respect to employees, goods, works and services. As a result, at least 40% of the costs of goods and equipment must be for equipment and materials purchased of local origin, 90% of the contract work (i.e. works and services) must be of local origin, and 100%, 70% and 60% of employees depending on qualifications (workers, engineers and management, respectively) must be of local origin. The Resource Use Contract has not been amended to remove the local content requirements for goods yet and it will continue to apply to goods procured by JV Inkai until either it is amended or January 1, 2021, whichever comes first.

4.5.8 Strategic deposits

On August 13, 2009, a governmental resolution On Determination of the List of Subsoil (Deposit) Areas having Strategic Importance No. 1213 came into force whereby 231 blocks, including all three of JV Inkai s Blocks, were prescribed as strategic deposits. The Kazakhstan government re-approved this list in 2011 and JV Inkai s Blocks remain on it.

Under the Subsoil Law, if a subsoil user s actions in the performance of subsoil use operations with respect to strategic deposits result in a change to the economic interests of the Republic of Kazakhstan which create a threat to national security, the Competent Authority is entitled to require an amendment to the resource use contract for the purpose of restoring the economic interests of the Republic of Kazakhstan. The Subsoil Law prescribes strict deadlines for the parties to negotiate and execute any such required amendments.

The Subsoil Law also allows the Competent Authority, with the consent of the Republic of Kazakhstan, to unilaterally refuse to perform its obligations under a contract if it determines that the subsoil use operations conducted thereunder will result in a change in the economic interests of Kazakhstan, which create a threat to national security. In such circumstances, the Competent Authority must provide not less than two months prior notice of such refusal. Under this provision, the Competent Authority also has the right to unilaterally terminate a contract without having to comply with the civil law provisions requiring a party to apply to a court or arbitration panel for termination.

The basis for exercise by the Competent Authority of any of these powers is a change in the economic interests of the Republic of Kazakhstan which creates a threat to national security , which might be interpreted broadly.

4.6 Draft Subsoil Code

At present, the subsoil use sector in Kazakhstan is regulated by the Subsoil Law (as defined in Section 4.5 *Subsoil Law* above) and related regulations. Currently, the Republic of Kazakhstanis developing a draft comprehensive code the Subsoil and Subsoil Use Code (Subsoil Code or Code). It is to supersede the current Subsoil Law and related regulations for the purpose of consolidation of the legislation in this area.

The Kazakhstan government initially planned to finalize and introduce a draft Subsoil Code to the Parliament in November 2016. However, as at the date of this technical report the Subsoil Code is still at the stage of development.

It is expected to be enacted in the second half of 2017.

The overview below is therefore based upon the most recent available draft of the Subsoil Code dated December 22, 2016. It is possible that at the time of its adoption the Subsoil Code could be significantly different than the current draft version.

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4.6.1 Re-introduction of the licencing regime

The draft Subsoil Code reintroduces the licencing regime, which was in effect until 1999. If adopted in its current form, the Subsoil Code would provide that a subsoil use right with respect to solid minerals and geological exploration of the subsoil would be granted on the basis of a licence only. The regime of the resource use contracts would only apply to exploration and production rights of hydrocarbons. Thus, the rights to explore for and produce uranium will continue to be provided on the basis of a licence.

A competent authority and a subsoil user would still be able to enter into a contract for extraction of solid minerals provided that the subsoil user s investment commitments is not less than a minimum amount stipulated under the Code. However, such a contract would no longer serve as the basis for the creation and termination of the subsoil use right which would only be granted under a licence. Instead, a contract would function as an agreement setting out in more detail the parties terms of cooperation and the terms of extraction of minerals. The execution of such a contract may not serve as basis for granting a licence.

The previous edition of the draft Subsoil Code dated May 2016 provided that any licences issued and contracts executed before the enactment of the Subsoil Code would remain valid. However, the December 2016 draft of the Subsoil Code no longer contains these transitional provisions. Therefore, status of the validity of the Resource Use Contract and JV Inkai s Licences under the Subsoil Code is unclear. It remains to be seen if the final version of the Code provides clarity.

4.6.2 Stabilization clause

The Subsoil Code provides new tests for the application of stabilization which are (i) establishment or aggravation of liability, or (ii) imposition of new obligations, and (ii) new obligations which define another terms of the subsoil use operation that are detrimental to the results of such operations. It seems that the new stabilization clause aims to clarify the stability and at the same time to provide the subsoil user with the ability to use the new right granted by the laws adopted after the date of the respective contracts/licences.

4.6.3 Dispute resolution

The Subsoil Code grants the subsoil user recourse to arbitration subject to the following conditions: (i) the subsoil user incurred expenses equivalent to an amount stipulated under the Code over the course of its subsoil operations; (ii) the dispute is compensation of the subsoil user s losses caused by revocation of licence or a violation by the subsoil user of the Subsoil Code that may lead to early revocation of licence. In case of the subsoil user s referral of the dispute to arbitration (subject to the conditions described above) the consent of the state is deemed to have been granted.

The Subsoil Code is silent on the status of arbitration clauses contained in resource use contracts currently in effect. The December 2016 draft of the Code no longer contains transitional provisions providing that the contracts executed before its enactment would remain valid. It may be that the dispute settlement provisions of the draft Subsoil Code will be further refined.

4.6.4 Transfer of subsoil use rights and pre-emptive rights

The Subsoil Code maintains the state s control over transactions involving subsoil use rights and direct and indirect ownership interests in a subsoil user. Like the current law, the Subsoil Code establishes that transfers of subsoil use rights, transfers of shares/interests in subsoil users and grant of security over a subsoil use right require consent of the competent authority. At the same time, unlike the current law, the Subsoil Code provides a completely new approach, the proposed test for the application of the consent is a transfer of subsoil user right (its share) or a change in direct and indirect controlling persons. Where the direct control means (i) holding 25% of shares (interest, convertible securities (convertible into shares)), or (ii) having 25% of votes in the highest management body, or (iii) having the right to determine decision under the law or contract, or (iv) receiving 25% of distributed net profit); and indirect control means control of the company having direct control over another company. Accordingly, transfers between shareholders having less than 25% of shares (vote or net profit) would not be subject to the consent.

Moreover, the Subsoil Code provides more exemptions from the requirement to obtain consent and excludes

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inter alia transfer of subsoil user rights or shares in controlling persons within the same person (i.e. no change in shareholders but only change in the shareholding), intragroup transfers, change of type of legal entity (transformation) and reduction of shareholders of the controlling entity (buy out).

Similarly to the current law, the Subsoil Code establishes the state s priority right to purchase any subsoil use right and interest in the respective subsoil user and interest in persons controlling such subsoil user under the contract on use where the site is of strategic importance. The above mentioned test on control and exemptions from the consent requirements are also applicable to the state priority right.

Unlike the current law, the Subsoil Code provides which deposit may be recognized as having strategic importance and refers only to hydrocarbons but does not list uranium. Therefore, it is unclear whether uranium fields would or would not be recognized as fields of strategic importance.

4.7 Strategic object

Kazakhstan law (Civil Code and the Law on State Property) defines the term strategic object and provides that imposition of encumbrances and their alienation is subject to the approval of the Kazakhstan government. In addition, the Law on State Property provides that the Republic of Kazakhstan shall have the priority right to purchase the strategic object being disposed of.

The Civil Code provides a general description of objects which might be recognized as strategic objects while Decree No. 651 of the Republic of Kazakhstan dated June 30, 2008 approves a specific list of objects qualified as strategic (the List of Strategic Objects). While a 40% interest in JV Inkai held by the Kazatomprom was on the List of Strategic Objects since 2008, Cameco s 60% interest in JV Inkai was included on the List of Strategic Objects only in August 2012.

Accordingly, any encumbrances and disposal of an interest in JV Inkai requires a decree of the Republic of Kazakhstan and waiver of priority right by the Republic of Kazakhstan.

4.8 Taxes and royalties

The Resource Use Contract lists the taxes, duties, fees, royalties and other governmental charges that are payable by JV Inkai, including income tax, value added tax, excise tax, excess profits tax, social tax, land tax, transportation tax, royalties on uranium extracted, commercial discovery bonus and custom duties, subject to changes due to the elimination of the tax stabilization provision in October 2009 noted below.

However, on January 1, 2009, a new Tax Code took effect. Pursuant to the Tax Code, a number of changes have been introduced to the taxation regime of subsoil users.

The most significant changes to the tax regime previously applicable to the Resource Use Contract introduced by the Tax Code are as follows:

The abolition of the stabilization of tax regimes provided by resource use contracts. Prior to Amendment No. 2 being signed, the Resource Use Contract contained a tax stabilization provision. In October 2009, JV Inkai signed this amendment to the Resource Use Contract to adopt the Tax Code, which included elimination of this tax stabilization provision.

The rate of corporate income tax on aggregate income has been 20% since January 1, 2009. In 2007, JV Inkai became subject to payment of the income tax. Under the Resource Use Contract, corporate income tax rate was 30%.

The Tax Code has replaced the previous royalty regime with a new tax the Tax on Production of Useful Minerals, a mineral extraction tax previously defined as MET. MET must be paid on minerals and certain other substances extracted. The rate in the Tax Code used to calculate MET on uranium (production solution) is currently 18.5%. Under the prior law, JV Inkai would pay royalties, calculated on a graduated scale, based on the sale price of production in each year.

Under the Resource Use Contract, a one-time commercial discovery bonus is payable when confirmation is received of Kazakh-defined recoverable reserves located in a particular licensed area. Under the Tax Code, the rate for future commercial discoveries is increased to 0.1% of the value of Kazakh-defined recoverable reserves. Previously, the bonus was calculated as 0.05% of the value of Kazakh-defined recoverable reserves.

The Tax Code changes the calculation of excess profits tax from that contained in the Resource Use Contract. However, JV Inkai is currently of the view that it will not be liable to pay any excess profits tax for the foreseeable future.

4.9 Known environmental liabilities

For a discussion of known environmental liabilities, see Section 20.1.5 Known environmental liabilities.

4.10 Permitting

For a discussion on permitting, see Section 20.1.2 Permitting.

4.11 Factors affecting access to the property

Known factors and risks that may affect access, title and right to work on the property are described below.

Under the Resource Use Contract and Licenses, JV Inkai has the rights to explore for and to extract uranium from the subsoil and it owns the uranium extracted from the subsoil. Its ability to conduct these activities, however, depends upon compliance with its obligations under the Resource Use Contract, the Licenses and laws of Kazakhstan, as well as ongoing support, agreement and co-operation from the government of Kazakhstan.

Under Kazakhstan law, the state has the right to nationalize private property by enacting a law on nationalization. As of the date of this technical report, Kazakhstan has not exercised such right but the risk of nationalization of JV Inkai s property still exists.

The Subsoil Law lists the violations which entitle the Competent Authority to unilateral termination of a resource use contract (for more details please refer to Section 4.5.4 *Contract termination)*. If JV Inkai or its participants commit any of these violations, there is a risk of JV Inkai losing its subsoil use rights due to unilateral termination by the Competent Authority.

The Subsoil Law provides the state with the right to demand the amendments of the resource use contract if activities of a subsoil user, exploring or developing a strategic deposit, entail such changes in the economic interests of the Republic of Kazakhstan that pose a threat to national security. This in turn might entail a risk of diminishment of JV Inkai s rights. The right to demand amendments might be applied broadly by the Republic of Kazakhstan leading to a risk of (i) curtailment of JV Inkai s rights or (ii) termination of the Resource Use Contract and the Licences. For more details please refer to Section 4.5.4 *Contract termination.*

JV Inkai is required to hold, and it does hold, a number of licences and permits (including but not limited to ecological permits) and therefore, must comply with their requirements. Failure to obtain and to comply with the requirements of licences and permits could result in the activities JV Inkai performs under a licence or permit being limited. For example, without an ecological permit, JV Inkai will be unable to conduct subsoil operations.

Generally, other breaches of law and/or contractual obligations (such as failure to pay taxes, breach of regular contract, or causing damages to a third party) may also lead to limitation of the right to use JV Inkai s property.

Please see Section 24.5.1 *Kazakhstan laws and regulations* for a discussion of other risks that may affect access, title and right to work on the property.

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5 Accessibility, climate, local resources, infrastructure and physiography

5.1 Access

The Inkai operation is located near the town of Taikonur, approximately 350 kilometres northwest of the city of Shymkent and approximately 155 kilometres east of the city of Kyzl-Orda in the south-central region of Kazakhstan. Taikonur can be reached from Astana or Almaty by flying to one of the regional cities of Shymkent or Kyzl-Orda, then driving on paved roads (*Figure 5-1*). The road to Taikonur is currently the primary access road for transportation of people, supplies and uranium product for JV Inkai.

Major airline service is available to Astana and Almaty from Europe, Russia, China and other countries in the region. From Astana or Almaty, commercial airline services are available to Shymkent and Kyzl-Orda. The flight from Almaty to Kyzl-Orda is a two-hour trip. The four-hour drive from Kyzl-Orda is on paved roads for 130 kilometres to the town of Shieli and then for 160 kilometres to Taikonur. The total trip time through Shymkent from Almaty is about eight hours for 470 kilometres on a paved road.

Rail transportation is available from Almaty to Shymkent then northwest to Shieli, Kyzl-Orda and beyond. A rail line also runs from the town of Dzhambul to Kazatomprom s Centralia facility to the south of Taikonur.

5.2 Climate

Inkai lies in the Betpak Dala Desert. The ground consists of extensive sand deposits, with vegetation limited to grasses and occasional low bushes. Major hydrographic systems in the area include the Shu, Sarysu and Boktykaryn rivers. These rivers typically exhibit surface water flow in May and June and revert to isolated reaches with salty water during the rest of the year.

The climate in south central Kazakhstan is semi-arid, with temperatures ranging from -35°C in the winter to +40°C in the summer. January is the coldest month, with an average temperature of -9°C. July is the warmest month, when temperatures climb to an average of +28°C. The climate of the region is continental, characterized by harsh winters and hot summers, low humidity and low precipitation. The daily fluctuation in air temperature during the summer can be up to 14°C.

The average precipitation varies from 130 to 140 millimetres per year, with snow accounting for 22 to 40% of this amount. The average air humidity is typically in the range of 56 to 59%.

The region is also characterized by strong winds. The prevailing direction of the wind is northeast, averaging 3.8 to 4.6 metres per second. Dust storms are common.

Site operations are carried out throughout the year, despite the cold winter and hot summer conditions.

5.3 Physiography

The surface elevation at Inkai ranges from 140 to 300 metres above mean sea level. The Inkai deposit is subdivided into two morphologically diverse regions:

- the sandy-brackish intercontinental deltas of Shu and Sarysu rivers the Betpak Dala Plateau

The sandy-brackish intercontinental deltas of the Shu and Sarysu rivers are located in the hollow between the elevation of the Betpak Dala plateau and the Karatau Mountain range. This plain has numerous brackish and lacustrine basins, dry river-beds, former river-beds, and aeolian relief of various configurations. The Betpak Dala is a slightly sloping and slanted north to south plain with deflationary basins and rare arched ridges.

5.4 Local resources

Currently, Taikonur has a population of about 680 people who are mainly employed in uranium development and exploration. Whenever possible, JV Inkai hires personnel from Taikonur and surrounding villages. The town has a school, medical clinic and small store. Most of the food is purchased in Shymkent or Shieli.

5.5 Infrastructure

Inkai is a developed producing property with sufficient surface rights to meet future mining operation needs for the current mineral reserves as well as site facilities and infrastructure. The electrical supply for Inkai is from the national power grid. Inkai is connected to the grid via a 35-kilovolt power line, which is a branch of the circuit that supplies the Stepnoye mine east of Inkai. In case of power outage, there are standby generators. Telephone communications utilize a satellite internet system.

Inkai has access to sufficient water from groundwater wells for all planned industrial activities. Potable water for use at the camp and at the site facilities is supplied from shallow wells on site. The water systems include well houses, pump stations, storage for reserve demands and fire protection and distribution to points of use and fire protection mains. Sewage disposal is in a standard septic tank and leach field system.

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FIGURE 5-1: GENERAL LOCATION MAP

(Source: Cameco, 2016)

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6 History

6.1 Ownership

There have been several changes in ownership of participating interests in the limited liability partnership, JV Inkai, established under the laws of Kazakhstan that govern Inkai. The current owners and their participating interests are as follows:

Cameco (60%)

Kazatomprom (40%)

In 1996, JV Inkai is first registered by the Kazakhstan Ministry of Justice. The participating interests were Cameco, Uranerzbergbau-GmbH, and National Joint Stock Company Atomic Power Engineering and Industry KATEP (KATEP), all with 33 1/3%.

In 1997, Kazatomprom is established. The Republic of Kazakhstan owns Joint Stock Company Sovereign Wealth Fund Samruk-Kazyna , who is the sole shareholder of Kazatomprom.

In 1998, KATEP s participating interest in JV Inkai is transferred to Kazatomprom. Cameco acquires all of the participatory interest of Uranerzbergbau-GmbH, becoming owner of a 66 2/3% participatory interest in JV Inkai. Cameco agrees to transfer a 6 2/3% participatory interest in JV Inkai to Kazatomprom, leaving Cameco with a 60% participating interest.

In August 2011, Cameco and Kazatomprom entered into a memorandum of agreement (2011 MOA) to increase annual uranium production at Inkai from Blocks 1 and 2 to 5.2 million pounds of U_3O_8 (100% basis). Under the 2011 MOA, Cameco s share of Inkai s annual production is 2.9 million pounds of U_3O_8 and is also entitled to receive profits on 3.0 million pounds of U_3O_8, defining the basis of its 57.5% share of mineral resources and mineral reserves (assuming annual production at 5.2 million pounds of U_3O_8).

See Section 24.3 *2016 Implementation Agreement* for information on the Implementation Agreement, which contemplates, once it closes, an adjustment of Cameco s and Kazatomprom s participating interests in JV Inkai.

6.2 Exploration and development history

Historical exploration

The Inkai deposit was discovered during drilling campaigns conducted in 1976 1978 by Volkovskaya Expedition. By that time, prospecting and exploration programs had also resulted in the identification of the Uvanas, Zhalpak, Kanzhugan and Mynkuduk deposits. Together with the Inkai deposit, they formed a large new uranium mineralization prospect in the Shu-Sarysu depression. Exploration drilling progressed until 1996.

In Blocks 1 and 2, the main exploration grid was developed along fence lines 400 metres to 800 metres apart, with drillholes centred 50 metres apart. In several areas, this was increased to 200 by 50 metres. In contrast, by 1996 Block 3 was characterized by significantly lower densities of drilling, ranging from 800 metres by 50 metres to 1,600 3,200 metres by 100 800 metres. All historic exploration and delineation drilling, as listed in *Table 6-1*, was carried out prior to JV Inkai obtaining its licences for Inkai. A map of the location of the historical and current drill holes is presented in Section 10 *Drilling*, in *Figure 10-1*.

TABLE 6-1: HISTORICAL DRILLING

Block	Area (km^2)	Number of holes
1	17	1,368
2	230	2,294
3	240	489

Regional and local hydrogeology studies were completed on Inkai dating back to 1979. Numerous borehole

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tests characterize the four aquifers within the Inkai deposit: the Uvanas, Zhalpak, Inkuduk and Mynkuduk.

Main processing and satellite plants

A pilot test, using the ISR mining method, was performed in the northeast area of Block 1 starting in December 1988. The pilot leach test in the north area of Block 2 was initiated in 2002.

In September 2005, JV Inkai decided to proceed with the main processing plant to be located at Block 1, and construction began soon after. Commissioning of the front half of the main processing plant was completed during the fourth quarter of 2008, and the processing of solutions from Block 1 commenced.

In 2009, construction of the main processing plant was completed, and in February 2010, regulatory approval to commission the main processing plant was received, allowing full processing of uranium concentrate on site. Also in 2009, JV Inkai constructed and began commissioning a satellite plant to process solution recovered from Block 2. In 2011, JV Inkai received regulatory approval for processing at the first satellite plant. In 2010 planning began for the engineering and construction of a TLF at Block 3. In 2015 JV Inkai completed construction of the Block 3 TLF and began pilot production from test wellfields.

6.3 Historical mineral resource and mineral reserve

There are no historical mineral resources and mineral reserve estimates within the meaning of NI 43-101 to report.

6.4 Historical production

A pilot test, using the ISR mining method, was performed in the northeast area of Block 1 starting in December 1988. The test lasted for 495 days and recovered approximately 92,900 pounds of U_3O_8. The pilot leach test in the north area of Block 2 started in 2002 and was completed in 2006. Commercial production started in 2009. Inkai production from Blocks 1 and 2 to year-end 2016 is shown in *Table 6-2*.

TABLE 6-2: INKAI BLOCK 1 AND BLOCK 2 URANIUM PRODUCTION

Period	Blocks	Production (M Lbs U_3O_8)	Cameco s share (M Lbs U_3O_8)
1988 1990	1	0.1	
2002 2006	2	2.0	1.2
2007	2	0.3	0.2
2008	2	0.5	0.3
2009	1 & 2	1.9	1.1
2010	1 & 2	4.3	2.6
2011	1 & 2	4.2	2.5
2012	1 & 2	4.4	2.6
2013	1 & 2	5.3	3.1
2014	1 & 2	5.0	2.9
2015	1 & 2	5.8	3.4
2016	1 & 2	5.9	3.4

2009-16	Total	36.7	21.5

JV Inkai is licensed to produce at an annual rate of 5.2 million pounds of U_3O_8. During 2015, the Subsoil Law in Kazakhstan was amended to allow producers to produce within 20% (above or below) of their licensed production rate in a year.

Block 3 ISR test was started in 2015 and is ongoing. At December 31, 2016, total production from test mining at Block 3 was 865,000 pounds.

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7 Geological setting and mineralization

7.1 Regional geology

The geology of south-central Kazakhstan is comprised of a large relatively flat basin of Cretaceous to Quaternary age continental clastic sedimentary rocks. The Chu-Sarysu Basin extends for more than 1,000 kilometres from the foothills of the Tien Shan Mountains located on the south and southeast sides of the basin, and merges into the flats of the Aral Sea depression to the northwest.

The basin is up to 250 kilometres wide, bordered by the Karatau Mountains on the southwest and the Kazakh Uplands on the northeast. The basin is composed of gently-dipping to nearly flat-lying fluvial-derived unconsolidated sediments comprising inter-bedded sand, silt and local clay horizons. These sediments contain several stacked and relatively continuous, sinuous roll-fronts , or oxidation-reduction (redox) fronts hosted in the more porous and permeable sand and silt units (Figure *7-1)*.

Economic uranium mineralization within the Chu-Sarysu Basin was studied extensively from 1971 to 1991. Several uranium deposits were identified across the Chu-Sarysu and its neighbour, the Syr-Darya basin, separated by the Karatau Range uplift. These deposits have been grouped into the Chu-Syr Darya mineralized region. The Zhalpak, Mynkuduk, Akdala, Inkai, South Inkai and Budyonovskoe deposits are hosted by Upper Cretaceous sequences, and form the Zhalpak-Budyonovskoe mineralized belt situated in the northwestern part of the Chu-Sarysu Basin. The Kanzhugan, Muyunkum, Totrkuduk and Uvanas deposits are hosted by Upper Cretaceous and Paleocene-Eocene sequences, forming the Uvanas-Kanzhugan mineralized belt situated in the central part of the Chu-Sarysu Basin.

The Cretaceous and Palaeogene sediments hosting the uranium deposits are associated with large fluvial systems.

FIGURE 7-1: SCHEMATIC CROSS-SECTION OF THE CHU-SARYSU BASIN LOOKING WEST

(Source: Kislyakov and Shetochkin, 2000; modified by Cameco in 2016)

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7.1.1 Hydrostratigraphy of the Chu-Sarysu Basin

Hydrostratigraphy plays key roles both in the formation of the uranium sandstone deposits and in mining them using the ISR method.

The Inkai deposit is located in the north-western part of the Suzak artesian basin that comprises two hydrogeological stages, an upper platform stage and a lower basement stage.

The upper platform stage is related to Quaternary-Neogene and Palaeogene-Cretaceous deposits. The hydrogeological section of the platform stage reveals two hydrogeological sub-stages. The upper hydrogeological sub-stage is the Betpak Dala aquifer (fine-grain sands) and other aquifers of sporadic occurrence. In general, these aquifers contain brackish and saline water not suitable for drinking. These upper aquifers are hydraulically isolated from the lower hydrogeological sub-stage aquifers by the regional Intymak clay aquitard of the Lower and Upper Eocene which is about 100 to 150 metres thick.

The lower basement stage contains groundwater in fractured rocks of Palaeozoic age. It contains four aquifers within Palaeocene and Upper Cretaceous strata, listed from top to bottom as follows:

Uvanas aquifer: contains fresh groundwater suitable for household and drinking purposes. The Uvanas aquifer is widely used in the region for domestic and livestock water supply. In the nearest vicinity of the deposit, in the town of Taikonur, there are six domestic water supply boreholes operated on the Uvanas aquifer. Additionally, outside Inkai, but in its vicinity, there are a few free-flowing artesian boreholes tapping groundwater from the Uvanas aquifer for livestock watering

Zhalpak aquifer: contains slightly brackish water which can be used for watering livestock. The aquifer is accessed by wells in proximity to Inkai. Groundwater from the Zhalpak aquifer is used for industrial and partial drinking water supply in the vicinity of the deposit site

Inkuduk aquifer: contains brackish and slightly brackish water not suitable for drinking

Mynkuduk aquifer: contains brackish and slightly brackish water not suitable for drinking.

Groundwater movement in the Chu-Sarysu Basin is towards the north-westerly discharge areas. The annual natural flow rate averages one to four metres, depending on the various permeabilities of the different sand horizons.

The lower aquifers have a common recharge area (the Karatau ridge and the Tien-Shan Mountains) and discharge into topographic depressions of the region-saline lands of Ashikol, Askazansor, and Lake Arys. Regional groundwater flows north-north-west. Permian claystones and siltstones underlay Mynkuduk aquifer and appear to be a regional aquitard. Elsewhere in the region, the groundwater is tapped by numerous boreholes for livestock watering. Groundwater of lower aquifers is not used at Inkai or in the surrounding area.

7.2 Local and property geology

The stratigraphic sequence at Inkai ranges from Cretaceous though to Quaternary sediments. A schematic stratigraphic cross-section of Inkai is presented in *Figure 7-2*.

Neogene-Quaternary sediments of continental origin form the uppermost cover. They do not host significant uranium occurrences. These are underlain by 100 to 150 metres of Palaeogene clay-dominated marine sediments. Elsewhere in the basin, these display a lower facies transition zone of brackish sediments that hosts the uranium deposits of Tortkuduk and of the Taukent area (Kanzhugan and Moynkum).

The underlying Upper Cretaceous strata are divided into three horizons, listed from youngest to oldest: the Zhalpak horizon; the Inkuduk horizon; and the Mynkuduk horizon.

Zhalpak horizon

The Zhalpak horizon is Campanian-Maastrichtian in age, and is generally comprised of a medium grained sand, with occasional clay layers.

Inkuduk horizon

The Inkuduk horizon is Coniacian-Santonian in age, and is typified by medium to coarse-grained sands, with

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occasional gravels.

In the Inkuduk horizon, there are three sub-horizons representing indistinct transgressive alluvial cycles composed of several incomplete elementary rhythms. Lower and middle sub-horizons are composed mainly of coarse clastic sediments of channel facies while the upper sub-horizon is made of floodplain channel formations. The thickness of the Inkuduk horizon is up to 120 metres, and the depth to the bottom varies from 300 to 420 metres at the Inkai deposit, being a function of both basin architecture and the topography.

The general plan of the river network at the time within the deposit did not change significantly. Relatively dissected topography, closeness of uplifted alimentation zones facilitated deposition of mottled and coarse clastic poor sorted sediments alternating in the section. Interbeds of siltstone-sand clays, medium and fine grained sands are subordinate in the Inkuduk horizon.

Mynkuduk horizon

The Mynkuduk horizon is Turonian in age, uncomfortably overlying the Permian argillites and dominated by fine to medium-grained sands. These sands are generally well sorted, reflecting a probable overbank environment.

Sediments of the Mynkuduk horizon represent an alluvial cycle of the first order where several (up to ten) elementary rhythms with a thickness up to several metres can be identified. Each of them begins with coarse, poorly sorted gravel, inequigranular sands with gravel and pebble and ends with small, clastic rocks, sometimes interbeds (up to 20 centimetres) of dense sands with carbonaceous cement. In some areas in the basal part of the horizon, mottled sandy clays and siltstones of floodplain facies are developed.

The dominating colour of the rocks is greyish-green to light-grey for the channel sand-gravel sediments. The total thickness of the sediments of the Mynkuduk horizon in the area is 60 to 80 metres.

Regular alternation of channel sediments with floodplain sediments is characteristic of lateral direction, where initial mottled and green sand-clay formations in floodplains and watersheds are replaced by channel midstream, grey bar-sand rocks.

The depth to the Paleozoic unconformity increases to the west and south. At the east end of the Mynkuduk deposit, the unconformity is at a depth of about 250 metres. It deepens to 350 to 400 metres where the Mynkuduk and the Inkai deposits meet, to 500 to 600 metres at the south end of Inkai, and to more than 700 metres at Budyonovskoe deposit.

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FIGURE 7-2: SCHEMATIC STRATIGRAPHIC COLUMN FOR THE CHU-SARYSU BASIN

(Source: Kislyakov and Shetochkin, 2000; modified by Cameco in 2016)

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7.2.1 Local hydrogeology

The unconsolidated Upper Cretaceous sediments provide an excellent groundwater-storing reservoir, some 250 to 300 metres thick. This reservoir is regionally confined by the underlying Palaeozoic rocks and the overlying thick Palaeogene marine clays (Intymak, Uyuk and Ikan aquitards). To varying degrees, there is local confinement created by the sedimentation cycles, with each cycle including fine sands to silts and occasional clay seams at the top.

The Upper Cretaceous groundwater regime exhibits a layered sequence of aquifers due to gravity separation by different salinity levels, or total dissolved solids (TDS). At Inkai, from youngest to oldest, top to bottom these are:

Uvanas & Betpak Dala fresh water (0.6   0.8 grams per litre TDS) aquifer

Zhalpak brackish water (1.1   1.5 grams per litre TDS) aquifer

Inkuduk salt water (2.3   3.6 grams per litre TDS) aquifer

Mynkuduk salt water (2.7   4.5 grams per litre TDS) aquifer.

The confined Upper Cretaceous aquifers produce artesian conditions where the topography is depressed below the piezometric surface of about 135   140 metres above sea level. The general water table is at a depth of eight to ten metres at Inkai.

The Inkai deposit includes the lower hydrogeological sub-stage (Paleocene and Upper Cretaceous). The hydrogeological conditions for the Quaternary-Upper Eocene sediments are not described here because aquifers of the upper sub-stage are not hydraulically connected to the Inkai deposit (Volkovgeology, 2007, 2015).

Available hydrogeology information is summarized below for the entire Inkai deposit with references for different blocks as specified.

The typical feature of the Upper Cretaceous aquifers (Zhalpak, Inkuduk and Mynkuduk) is a quasi-uniform lateral structure, i.e. high heterogeneity but in a very local scale. Thus, in a scale of pumping tests, hydraulic properties vary laterally very little, even though borehole logs reveal sediments of very different grain sizes. All these aquifers present a vertical anisotropy due to low-permeable lenses and thin layers between the aquifers and sub-horizons.

Intymak aquitard (Middle to Upper Eocene)

The Intymak aquitard is composed of greenish-grey, bluish-grey intercalated, rarely massive marine clays, varying in thickness from 70 to 120 metres. Intymak clays outcrop immediately to the north-west of Block 3 in the Batykaryn river terrace. The Intymak clays comprise a regional aquitard in the Chu-Sarysu Basin.

Uyuk-Ikan aquitard (Lower Eocene)

The Uyuk-Ikan aquitard is represented by massive grey and greenish-grey marine clays. The thickness varies from 22 metres in the northern part of Block 3 to 70 metres in the southern part of Block 2.

Uvanas and Byurtusken aquifers (Lower Paleocene)

The thickness of the Uvanas and Byurtusken aquifers varies from 15 metres in the northern part of Block 2 up to 80 metres in the south and south east, beyond the deposit boundary. At Inkai, the aquifers occur at depths of 170 to 280 metres and have a thickness from 20 to 30 metres. Water bearing sediments are fine to medium grain sands.

Based on 15 single borehole pumping tests at Blocks 1 and 2 (Volkovgeology, 1991) and five cluster pump tests at Block 3 (Volkovgeology, 2007, 2015), the calculated transmissivity of the Uvanas and Byurtusken aquifer varies from 47 to 168 square metres per day, with horizontal hydraulic conductivities between 2.4 and 8.6 metres per day. Borehole yields were 1.6 to 11.0 litres per second.

Zhalpak aquifer (Campanian-Maastrichtian)

The depth to the bottom of the Zhalpak aquifer varies from 195 metres in the northern part of Block 3, to 270 metres in the northern part of Block 2, and to 355 metres in the southern part of Block 1. The aquifer thickness is 40 to 60 metres. Water bearing sediments are fine and medium grained sands with gravels. In the top of the Zhalpak Formation, there is a one to 10-metre layer of clays and fine sands that separates the Zhalpak aquifer from the overlying Uvanas aquifer. This layer is assumed to be the Upper Zhalpak aquitard (Geolink, 2003, Volkovgeology, 2007, 2015). There are clays and argillaceous sands underlying the Zhalpak aquifer that serve as local aquitards. Those low-permeable sediments are somewhat discontinuous; therefore, some hydraulic connection between the Zhalpak and underlying aquifers is possible.

The hydraulic properties of the Zhalpak aquifer were characterized by 10 pumping tests within Block 2, and seven pumping tests within Block 3. From their interpretation (Volkovgeology, 1991, 2007, 2015), the estimated transmissivity varies from 226 square metres per day to 575 square metres per day, with an average value of 413 square metres per day. Elsewhere in the mine, transmissivities of the Zhalpak aquifer were estimated within a similar range for Block 2. Horizontal hydraulic conductivities on Block 2 were estimated at the range 5.5 to 11.4 metres per day, with an average value of 8.9 metres per day.

Inkuduk aquifer (Upper Turonian-Santonian)

The top of the Inkuduk aquifer is located at an approximate depth of 250 to 380 metres, with an average thickness between 110 and 130 metres. The aquifer contains fine-to-coarse granular sands with gravels and pebbles. Three sub-layers are identified and listed from top to bottom as: sands with clay lenses; fine and medium-grained sands; and sands with gravels and pebbles.

These sub-layers are not always present, and there are no clear boundaries between them. Towards northeast of Block 2 and the entire site, the clay content is slightly increasing in all sub layers. Clay lenses typically separate the Inkuduk aquifer from the upper and lower horizons. This aquifer hosts a portion of the mining zone. In Blocks 2 and 3, uranium mineralization develops within the middle and the lower parts of the Inkuduk aquifer, down to the depths of 270 to 370 metres, depending on local conditions.

The Inkuduk aquifer is characterized by 27 borehole tests conducted by Volkovgeology prior to 1991, and 38 borehole tests comprising eight cluster aquifer pump tests, as well as 28 single well tests conducted at Block 3 from 2010 to 2013 by Volkovgeology, under the contract with JV Inkai. Horizontal hydraulic conductivities obtained from different parts of test interpretation graphs were between 6.3 and 22.8 metres per day, with 80% of values in the range 10 to 18 metres per day.

Borehole yields for the Inkuduk aquifer in Block 2 vary between 3.2 and 18.30 litres per second, and specific borehole yields vary between 0.8 and 2.4 litres per second. Generally, hydrogeological tests revealed that horizontal hydraulic conductivities of the Inkuduk aquifer were consistent through the whole cross-section. Hydraulic conductivity of the lower sub-horizon was estimated in the range of 9.2 to 16.1 metres per day; for the middle sub-horizon, 11.8 to 15.8 metres per day; and for the upper sub-horizon, approximately 13 metres per day. Transmissivities for different sub-horizons were estimated, on average, as 472 square metres per day, 613 square metres per day, and 336 square metres per day for the lower, the middle, and the upper horizons, respectively.

Mynkuduk aquifer (Lower Turonian)

The top of the Mynkuduk aquifer is encountered at depths of 360 to 370 metres, with a thickness of 30 to 40 metres in the northeast, increasing to 70 to 90 metres in the south-west. The average thickness of the aquifer at Block 2 is 48 metres.

The aquifer lies on the Paleozoic argillaceous sediments that are recognized as a regional aquitard. The water bearing sediments are sands of various grain sizes with clays, gravels and pebbles. Generally, coarse sand and gravel fractions are associated with the upper part of the aquifer, while more clayish fractions are associated with the lower part of the aquifer. Towards the north-east of Block 2 and the entire site, the clay content is slightly increasing in all sub layers, particularly in the upper sub-horizon of the Mynkuduk aquifer.

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The Mynkuduk aquifer hosts a portion of the deposit. In Block 2, the lower boundary of uranium mineralization is found for different locations at depths of 380 to 430 metres; however, this aquifer contains minor mineralization (compared to the Inkuduk aquifer on Block 2).

The Mynkuduk aquifer is characterized by 95 boreholes, 20 hydrogeological single borehole tests, 36 multi-borehole tests and five injection tests (Volkovgeology, 1991). Borehole yields vary from 1.5 to 16.7 litres per second, with borehole specific yields between 0.2 to 2.6 litres per second.

Horizontal hydraulic conductivities at the deposit area vary from 7.1 to 13 metres per day, with the average value of 10.9 metres per day. Site transmissivities vary between 394 and 694 square metres per day, with the average value of 564 square metres per day. Block 2 was characterized by 20 borehole tests prior to 1991.

Resulting horizontal hydraulic conductivities are generally higher for Block 2 than for Block 1, with values varying between 7.4 and 17.3 metres per day, and an average value of 13 metres per day. Block 2 transmissivities obtained from pumping tests were in the range 460 to 755 square metres per day.

Vertical hydraulic conductivities were not well defined during exploration activities. They were calculated through calibration of the regional groundwater flow model by Geolink (2003).

Prevailing values of both horizontal and vertical hydraulic conductivities used by Geolink for the regional groundwater flow model are shown in *Table 7-1.*

TABLE 7-1: HYDRAULIC CONDUCTIVITY

Model	**Hydraulic conductivity (m/d)**		
Aquifer/Aquitard	**Horizontal**	**Vertical**	**Anisotropy ratio(rounded)**
Uvanas	4.0	0.62	6 : 1
Upper Zhalpak aquitard	1×10^{-5}	2.5×10^{-5}	1 : 2.5
Zhalpak	14.6	0.023	635 : 1
Upper Inkuduk	3.0	0.5	6 : 1
Middle Inkuduk	10.5	0.5	20 : 1
Lower Inkuduk	14.4	0.5	30 : 1
Upper Mynkuduk	10.7	1.0	10 : 1
Lower Mynkuduk	10.3	1.0	10 : 1

Calibrated values of horizontal hydraulic conductivity are generally higher than vertical hydraulic conductivity values by about one order of magnitude, with the exception of the Zhalpak aquifer. This aquifer has discontinuous lenses of low-permeable clays and argillaceous sands with a calculated anisotropy ratio of 635:1.

7.2.2 Hydraulic connectivity

The Uvanas aquifer is confined by 100 to 150 metres of clays (regional aquitard), so it can be considered hydraulically isolated in the region from the overlying Betpak Dala aquifer.

However, Geolink (2003) data analysis and the modelling study revealed an insignificant leakage of groundwaters of the Uvanas aquifer into the overlying Betpak Dala aquifer for the northern flank of Block 1. The reason for this leakage appears to be open exploration wells that allow some hydraulic connection.

The aquifers of the lower hydrogeological sub-stage are hydraulically connected. This connection is more obvious between three lower aquifers (the Zhalpak, the Inkuduk and the Mynkuduk) that, according to borehole logs and geophysics results, do not have continuous separating low-permeability layers. These aquifers are separated from each other by clay lenses and by sediments with higher clay contents. Furthermore, a multi-stage pumping test conducted by KAPE (2002) demonstrated a hydraulic connection between the Zhalpak aquifer and the horizons of the Lower Cretaceous (e.g., Inkuduk and Mynkuduk). Re-interpretation of the Volkovgeology (1991) pumping tests conducted by KAPE (2002) also supports this hypothesis.

The hydraulic connection of the Uvanas aquifer with the underlying aquifers is complicated by the presence of a thin (one to 10-metre) layer of low-permeable deposits in the upper part of the Zhalpak aquifer. Previous site studies (Volkovgeology, 1991; KAPE, 2002) conclude that these two aquifers are considered hydraulically isolated. However, this conclusion was based on the presence of low-conductive sediments between these two aquifers and the results of one pumping test in the Uvanas aquifer when no drawdown was observed in the underlying aquifers. Subsequent site studies (Geolink, 2003) indicate that this conclusion may be incorrect.

Piezometric levels of the Uvanas aquifer are very close to that of the Zhalpak aquifer (the difference may run to less than 10 to 20 centimetres) and piezometric level data for both aquifers show a synchronous decrease over the last 20 years. This evidence suggests a hydraulic connection between the aquifers in the lower hydrogeological sub-stage. However, the degree of interconnection between the Uvanas aquifer and Zhalpak aquifer is significantly less than between the Zhalpak and Inkuduk, and Inkuduk and Mynkuduk aquifers.

7.2.3 Piezometric measurements

The majority of water level measurements which were taken in Block 1 concerned the Mynkuduk aquifer, while measurements at Blocks 2 and 3 were carried out on Inkuduk and Zhalpak aquifers (Volkovgeology, 1991, 2007, 2015; KAPE, 2002). Overall, piezometric data indicate that the Uvanas, Zhalpak, Inkuduk and Mynkuduk aquifers are confined, with piezometric levels varying from approximately 20 metres above ground surface on the southeast to about 20 metres below ground surface on the north and north-west. The horizontal hydraulic gradients at Inkai are relatively small (e.g., 2 to 3 x 10-4). Estimated lateral groundwater movement is approximately 0.5 to 3.0 metres per year.

Concurrent piezometric measurements from four aquifers in cluster wells K1, K2 and K15 indicate similar piezometric levels with differences of 0.7 metres (Volkovgeology, 1991; Geolink, 2003). This observation suggests that the natural piezometric surfaces for these aquifers coincide.

Monitoring of piezometry variations by Volkovgeology (1991) revealed that, between 1981 and 1991, the site piezometry was gradually declining in all four aquifers. This drop was observed throughout at the mine, including boreholes in Block 2. The drop of piezometric levels between 0.3 and 1.2 metres per year was observed in the majority of exploration boreholes, with a site average of 0.5 to 0.7 metres per year. This drop in the piezometric surface was likely related to aquifer exploitation beyond the mine site, in the southern, south-eastern and south-western parts of the West-Chu artesian basin. Other reasons could be the presence of free-flowing artesian boreholes used for livestock watering.

Between 2001 and 2004, piezometric levels of the Upper Cretaceous complex continued to decline, but at a slower rate of 0.1 to 0.3 metres per year (KAPE, 2006). Decline of piezometric levels is expected to continue to slow down due to abandonment of free-flowing boreholes within and adjacent to the mine.

7.2.4 Groundwater chemistry

Typical vertical hydrochemical zoning is observed in the water-bearing complex of the lower hydrogeological sub-stage. There is a regular top-down increase in total dissolved solids from 0.6 to 4.7 grams per litre. These aquifers have also lateral hydrochemical zoning. As groundwater flows from its source towards north-west the salinity of water increases and the hydrochemistry changes.

Apart from upper zones of the Zhalpak aquifer, the groundwaters are not suitable for drinking due to high TDS, but up to certain depth (usually top of the Inkuduk aquifer) can be used for livestock watering.

Groundwater in the Zhalpak aquifer is fresh to slightly brackish (TDS=0.9 to 1.8 grams per litre). Uranium concentrations are 1.0 x 10-7 to 2.1 x 10-6 grams per litre; radium concentrations 1 x 10-12 to 6 x 10-12 grams per litre.

These concentrations are consistent with typical background concentrations of these elements in sedimentary rocks. Brackish and salt water is found in the two lower aquifers.

TDS of the Inkuduk aquifer vary between 1.2 and 3.6 grams per litre, increasing with depth of burial. The

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groundwaters of the upper sub-horizon with TDS less than 1.6 grams per litre are suitable for industrial needs. TDS of the Mynkuduk aquifer is quite high: 2.7 to 4.7 grams per litre, increasing from north to south with deepening of the layer. The groundwaters from both aquifers are of a SO4-Cl-Na type. Uranium mineralization in Block 2 occurs in the middle and upper parts of the Inkuduk aquifer. In Block 1, uranium mineralization generally associates with Mynkuduk aquifer.

7.3 Mineralization

7.3.1 Host rocks

As presented in *Figure 7-3,* the mineralization is hosted by three horizons: the Middle Inkuduk horizon; the Lower Inkuduk horizon; and the Mynkuduk horizon. Horizons are divided into sub-horizons as shown in *Table 7-2.* Ten mineralized zones have been identified on Blocks 1, 2 and 3. These include four zones in the Mynkuduk horizon labelled with indices 1, 2, 3 and 15, and six zones in the Inkuduk horizon labelled with indices 10, 10a, 11, 12, 13 and 14. Their distribution among Blocks and relationship to the horizons are also listed in *Table 7-2.*

TABLE 7-2: HORIZONS AND SUBHORIZONS DIVISION

Horizon	Horizon index	Sub-Horizon	Sub Horizon index	Zones indices in Blocks: Block 1	Block 2	Block 3
		Upper part of Middle Inkuduk	in23			
Middle Inkuduk	in2	Middle part of Middle Inkuduk	in22		11, 12, 13	11
		Lower part of Middle Inkuduk	in21			
		Upper part of Lower Inkuduk	in12			
Lower Inkuduk	in1			10a	10	14
		Lower part of Lower Inkuduk	in11			
		Upper Mynkuduk	mk3			
					2	
Mynkuduk	mk	Middle Mynkuduk	mk2			15
		Lower Mynkuduk	mk1	3	1	

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FIGURE 7-3: INKAI URANIUM ROLL FRONT

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Block 1

- Bulk of the uranium mineralization contained in the Mynkuduk horizon and extending over more than 10 kilometres
- Small portion contained in the Lower Inkuduk horizon
- Depth to the bottom of mineralization in the Mynkuduk horizon ranges from 450 to 528 metres. Average depth is 490 metres
- Mineralization width in plan view ranges from 40 to 600 metres and averages 250 metres
- Mineralized levels are generally at the lower part of the horizon, close to the Permian-Upper Cretaceous unconformity, but may also be found at a higher level, above the oxidized part of the Mynkuduk.

Block 2

- Bulk of the mineralization contained in the Lower and Middle Inkuduk horizons extending over more than 35 kilometres
- Small portion is contained in the Mynkuduk horizon
- Depth to the bottom of mineralization in the Inkuduk horizons ranges from 300 to 426 metres. Average depth for Lower Inkuduk is 390 metres and 340 metres for the Middle Inkuduk
- Mineralization width for the Inkuduk horizon in plan view ranges from 40 to 1400 metres and averages 350 metres.

Block 3

- Bulk of mineralization contained in the Lower and Middle Inkuduk horizons extending over more than 25 kilometres
- Small portion contained in the Mynkuduk horizon

Depth to the bottom of mineralization for the Middle Inkuduk horizon ranges from 278 to 415 metres. Average depth is 330 metres. Width in plan view ranges from 40 to 1600 metres and averages 350 metres

Depth to the bottom of the Lower Inkuduk horizon is 331 to 445 metres. Average depth is 360 metres. Width in plan view ranges from 40 to 600 metres and averages 250 metres

Depth to the bottom of the Mynkuduk horizon is 360 to 16 metres. Average depth is 430 metres. Width in plan view ranges from 40 to 350 metres and averages 200 metres.

Regional structures in the Chu-Sarysu Basin have had some control to the development of the sedimentary facies and to the movement of uranium bearing groundwater to form the roll fronts. Structure contour maps, on the surface of the basement Palaeozoic rocks, indicate that perhaps linear depressions in the surface have coincidence with overlying roll fronts; the hydrostratigraphy of the Cretaceous formations being the primary control to mineralization.

7.3.2 Oxidation and mineralization

Different lithologic and geochemical types have been studied for the content of their organic carbon, total iron, and iron contents.

The zone of uranium mineralization is located along the geochemical barrier marked by the contact zone of the incompletely oxidized rock and the primary grey-coloured rock. Iron oxides are nearly absent in this zone. Organic carbon content is decreased. Some associated pyrite, and sometimes carbonates, are observed. Four geochemical host rocks types can be identified at the deposit:

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diagenetically reduced grey sands and clays containing coalified plant detritus

green-grey sands and clays, reduced both diagenetically and epigenetically by gley soil (anaerobic organic) processes

non-reduced initially mottled sediments

yellow-coloured lithologies that underwent stratal epigenetic oxidation.

The initial colours are typical of channel of flood-plain facies. Diagenetically reduced grey sands and gravel of channel facies are more favourable for uranium deposition compared to greenish-grey or grey-green sands.

Occurrence and development of facies of Upper Cretaceous continental mottled alluvial formation is controlled by syn-sedimentary structures consistent with the tectonic pattern of the depression. Structural-facies control of mineralization is clearly expressed in mineralization of the Mynkuduk horizon. In the upper horizons such control is weakly expressed.

From observations of core, the redox boundary can be readily recognized by a distinct colour change from grey and greenish-grey on the reduced side to light-grey with yellowish stains on the oxidized side, stemming from the oxidation of pyrite to limonite and consumption of organic carbon.

The propagation of the oxidation fronts is affected by hydrostratigraphy (controlling fluid paths and velocities), and rock composition (controlling redox reactions). The implied groundwater movement direction was from the southeast to northwest, leading to the formation of oxidation tongues also oriented to the northwest. It gives rise to characteristic geometries of the redox fronts and associated mineralization described in more detail in the following section.

7.3.3 Geometry

The Inkai deposit has developed along a regional system of superimposed redox fronts in the porous and permeable sand units of the Chu-Sarysu Basin. The overall strike length of the redox front at Inkai is approximately 60 kilometres. The overall stratigraphic horizon of interest in the basin, located between 290 and 520 metres below surface, is approximately 200 to 250 metres thick.

Plan view

In a plan view the mineralized fronts have an irregular sinuous shape comprising southwestern and northeastern limbs joining to form prominent northeast-oriented frontal crests and southeast-oriented posterior troughs observed at a variety of scales. The wavelength of the larger-scale sinusoid varies from one to five kilometres, with the corresponding peak-to-peak amplitude varying from two to ten kilometres. Often, the irregular shape of a larger scale sinusoid is further complicated by smaller scale irregular sinusoids with more variably oriented limbs, crests and troughs, with wavelengths ranging from 100 to 500 metres and amplitudes from 200 to 1,000 metres. The width in a plan view of the limbs is typically narrower than that of the frontal crests and rear troughs. The crests and the troughs usually contain most of the metal accumulations. There are notable differences in the mineralization width in a plan view between different horizons and sub-horizons, as well as between different locations for the same sub-horizon, as presented in *Figure 7-3.* Overall, the mineralization in the Mynkuduk and Lower Inkuduk horizon is less than 40 to 100 metres wide in the limbs, and reach 600 metres in the crests and troughs. The mineralization in the Middle

Inkuduk horizon tends to be comparatively wider, especially in the central part of the deposit. It is 50 to 400 metres in the limbs, and reaches 1,400 metres in the crests and troughs in the central part of the deposit, but its width decreases and almost completely pinches out in the northern part of Block 3.

In the Middle Inkuduk horizon, the mineralization is found in coarse sands of the main channel or streambed facies. Here, the mineralized fronts are the farthest advanced to the northwest in the direction of groundwater flow. In the Lower Inkuduk and Mynkuduk horizons, mineralization usually lags somewhat behind, along a complex system of superimposed suturing oxidation tongues. Stacked mineralization is also observed where it occurs in different horizons over the same area; for example, in the north-east of Block 2 and south-west of Block 3, where up to five mineralization levels are stacked.

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Cross-section view

A variety of roll-front morphologies are observed, as represented in *Figure 7-4,* and are classified in five major groups:

- simple rolls, mineralization along the nose or edge of a single oxidation tongue, including the classic C-shaped rolls (A, E and H)
- cascade type, where two or more superimposed oxidation tongues form overlapping rolls (stacked mineralization) (B and D)
- adjacent type, where two or more tongues develop in the same level enclosing mineralization in between (C)
- combined cascade-adjacent type (G)
- tabular (F)

7.3.4 Mineralogy

Uranium

The main uranium minerals are sooty pitchblende (85%) and coffinite (15%). Sooty pitchblende occurs as micron-sized globules and spherical aggregates, while coffinite forms tiny crystals. Both uranium minerals occur in pores on interstitial materials such as clay minerals, as films around and in cracks within sand grains, and as pseudomorphic replacements of rare organic matter, and are commonly associated with pyrite. The latter seems to have formed after the growth of pitchblende as it often coats or rims the uraniferous films and aggregates. No other potentially deleterious trace elements have been detected. All potential contaminants such as molybdenum (Mo), selenium (Se) and vanadium (V) occur in background levels consistent with average values for the Earth s crustal rocks. The uranium mineralization is essentially clean and monometallic. Vanadium and molybdenum show elevated values where occasional organic debris has accumulated. The general distribution of potential contaminants in the roll-fronts is represented in *Figure 7-5.*

Poor and rich mineralization are distinguished not by the composition of uranium minerals but by their distribution. Poor mineralization is more dispersed than rich one. Authigenic mineralization is composed of pyrite, siderite, calcite, native selenium, chlorite, sphalerite, pyrolusite and apatite.

Trace elements

Quantitative methods of analysis in mineralized and waste sands were used to study the content of rhenium, scandium, yttrium, and the total of rare earths with yttrium, selenium and molybdenum.

Selenium was studied by X-ray spectral analysis on the grid 800 x 100 50 metres (the total number of samples comprised about 30,000). Selenium is almost absent in uranium mineralization. It is located only along the margins of grey sands, where it is fixed in the sub-zone of radium enrichment of up to two metres thick. The average selenium bodies are one to two metres thick and grades of 0.01 to 0.03%. They typically do not coincide with the contours of uranium mineralization.

Molybdenum accompanies uranium mineralization in trace amounts. Molybdenum content in mineralized uranium rocks is two to five times that in waste rocks. The molybdenum content in oxidized permeable rocks is 20 to 50% lower than that in non-oxidized waste rocks. Anomalous molybdenum content does not extend outside uranium occurrences

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FIGURE 7-4: ROLL-FRONT MORPHOLOGY OF MINERALIZATION

(Source: Kislyakov and Shetochkin, 2000; modified by Cameco in 2016)

FIGURE 7-5: TYPICAL CHARACTERISTICS OF A ROLL-FRONT DEPOSIT

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8 Deposit types

8.1 Roll-front deposits

The Inkai uranium deposit is a roll-front type deposit. Roll-front deposits are a common example of stratiform deposits that form within permeable sandstones in localised reduced environments. Microcrystalline uraninite and coffinite are deposited during diagenesis by oxygenated and uraniferous groundwater, in a crescent-shaped lens that cuts across bedding and forms at the interface between oxidized and reduced lithologies. Sandstone host rocks are medium to coarse grained and were highly permeable at the time of mineralization.

They form in continental-basin margins, fluvial channels, braided stream deposits and stable coastal plains. Contemporaneous felsic volcanism or eroding felsic plutons are sources of uranium. In tabular mineralization, source rocks for uranium-bearing fluids are commonly in overlying or underlying mud-flat facies sediments.

Fifteen economic uranium deposits have been discovered within Cretaceous and Palaeogene sediments of the Chu-Sarysu and Syr-Darya Basins across Kazakhstan. These are grouped into the Chu-Syr Darya mineralized region, and situated within the two basins that are separated by the Karatau Range uplift.

Soviet geologists established the spatial relation for uranium mineralization between the boundaries of the yellow oxidized sand sediments of aquifers and unoxidized grey sand sediments in Uzbekistan in 1956. These were named bed oxidation zones deposits by Soviet geologists, and characterised by: