November 28, 2022

Mesaba Project

Form 43-101F1 Technical Report

Mineral Resource Statement

St. Louis County, Minnesota

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Prepared For:

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DATE AND SIGNATURES PAGE

The effective date of this report is November 28, 2022. See Appendix A, Contributors and Professional Qualifications, for certificates of qualified persons. These certificates are considered the date and signature of this report in accordance with Form 43-101F1.

MESABA PROJECT
FORM 43-101F1 TECHNICAL REPORT
MINERAL RESOURCE STATEMENT

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APPENDIX	DESCRIPTION
A	Contributors and Professional Qualifications • Certificate of Qualified Person ("QP")

1 SUMMARY

PolyMet Mining Corp. ("**PolyMet**") requested Independent Mining Consultants, Inc. ("**IMC**") and JDS Energy & Mining Inc. ("**JDS**") to complete an update to the mineral resource estimate of the Mesaba Polymetallic Deposit located in St. Louis County, Minnesota. The technical work was completed during October 2022 and the effective date of this report is November 28, 2022. The updated mineral resource is tabulated in Table 1-1 within a pit shell defined by the input parameters shown in Sections 1.12 and 14.12 of this report.

Table 1-1: Mesaba Mineral Resource

	NSR Cutoff = $12.00/t								
	Short ktons (1)	**NSR $/t**	**Cu %**	**Ni total, %**	**Co ppm**	**Pt ppm**	**Pd ppm**	**Au ppm**	**Ag ppm**
Metal Prices			3.66/lb	6.79/lb	28.75/lb	1265/oz	1323/oz	1668.oz	23/oz
Measured	339,829	32.52	0.497	0.115	73.9	0.036	0.101	0.028	1.23
Indicated	1,866,958	27.57	0.415	0.100	76.9	0.034	0.096	0.024	1.18
Total M&I	2,206,787	28.33	0.428	0.102	76.5	0.034	0.097	0.025	1.19
Inferred	1,422,703	24.89	0.368	0.094	67.9	0.043	0.143	0.026	0.98

Note 1: ktons = short tons x 1000; Total Pit Shell ktons = 14,472,079; Tons and grades may not add due to rounding; Mineral Resources are reported on an undiluted basis.

The Mesaba Mineral Resources meet the current CIM definitions for classified resources. However, due to the uncertainty that may be attached to Inferred Mineral Resources, it cannot be assumed that all or any part of an Inferred Mineral Resource will be upgraded to an Indicated or Measured Mineral Resource as a result of continued exploration. Confidence in the Inferred portion of the estimate is insufficient to allow the meaningful application of technical and economic parameters or to enable an evaluation of economic viability worthy of public disclosure. Inferred Mineral Resources must be excluded from estimates forming the basis of feasibility or other economic studies.

The qualified person for the mineral resource is Herbert E. Welhener, SME-RM of IMC.

1.1 INTRODUCTION

IMC prepared this technical report (the "**Report**") within the meaning of National Instrument 43-101 – Standards of Disclosure for Mineral Projects ("**NI 43-101**"), Form 43-101F1 – Technical Report ("**Form 43-101F1**") and Companion Policy 43-101CP – Standards of Disclosure for Mineral Projects (the "**Companion Policy**") for PolyMet on the Mesaba Polymetallic Project (the "**Mesaba Project**" or the "**Project**"), located in St. Louis County, Minnesota. Teck Resources Limited ("**Teck**") indirectly owns 100% of the Project through its wholly owned subsidiary Teck American Inc.

Mr. Welhener has been informed by the Company that this Report is required as a result of Section 4.2(1) of NI 43-101.

Pursuant to a combination agreement dated July 19, 2022 (the "**Combination Agreement**") among the Company, Poly Met Mining, Inc., a wholly-owned subsidiary of the Company, Teck, and Teck American Inc., a subsidiary of Teck, the parties have agreed to form a 50:50 joint venture (the "**Transaction**") that will place the Mesaba Project and the Company's NorthMet Project under single management. PolyMet and Teck will become equal owners in Poly Met Mining, Inc., which will be renamed NewRange Copper Nickel LLC upon closing of the Transaction. As of the date of this Report, the closing of the Transaction remains pending.

Mesaba adds one of the world's largest undeveloped copper, nickel, and platinum group metals ("**PGM**") resources with a potential for multi-generational production to the PolyMet portfolio. The two projects account for approximately one-half of the known resources of copper, nickel, PGM in Minnesota's Duluth Complex. Teck is progressing baseline

environmental studies and resource definition and mineral processing studies on Mesaba. Further studies and community and tribal consultation will be required to fully define the long-term development potential of Mesaba. The Transaction is anticipated to be completed by the end of Q1 2023 and remains subject to satisfaction of customary closing conditions and receipt of certain regulatory approvals.

Mr. Welhener understands that the Company does not currently have ownership or other equity interest in the Mesaba Project. The Project is owned by Teck and this Report relies exclusively upon general information available in the public domain and as otherwise made available to PolyMet from Teck.

1.2 TERMS OF REFERENCE

Currency is expressed in United States dollars (US$) unless stated otherwise. Units presented are either metric units or imperial units and are clearly identified.

Mineral Resources are reported using the 2019 CIM Estimation of Mineral Resource and Mineral Reserves Best Practice Guidelines (the "**2019 CIM Definition Standards**"). Mineral Resources are presented on a 100% basis.

1.3 PROJECT SETTING

The Mesaba Project is located in St. Louis County, Minnesota. For purposes of this Report, the Project boundaries are defined by lands included within the four mineral leases held by Teck. The Mesaba deposit as described herein generally coincides with the Project boundaries, and it is part of the larger Duluth Complex. The Project includes surface and mineral interests that are owned by the State of Minnesota and other private parties along the southern margins of (and mostly within) the boundaries of the Superior National Forest, which is managed by United States Forest Service ("**USFS**"). The Forest Land and Resource Management Plan for the Superior National Forest provides for exploration, development and production of mineral and energy resources within certain areas within its boundaries. The USFS generally distinguishes non-federal minerals owned by states and private parties and federal minerals owned by the United States in its management of the national forests in recognition of established property rights.

The Project is readily accessible by paved state and county roads. The distance by road from Duluth is approximately 115 miles (185 km) via US-53, MN-169, County Hwy-21, MN-70 and County Hwy-70 through Babbitt to the Project boundary. Access to the site uses US Forest Service Road 112 to US Forest Service Road 423 ("**FR 423**"). At FR 423, Teck must maintain a road use permit issued by the USFS. At the Dunka River, Teck installed an 80 ft (24 m) long bridge and constructed an access road that linked to other established field roads. Teck obtained regulatory authorizations from the USFS and Minnesota Department of Natural Resources ("**MDNR**") required for construction (where necessary), use, and maintenance of this roadway access infrastructure.

A dedicated private railroad owned and operated by Northshore Mining Company ("**Northshore**"), a subsidiary of Cleveland-Cliffs Inc. ("**Cleveland Cliffs**"), for its Peter Mitchell iron ore/taconite mine crosses the surface above the Mesaba deposit in an area that is subject to Teck's mineral leases. This private rail line and others provide access to Lake Superior port facilities at Duluth-Superior, Taconite Harbor, and Silver Bay.

Babbitt is the nearest community to the Mesaba Project, located five miles north, with a population of about 1,500. The local infrastructure related to mining is excellent. Grid electricity, railroad networks, paved state highways, mine equipment suppliers, mining professionals, and relatively low-cost labor are available locally to service the six operating Mesabi Range iron ore (taconite) mines to the north and west of the Project. The Project lies directly to the south - southeast of Cleveland Cliffs' Northshore taconite mining operations with established power infrastructure owned by Minnesota Power ("**MP**").

Topography in the vicinity of the Mesaba Project is rolling with elevations ranging from 1,500 to 1,640 ft. The northern and western portions of the Project area are poorly drained, with numerous swampy areas. The climate is classified as continental. Any future mining activities would be conducted year-round. Exploration is possible year-round. The

Project area contains a variety of vegetation communities, ranging from upland mixed hardwood-conifer to areas of black spruce bogs, open bogs and marshes. Regenerated forested areas contain balsam fir, jack pine, black spruce, poplar, quaking aspen and paper birch.

The Mesaba Project surface area has been disturbed by past activity including logging, diamond drilling, drill and mine service road construction, rail-line installation and third-party taconite mine-waste dump construction. Previous owners/operators of the mineral interests completed a shaft and underground drilling on a portion of the lands now subject to Teck's mineral leases. Many of the old drill roads are overgrown and logged areas are in varying stages of regeneration.

1.4 MINERAL TENURE, SURFACE RIGHTS, WATER RIGHTS, ROYALTIES AND AGREEMENTS

Teck holds a 100% indirect interest in the Mesaba Project.

The mineral lease position for the Mesaba Project comprises portions of Sections 15, 20, 22, 24–35, T60N, R12W and Section 36, T60N, R13W, 4th Principal Meridian, St. Louis County, Minnesota.

The mineral leases are held by Teck under four mineral leases with three entities:

- a lease with Longyear Mesaba Company ("**Longyear Mesaba**");
- a negotiated State Metallic Minerals lease ("**MM-9831N**") with the State of Minnesota;
- a standard State Metallic Minerals lease ("**MM-9857**") with the State of Minnesota; and
- a lease with the DuNord Land Company LLC ("**DuNord**").

In addition to the rights to explore and develop minerals owned by the State of Minnesota, the negotiated State Metallic Minerals lease MM-9831N includes access and use of the surface (all of which is owned by the State of Minnesota), and the State Metallic Minerals lease MM-9857 provides for access and use over the portion of the leased acreage where the State also owns the surface. Access to any private surface overlying State minerals would be subject to additional notice requirements. The LMC lease provides Teck with mineral rights, which were reserved by Longyear Mesaba (together with rights to use the surface for, among other things, mining purposes) in the deed conveying the surface to a third party and severing the surface and mineral estate. Teck does not own the surface over most of the leased acreage in the Longyear Mesaba lease. The DuNord lease also includes severed mineral rights. Teck owns the surface over most of the leased acreage in the DuNord lease. A third party owns certain other surface overlying minerals controlled by the DuNord lease. DuNord's predecessor-in-interest reserved the mineral rights, including rights to use the surface for mineral exploration and mining purposes, in the deed severing the mineral estate from the surface estate and then conveyed the severed mineral rights to DuNord.

Royalties are due on metallic minerals on three of the four Mesaba leases (the two State leases and the DuNord lease) based on the State of Minnesota Base Royalty Rate Table for net return value (minimum royalty of 3.95%) plus a premium of 0.55%. The Longyear Mesaba lease establishes a minimum royalty of 4% of net return value. Advance royalties are payable under the DuNord and Longyear Mesaba leases which are credited against future production royalties after mining commences.

Mineral ownership and most of the surface ownership outside of the boundaries of the Mesaba Project are held by third parties at the Mesaba deposit periphery. Unless Teck obtains rights to use, or acquire, these third-party lands, the ultimate pit shape for the Mesaba Project will be constrained by this third-party ownership.

Teck controls certain surface lands both within the Mesaba Project boundaries and near the Project. Teck owns the fee surface rights to a total of 1,866 acres in St. Louis County and 704 acres in Lake County. Teck also leases 1,623 acres for surface use only, in St. Louis County.

Teck does not own the surface rights associated with the majority of the mineral leases within the Mesaba Project. Surface acquisitions to date include approximately 920 acres overlying the four Teck mineral leases. Teck's other surface ownership includes a warehouse and office in Babbitt and scattered parcels of land south of the deposit that potentially could be used for surface facilities, stockpile, or waste rock storage facilities ("**WRSFs**").

Most of Teck's surface tenure consists largely of forested tracts, some of which have wetlands features. Acreages purchased by Teck in 2014 and 2018 are subject to easements for railroad and utilities across them. All of the purchased surface acreage has severed mineral rights that are owned by third parties. Project development may require securing additional surface rights over the Mesaba deposit to facilitate mining, and additional surface rights may be needed for a process plant, tailings facilities, stockpiles, or other infrastructure to support the Mesaba Project.

Corridors for transportation and infrastructure will likely need to be established by entering into commercial agreements and/or securing governmental approvals for reaching Teck's mineral lease area using the existing roadway network or constructing new roads. Power line rights-of-way must be verified and/or obtained.

Six Bands of Minnesota Ojibwe (Chippewa) hold lands and treaty rights in the vicinity of the Mesaba Project. The Bands closest to the Mesaba Project area are the Bois Forte Band of Chippewa, Grand Portage Band of Lake Superior Chippewa, and the Fond du Lac Band of Lake Superior Chippewa; all are part of the umbrella Minnesota Chippewa Tribe ("**MCT**"), which is comprised of six reservations and is a federally recognized tribal government. Each of these three Bands closest to the Project are also federally recognized tribal governments. These Indigenous People comprise key communities of interest for the Mesaba Project. One or more Bands may be formally involved in environmental review and permitting proceedings as a participating governmental entity or in a commenting capacity. The State of Minnesota and the U.S. Corps of Engineers will engage in government-to-government consultation with these Bands and the U.S. Environmental Protection Agency and in addition certain agencies of the State of Minnesota routinely engage in formal and informal dialogue with the Bands.

1.5 GEOLOGY AND MINERALIZATION

The Mesaba Project deposits are classified as contact-type magmatic nickel–copper–platinum group element ("**PGE**") deposits which are a broad group of deposits containing Ni, Cu, and PGEs occurring as sulfide concentrations associated with a variety of mafic and ultramafic magmatic rocks.

The major regional lithologies belong to the Duluth Complex, a series of Keweenawan-age tholeiitic intrusions and coeval flood basalts that formed along a portion of the Midcontinent Rift. The northwest, convex edge of the complex defines its basal contact, which dips to the southeast towards the rift. The complex is underlain by Neoarchean granites (Giants Range granitic rocks) and greenstones (Vermilion District) to the north, and Paleoproterozoic sediments (Virginia Formation and Biwabik Iron Formation) to the south. Roof rocks to the Duluth Complex consist of Mesoproterozoic intrusive and volcanic rocks of the Beaver Bay Complex and North Shore Volcanic Group, respectively. The Duluth Complex consists of a number of sub-intrusions. Four general rock series are distinguished on the basis of age, dominant lithology, internal structure, and structural position, including a felsic series, an early gabbro series, an anorthositic series, and a layered series. The Duluth Complex layered series hosts a number of known disseminated copper–nickel occurrences, all of which are located within the basal portions of the Partridge River ("**PRI**"), Bathtub ("**BTI**") and South Kawishiwi ("**SKI**") sub-intrusions.

Mineralization within the Mesaba Project area is hosted within rocks of the PRI and BTI intrusions. Teck's current lithological classification scheme for the area is primarily based on major element geochemistry rather than trying to identify individual layered intrusive units. The more complex spatial relationships resulting from this model suggest a dynamic magma system that experienced multiple recharge events, and which created a complex framework of eroded, assimilated, and intermixed mafic lithologies.

There are several prominent structural features within the Mesaba Project area that were important to formation of the BTI intrusion and may exert an influence on mineralization trends.

The deposit has an approximate 4.9 km strike length. Mineralization is dominated by a laterally continuous 130–650 ft (40–200 m) thick disseminated sulfide zone within the basal portion of the Norite, Bathtub Intrusion Mineralized Zone ("**BTMZ**"), Bathtub Intrusion Mineralized Zone - Contaminated ("**BTMZ-C**"), and Partridge River Intrusion Basal Unit ("**PRB**") units. The BTMZ_C unit has a higher percentage of non-mineralized wall rock material thus 'contaminated' compared to the make up of the BTMZ unit. Mineralization extends down-dip, along the basal contact, for 1,006 m at the southwest end and for 1,981 m at the northeast end of the Bathtub Intrusion.

The Bathtub syncline is often the loci of the strongest mineralization. This concentration into a depression is most probably the result of gravitational settling. Short intercepts (0.3–4.6 m) of semi-massive to massive sulfides are encountered at or near the contact with the Virginia Formation footwall; however, with the exception of the Local Boy area in the southeastern part of the deposit, these appear to be discontinuous and do not represent a large proportion of the overall mineralization. Higher in the intrusive package, within the BTI unit, are thinner zones of erratic and discontinuous disseminated sulfide mineralization referred to as "cloud zones".

Disseminated sulfides dominate the style of mineralization found in the Mesaba deposit. Semi-massive to massive sulfide zones most commonly occur at the basal contact of the intrusive or entirely in the underlying Virginia formation within 3 m of the basal contact. The most common sulfide minerals are chalcopyrite, cubanite, pentlandite, and pyrrhotite with lesser amounts of talnakhite, bornite, chalcocite, digenite, sphalerite, and mackinawite.

1.6 HISTORY

During the period 1952–1997, Bear Creek Mining Company ("**Bear Creek**"), Reserve Mining Corporation, American Metal Climax, Inc. ("**Amax**"), Humble Oil and Refining Co. ("**Humble**")/Exxon Company ("**Exxon**"), International Nickel Co. ("**Inco**"), Kennecott Copper Corporation ("**Kennecott**"), Minnesota Natural Resources Research Institute ("**NRRI**"), Rhude & Fryberger, and Arimetco International, Inc. ("**Arimetco**") completed various activities related to exploration in the vicinity of the Mesaba deposit, including: geological mapping, ground and airborne geophysical surveys, core drill programs, metallurgical test work and pilot plant testing, low-grade surface bulk sampling, construction of a shaft and drifting on the Local Boy zone, underground bulk sampling, and technical studies.

In 1998, Cominco American Incorporated, a predecessor company to Teck, identified the Babbitt, now Mesaba, deposit as a candidate for development using Teck's proprietary Cominco Engineering Services Ltd ("**CESL**") hydrometallurgical technology.

Teck collected a 5,000 t surface bulk sample from a site drilled by NRRI in 2001, conducted an additional bulk sample in 2008, and in this general timeframe, completed ground and airborne geophysical surveys, a light imaging and radar detection and ranging ("**LiDAR**") survey, metallurgical test work, commissioned CESL hydrometallurgical pilot plant test work program, core drilling, historical core re-logging and re-assay programs, mineral resource estimates, and internal technical studies.

1.7 DRILLING

PolyMet has conducted no drilling in the Project area.

Prior to Teck's involvement in 1998, a total of 624 surface and underground holes (613,524 ft) were drilled. Of the drill sample intervals used for resource estimation, 58.5% are from drill holes completed prior to Teck's involvement in the Mesaba Project.

Since 1998, Teck has completed 221 drill holes (196,373 ft [59,854 m]). Teck, in the period from 2001 to 2013, focused on drilling in support of bulk sampling and providing additional material for metallurgical test work. Teck drilling programs, completed in 2007, 2008, and 2013, were designed to gather geological, geostatistical, geometallurgical, geotechnical, and hydrogeotechnical information. The programs total 256 holes (149,059 ft [45433 m]). Thirteen drill holes (13,830 m) were completed in 2021–2022, after the cut-off date for the database used in Mineral Resource

estimation. These programs focused on providing materials for metallurgical variability samples (four drill holes), and geotechnical drilling (seven drill holes). Two drill holes were conducted for exploration purposes.

The long exploration history and the involvement of many different Bear Creek Mining or Amax geologists resulted in inconsistent geological logs and lithologies in the various historical programs. Each company logged using their own geological nomenclature and coding system that was different from Teck's current system. Teck has subsequently relogged a significant portion of the historical core.

1.8 SAMPLING

PolyMet has conducted no sampling, sample preparation or analysis for any material in the Project area.

Limited information is available on the historical sampling programs. Teck has completed a significant data verification program on the historical core, including reassaying. A program of relogging and sampling of historic surface holes started in July 2008. At the end of 2018, a total of 483,272 ft in 409 drill holes had been re-logged and 290,743 ft sampled. Of the footage sampled, 162,538 ft had been assayed. The remaining footage, which is mostly barren, has yet to be assayed.

Core samples were generally taken on 5 ft (1.5 m) intervals with breaks at major lithological contacts. The minimum sampling interval was 0.3 ft (0.09 m) and the maximum was 15 ft (4.6 m). The entire intrusive interval was sampled. Sampling continued into the footwall sediments for a minimum of 50 ft (15 m) and deeper if copper or nickel sulfides were present. The banded iron-formation was the marker within the footwall sediments at which most drill holes were terminated. Generally, the iron formation was not sampled.

Specific gravity ("**SG**") measurements using the simple Archimedes principle (weight in water versus weight in air), were performed on over 4,007 pieces of core from the 2007–2008 drill program and re-logged historic holes. No wax was required as the rock is very dense with no significant porosity. The SG measurements were taken at intervals ranging from 16–98 ft (4.9–29.9 m) based on the complexity of the lithology.

Historical analytical laboratories used included Union Assay Office, Inc. ("**Union**") located at Salt Lake City, Utah, Geophysics Division ("**Denver-Spec**") located at Denver, Colorado, Lerch Brother Inc. ("**Lerch**") located at Hibbing, MN, and Amax**.** With the exception of Denver-Spec, the laboratories were independent of the company operating at the time. No accreditations are known for any of the laboratories used.

Teck has used non-independent and non-accredited internal facilities, including the Babbitt core facility for sample preparation and the Applied Research and Technology Group ("**ART**"), located at Trail, British Columbia for metallurgical test work. Independent analytical laboratories include: ALS Chemex located at Thunder Bay, Ontario; ALS Chemex located at Vancouver, British Columbia; Global Discovery Laboratories ("**GDL**") located at Vancouver, British Columbia; and Acme Laboratories ("**Acme**") located Vancouver, British Columbia, later acquired by Bureau Veritas.

Sample preparation has been done by the following companies:

- ALS Chemex
- Teck Babbitt (2010–2012)
- Teck Babbitt (2012 to date)

Analytical work has been done by the following companies:

- GDL
- ALS Chemex
- Acme/Bureau Veritas

Teck's quality assurance and quality control ("**QA/QC**") programs involved inserting standard reference materials (standards), blanks, core duplicates, and coarse crush duplicates.

The drill hole and associated sample data for the Mesaba deposit is hosted by an acQuire database located on the Teck Vancouver server.

Sample security for the historical drilling programs of Bear Creek, Reserve Mining, Amax, Humble Oil and Inco is not documented. The majority of the core from these programs is stored in a locked MDNR facility in Hibbing, Minnesota. A limited number of pulp samples generated by Amax from its programs are also stored at the Hibbing facility.

Chain-of-custody procedures undertaken by Teck consist of filling out sample submittal forms that are sent to the laboratory with sample shipments to make certain that all samples are received by the laboratory. All core crushed and pulverized samples from the 2007–2013 Teck drilling programs is stored in Teck's office, core processing and storage facility in Babbitt. This facility is leased from the town of Babbitt and is locked at all times except when Teck employees are present.

1.9 DATA VERIFICATION

IMC conducted an independent check of 10% of the assay certificates verifying that the conversion of assay information to a digital assay database was acceptable. These checks were predominantly for the copper and nickel assays with a few checks on sulfur and cobalt. IMC also reviewed the standards, blanks and duplicate assays in the database for copper nickel and cobalt. Prior to this review, Teck has done comprehensive work to validate the historic drill hole data as discussed below. IMC believes that the database is acceptable to be the basis for a mineral resource estimate.

IMC has reviewed the documentation of Teck's work on validating the historic information in the database which is described in the following paragraphs. Scanned historical drill hole survey logs were used in 2015–2016 to validate the digital downhole survey database and update where necessary.

A random check of 10% of the Mesaba holes in the NRRI database (74 holes checked) was conducted in 2016. This identified that appropriate values for Amax copper, nickel and sulfur assays were averaged values derived from two or more assay results on the same drill core interval. Teck concluded that inclusion of multiple averaged values would require that the entire historic database be reconstructed. All of the known assay results were entered into a new database that included parent results, crusher duplicate results, laboratory replicate results, and results for all of the internal standards inserted by Amax. Although the QP uses the primary assay results, both types of data (primary and averaged) were entered into the new database to provide future reference to the historical data.

A review of all of the available Bear Creek data was completed. This included sampling methodology and preparation, crusher sample results, and data reviews performed by Bear Creek at the time. The QP considers that the Bear Creek data is acceptable for use for copper, nickel and sulfur estimation.

A similar in-depth review was performed for the Amax data available. This included sampling methodology, sample preparation and analysis, QA/QC data, and reassay data from Amax resampling of Bear Creek drill core. The QP considers that the Amax data is acceptable for use for copper, nickel and sulfur estimation.

Significant effort was expended by Teck to compile all the historical assay data from primary data sources. This was primarily because when a representative sample of the NRRI compilation was compared to the primary data sources, several inconsistencies were noted in how these data were established, in particular, for repeat and duplicate analysis. Where assays were duplicated, at times the results were averaged and at times, a particular analysis was selected. The overall review showed that there is no systematic bias of one dataset against another. If the data are treated as a duplicate dataset of unknown type and the implied failure rate is evaluated, results show a <10% failure rate for copper and nickel irrespective of whether these are sample duplicates or crush duplicates. It can be concluded that the sampling program was sufficiently precise to allow for the production of reproducible data. Teck recommended that the

initial sample be used as the primary assay source and that all subsequent assays be treated as duplicates, not as replacements for the primary data. This data source was considered acceptable for use in resource estimation.

A variety of matrix-matched standards were manufactured and certified for copper, nickel sulfur and PGEs, and these standards have been used for original drill programs and reassay programs. A review of the data indicated that the matrix-matched standards show good agreement for copper, nickel and sulfur. The PGE data are also suitable for use in resource estimation. The silver data are suitable for resource estimation only in the low detection limit geochemical methods and the cobalt data, while quantized, are also sufficiently accurate and precise for use in resource estimation.

During 2017, a QA/QC review was conducted on the copper, nickel, sulfur cobalt, iron, silver, arsenic, selenium, uranium, vanadium, gold, and PGE data. It was concluded that:

- the three elements with the greatest spatial representivity are copper, nickel and sulfur;
- the PGEs have nearly as good spatial coverage with approximately ⅔ of the samples with a valid Ni assay also having a valid PGE assay. There may be an opportunity to increase the confidence in areas with missing PGE data through a reassaying program, if the samples are available; and
- the spatial distributions of selenium, vanadium and uranium are poor and should only be used for sectional interpretation.

The QP is of the opinion that the data verification programs completed on the data collected from the Project are consistent with industry best practices and that the database is sufficiently error-free to support the geological interpretations and Mineral Resource estimation.

1.10 METALLURGICAL TEST WORK

PolyMet has conducted no metallurgical test work in the Project area. Shane Tad Crowie, P.Eng of JDS has reviewed the metallurgical test work on behalf of PolyMet. The following paragraphs discuss the metallurgical test work which has been completed to date.

Test work on the Mesaba Project dates back to the early 1950s. Results from comminution test work characterized Mesaba mineralized material as being of medium hardness. Grinding test work and pilot plant studies targeting grinding circuit performance conducted in the late 1970s indicated that the Mesaba mineralization was amenable to either autogenous grinding in closed circuit with pebble crushing or fully autogenous grinding. Historical flotation test work indicated that a bulk copper concentrate could be produced at copper recoveries of more than 90% and nickel recovery of approximately 75%. Copper concentrate containing <1% nickel could be produced, but no saleable nickel concentrate could be generated.

Test work completed by Teck and third party laboratories includes:

- optical mineralogical evaluation; bulk modal mineralogy mineral liberation analysis ("**MLA**") examinations on selected drill core samples;
- JK drop weight tests; SMC Tests; Bond ball mill work index and bulk density testing; and
- bench-scale flotation tests produced a marketable copper concentrate (>24% Cu, <0.5% Ni) and a copper–nickel concentrate that could be further refined in a CESL refinery. The test work was completed on composites and variability drill core intervals.

CESL test work was conducted at bench, mini-pilot plant and pilot plant scales. Pilot plant operations confirmed the successful processing of low-grade bulk concentrate; >95% of the copper, nickel and cobalt were leached into solution with low (7%) sulfur oxidation. The campaign produced a high-grade mixed nickel–cobalt hydroxide precipitate ("**MHP**") product. Nine nickel producers were contacted to evaluate the marketability of the high-grade MHP product. Five determined that they would be able to process the MHP product without changes; two would require capital

improvement projects to their refineries to handle the product; and the remaining two would be unable to accept the material due to impurity constraints.

Mineralogical characterization was completed for a suite of 383 drill core intervals from the 2013 Mesaba geometallurgical drilling program. Chalcopyrite and cubanite were the principal economic copper minerals present at Mesaba with lesser amounts of copper–nickel–iron sulfides, bornite, chalcocite, and a copper sulfosalt. Pentlandite was the principal economic nickel mineral. Nickel was also hosted by lesser amounts of copper–nickel–iron sulfide, bravoite (nickel-bearing pyrite) and nickeline or maucherite (nickel arsenides).

Selected 2013 program samples were reanalyzed in 2020, using an X-ray modal analysis ("**XMOD**") mode rather than the XBSE mode used in 2013. The improved silicate MLA data were used in conjunction with electron microprobe ("**EPMA**") data collected in 2019 to better constrain nickel deportment and to produce an updated sulphide model.

A mineral chemistry program was completed in 2019 using an electron microprobe analyzer at the University of Minnesota. The major minerals noted from the analysis were olivine, orthopyroxene, biotite, and various sulfides.

A model was developed in 2020 to define a sulfide model, recovery equations for copper and nickel, and geometallurgical domains. This deportment study demonstrated that nickel deportment to non-recoverable minerals is a strong function of lithology, because of the significantly different partition coefficients for nickel in orthopyroxene versus olivine.

Separate approaches were required to model the modal abundance of pentlandite in the mineralized (GM10, GM20, GM30), the ultramafic (GM40) and non-mineralized (GM50) geometallurgical domains. Simple linear regression models were sufficient to model the nickel deportment to pentlandite as a function of total nickel.

Equations were developed to model the modal abundances of chalcopyrite and cubanite, and the sulfur deportment to each copper sulfide phase. Pyrrhotite abundance was estimated using the sulfur model. An expanded quantitative mineralogy and metal deportment study is recommended to produce a more comprehensive and robust sulfide model.

The copper recovery to the combined rougher concentrate was first calculated for the variability tests performed in the 2014 and 2015 program. The subsequent locked-cycle test work was used to estimate losses from the cleaning circuit. The predicted recovery varies ranging from 86% for material grading in the 0.2% Cu cut-off grade range and plateaus at 91.1%. The recovery range observed in the locked-cycle tests was 89–92%.

The nickel recovery was calculated from the sulfidic nickel content from the sulfide model that was developed from the 2019 mineralogical studies completed to determine nickel deportment between sulfide and silicates. The fraction of nickel contained in sulfide was found to be proportional to the sulfur content of the mineralization, and inversely proportional to the magnesium content. The predicted nickel recovery to the bulk concentrate for blocks above the 0.2% Cu cut-off varied from 47–64% (25th to 75th percentile) which corresponded well with the range observed in the locked-cycle tests (43–68%).

The recovery assumptions used for cobalt and precious metals are based on the average of the 2019 locked-cycle tests.

Samples selected for metallurgical testing were representative of the various styles of mineralization and were obtained from two bulk sample sites. Sufficient samples were taken, and tests were performed using sufficient sample mass for the respective tests undertaken. Copper recovery will be subject to variability due to varying mineralization responses, and nickel recovery will be subject to variability due to presence of nickel in pyrrhotite and silicate nickel.

No elements reach penalty limits in the nickel concentrate that was produced during the test work programs. A penalty would be payable on the copper concentrate should the nickel content exceed 0.5% Ni. Depending on market

conditions, Teck would have the option of reducing copper recoveries to the copper concentrate to reduce the nickel reporting to that concentrate, or could elect to maximize copper recovery and pay the penalty.

Tad Crowie, QP for metallurgy, finds the current status of the metallurgical test work to be acceptable for input to the definition of the Mesaba mineral resource.

1.11 MINERAL RESOURCE ESTIMATION

IMC developed a mineral resource estimate using data from previous Teck work, including:

- a 100x100x50 foot regularized block model created from Teck's sub-block model for the definition of the lithology domains of the deposit;
- the geometallurgy domains from the regularized block model;
- the specific gravity values from the regularized block model;
- the drill hole assay data base;
- the topography file of the deposit area; and
- the metallurgical recoveries discussed in Section 1.10 and Section 13.

The lithology codes in the assay database were back assigned from the lithology codes within the block model in order to have consistency between the two. Copper, nickel and sulfur were nearly completely assayed, however, many of the accessory metals, particularly cobalt, were substantially under assayed relative to copper. IMC reviewed the assay data base and prepared cumulative frequency plots for the assays for each metal within each lithologic domain. A small fraction (approximately one tenth of a percent) of the assay intervals were capped with 0.11% of the copper assays being the largest percentage receiving capping and the capping grade varied by lithology domain.

The assay data was composited to nominal 50-foot composites which respected the model lithology domains. A boundary analysis for all of the metals for each lithology type was completed including the estimation domains of Local Boy and the Pyrrhotite zone. These two estimation domains exhibit substantial different grade distribution from the host lithology unit and have been assigned unique domain codes. The results of this work indicated that the majority of the lithology units should treated as separate units during the grade estimation process. The exception to this is the Bathtub intrusion where some of the sub-units were combined for grade estimation.

IMC did a variogram analysis for both the IMC estimation domains and the Teck estimation domains and the results generally agreed. Search parameters of 1000 by 600 feet with a primary orientation of 235 degree bearing and a 5 degree plunge was used for all metals respecting the IMC estimation domains. Grades were estimated using inverse distance squared method. As mentioned above, some metals have significantly fewer assays (and composites) compared to copper, nickel and sulfur. For these metals, areas of no assay values were flagged and removed from receiving grade estimates. These model areas would carry a zero grade for the metal being estimated.

Block grades were classified into measured, indicated, and inferred categories based on the number of composites used to estimate the block, and the distance to the closest composite during the block grade estimate. The estimation counts and distances for copper were used for this process.

The procedure was as follows:

1) If any of the metals assigned by inverse distance are estimated, then
   imc_class = 3 Inferred

2) If imc_cu_num > = 7.0 (3 holes) and imc_cu_cdist < 500 ft, then
   imc_class = 2 Indicated

3) If imc_cu_num = 10 (4 holes) and imc_cu_cdist < 90 ft then

imc_class = 1 Measured

Where:

imc_cu_num = number of composites used in the estimate and
imc_cu_cdist = the distance to the closest composite.

Checks were made of the resource block model including visual review of sections and level plans through the model, bias checks by domain and metal grade estimation, and swath plots. The results of these checks confirmed that the resource block model is acceptable to support a mineral resource estimate.

1.12 MINERAL RESOURCE STATEMENT

Mineral Resources are reported in Table 1-2 on a 100% basis using a 12.00 NSR cutoff grade. Mineral Resources are classified using the 2019 CIM Definition Standards. The estimates have an effective date of November 28, 2022. Table 1-3 summarizes the contained metal within the resource pit shell.

Table 1-2: Mesaba Mineral Resource

	NSR Cutoff = $12.00/t								
	Short ktons	**NSR $/t**	**Cu %**	**Ni total %**	**Co ppm**	**Pt ppm**	**Pd ppm**	**Au ppm**	**Ag ppm**
Metal Prices			3.66/lb	6.79/lb	28.75/lb	1265/oz	1323/oz	1668.oz	23/oz
Measured	339,829	32.52	0.497	0.115	73.9	0.036	0.101	0.028	1.23
Indicated	1,866,958	27.57	0.415	0.100	76.9	0.034	0.096	0.024	1.18
Total M&I	2,206,787	28.33	0.428	0.102	76.5	0.034	0.097	0.025	1.19
Inferred	1,422,703	24.89	0.368	0.094	67.9	0.043	0.143	0.026	0.98

Notes:
1. Mineral Resources are reported assuming open pit mining methods, above a cut-off grade of 12.00 NSR. Estimates were confined within a conceptual open pit shell using pit definition software.
2. Mineral Resources are reported on an undiluted basis.
3. Inputs to the shell included long-term consensus metal prices of US$3.66/lb for Cu, US$6.79/lb for Ni, US$28.75/lb for Co, US$1,668/oz for Au, US$23.00/oz for Ag, US$1,323/oz for Pd, US$1,265/oz for Pt; direct mining costs of US$1.40/t moved; process costs of US$7.17/t milled; G&A costs of US$1.00/t milled, and inter-ramp pit slope angles of 37º, and 45º for overburden, hard rock respectively.
4. Pit shell total tons: 14,472,079 ktons.
5. Tonnages are reported in imperial units (tons). Grades are reported either as percentages (%) or parts per million (ppm).
6. Rounding as required by reporting guidelines may result in apparent summation differences between tons, grade and contained metal content.

Table 1-3: Mineral Resource by Class and Contained Metal

	Copper	**Nickel**	**Cobalt**	**Platinum**	**Palladium**	**Gold**	**Silver**
	Lbs x 1000	**Lbs x 1000**	**Lbs x 1000**	**Ozs x 1000**	**Ozs x 1000**	**Ozs x 1000**	**Ozs x 1000**
Measured	3,377,900	781,607	55,370	357	1,002	277	12,201
Indicated	15,495,751	3,733,916	316,735	1,851	5,255	1,312	64,472
Total M&I	18,873,651	4,515,523	372,105	2,208	6,257	1,589	76,673
Inferred	10,471,094	2,674,682	212,855	1,768	5,917	1,071	40,748

Note: Lbs x 1000 = Pounds times 1,000; Ozs x 1000 = Troy Ounces times 1,000; Contained metal within mineral resource pit shell.

The Mesaba Mineral Resources meet the current CIM definitions for classified resources. However, it should be noted that due to the uncertainty that may be attached to Inferred Mineral Resources, it cannot be assumed that all or any

part of an Inferred Mineral Resource will be upgraded to an Indicated or Measured Mineral Resource as a result of continued exploration. Confidence in the Inferred portion of the estimate is insufficient to allow the meaningful application of technical and economic parameters or to enable an evaluation of economic viability worthy of public disclosure. Inferred Mineral Resources must be excluded from estimates forming the basis of feasibility or other economic studies.

Mineral Resources are reported with an effective date of November 28, 2022 using the 2019 CIM Definition Standards. The Qualified Person for the estimate is Herbert E. Welhener. Mineral Resources are reported on a 100% basis.

1.13 RISKS AND OPPORTUNITIES

1.13.1 Risks and Uncertainties

The geological model is the result of interpretations that may change with additional data. The geometry of mineralized domains used for resource estimation may be more isolated than connected in some parts of the deposit, particularly in upper lenses where mineralized zones are more often thin or lower grade. Boundaries within the upper mineralized lenses, with respect to grade, may be less sharp than have been interpreted. There is a degree of uncertainty and subjectivity that comes with connecting zones of alternating mineralized intervals between drill holes which may cause over projection of mineralization zones. The opposite can also be true such that a mineralization zone appears more disconnected than it is due to a break in mineralization caused by a subtle late cross-cutting intrusion or xenolith.

The geometry and connectivity of geological domains have some uncertainty. Therefore, the associated sulfide model and recovery estimates could be higher, or lower, for a given resource block.

Geological domains in the Local Boy area and the area directly north of Local Boy are modelled based on proxy geochemical data, which could lead to minor errors in interpretation that could result inconsistent geological modelling in the area and the associated recovery implications.

The presence of graphite can affect metallurgical recoveries. The model estimation domains do not explicitly model graphite. Outside of the Virginia Formation footwall, graphite can be expected to be found in the Virginia Formation xenoliths and the norite domains, but can also occur in other igneous domains typically closer to the footwall.

Due to the uncertainty related to the degree of faulting that has taken place in the deposit, separate fault blocks are not included in the geological model. Mineralization in the north may be more horizontally oriented rather than steeply ramping, if any significant displacement caused by faulting occurred.

Mine optimization should focus on minimizing mining disturbance and exposure of the pyrrhotite bearing footwall Virginia Formation.

Sulphide-bearing waste rock management will be required that could be achieved by a range of engineering and design solutions including co-disposal of sulphide-bearing waste rock with non-sulphide bearing waste rock, geolining, or lined waste rock facilities. Each of these approaches will effectively contain or capture precipitation exposed to sulphide-bearing waste rock. These designs and facilities are successfully used in other sulphide mining operations. Water contamination under both acid and non-acid leaching conditions is possible. Continued monitoring and testing of existing long term HCT's to support waste pad design, wastewater management requirements and water quality forecasting is required.

The Duluth Complex along with other mafic and ultramafic rocks can contain acicular mineral alteration products. Identification and isolation of such zones in mine planning is needed to allow for planning and appropriate management of this material if present.

Historical mining dangers may occur in the Local Boy area in the form of open cavities resulting from previous mining efforts.

Mineral interests, including in some instances mining leases, are held by third parties at the Mesaba deposit periphery. Acquisition of additional mineral interests may be necessary to ensure that the ultimate pit shape is not constrained. Additional surface rights acquisitions should also continue to be evaluated on an as needed basis.

1.13.2 Opportunities

The deposit remains open at depth to the south and potential remains to increase the known disseminated mineralization extent.

Exploration potential that remains in the Project area includes:

- potential for high-grade massive sulfide zones such as the Local Boy zone to be present in the poorly-drilled areas to the south;
- potential for high-grade massive sulfide zones within structures such as the Grano and South Minnamax faults which may be feeder zones to the larger disseminated mineralization; and
- copper dominated, PGM mineralisation has been identified in both Teck and peripheral third-party drill holes. This mineralization is typically hosted in the PRI to the southeast of the BTI.

1.14 INTERPRETATION AND CONCLUSIONS

The QP is of the opinion that Mineral Resources were estimated using industry-accepted practices, and conform to the 2014 CIM Definition Standards. Mineral Resources are based on open pit mining assumptions.

Based on the available data, and under the assumptions presented in this Report, Mineral Resources show reasonable prospects of eventual economic extraction.

1.15 RECOMMENDATIONS

Listed below is a summary of the QPs' recommendations for the advancement of the Mesaba project. The details of these recommendations are included in Section 26.

1. Prioritize the re-assay program of pre 2018 drill samples (currently underway);
2. Continue with the planned 2022-2023 drill program to confirm and potentially expand the mineralization identified in wide spaced drill areas and areas within GMU 50;
3. Complete the 3 shorter spaced geostatistical crosses drill program to evaluate close spaced variations in the mineral deportment;
4. Continue the refinement of the geometallurgy model with additional test work;
5. Incorporate all of the above into a new block model;
6. Complete environmental base line studies;
7. Advance the project to a PEA; and
8. Continue negotiations with surface owners within the Project boundary and near the periphery of the Project.

2 INTRODUCTION

2.1 INTRODUCTION

IMC and JDS prepared this Report for PolyMet on the Mesaba Project, located in St. Louis County, Minnesota, USA (Figure 2-1). Teck indirectly owns 100% of the Project through its wholly owned subsidiary Teck American Inc.

Herb Welhener, SME-RM of IMC and Shane Tad Crowie, P.Eng of JDS, have been informed by the Company that this Report is required as a result of Section 4.2(1) of NI 43-101.

Pursuant to the Combination Agreement among the Company, Poly Met Mining, Inc., a wholly-owned subsidiary of the Company, Teck, and Teck American Inc., a subsidiary of Teck, the parties have agreed to form a 50:50 joint venture that will place the Mesaba Project and the Company's NorthMet Project under single management. PolyMet and Teck will become equal owners in Poly Met Mining, Inc., which will be renamed NewRange Copper Nickel LLC upon completion of the Transaction.

Herb Welhener, SME-RM of IMC and Shane Tad Crowie, P.Eng of JDS understand that the Company does not currently have ownership or other equity interest in the Mesaba Project. The Project is owned by Teck and this Report relies exclusively upon general information available in the public domain and as otherwise made available to PolyMet from Teck.

2.2 TERMS OF REFERENCE

The Report supports a mineral resource statement for the Mesaba deposit located in St. Louis County, Minnesota

Currency is expressed in United States dollars (US$) unless stated otherwise. Units presented are either imperial or metric units, and clearly noted.

Mineral Resources are reported using the 2019 CIM Estimation of Mineral Resources and Mineral Reserves best Practice Guidelines, adopted by the CIM Council on November 29, 2019 (the "**2019 CIM Definition Standards**"). Mineral Resources are presented on a 100% basis.

Information and data contained in this technical report or used in its preparation include the following which was obtained from Teck:

- a regularized block model (block size 100x100x50 feet) created from an internal Teck sub-block model;
- a topography file;
- an internal Teck report which documented the work that went into the Teck block model development dated April 20, 2022;
- a QA/QC file;
- the metallurgical recovery equations for copper and bulk nickel concentrates;
- a Leapfrog model of the lithology;
- an excel file of a portion of the block model for GMU50 showing calculations for the NSR values; and
- various email correspondence answering IMC questions and providing additional information.

2.3 QUALIFIED PERSONS

The following serve as the qualified persons for this Technical Report as defined in NI 43-101, and in compliance with Form 43-101F1. Table 2-1 lists the QPs and the sections of the Report that each QP is responsible for.

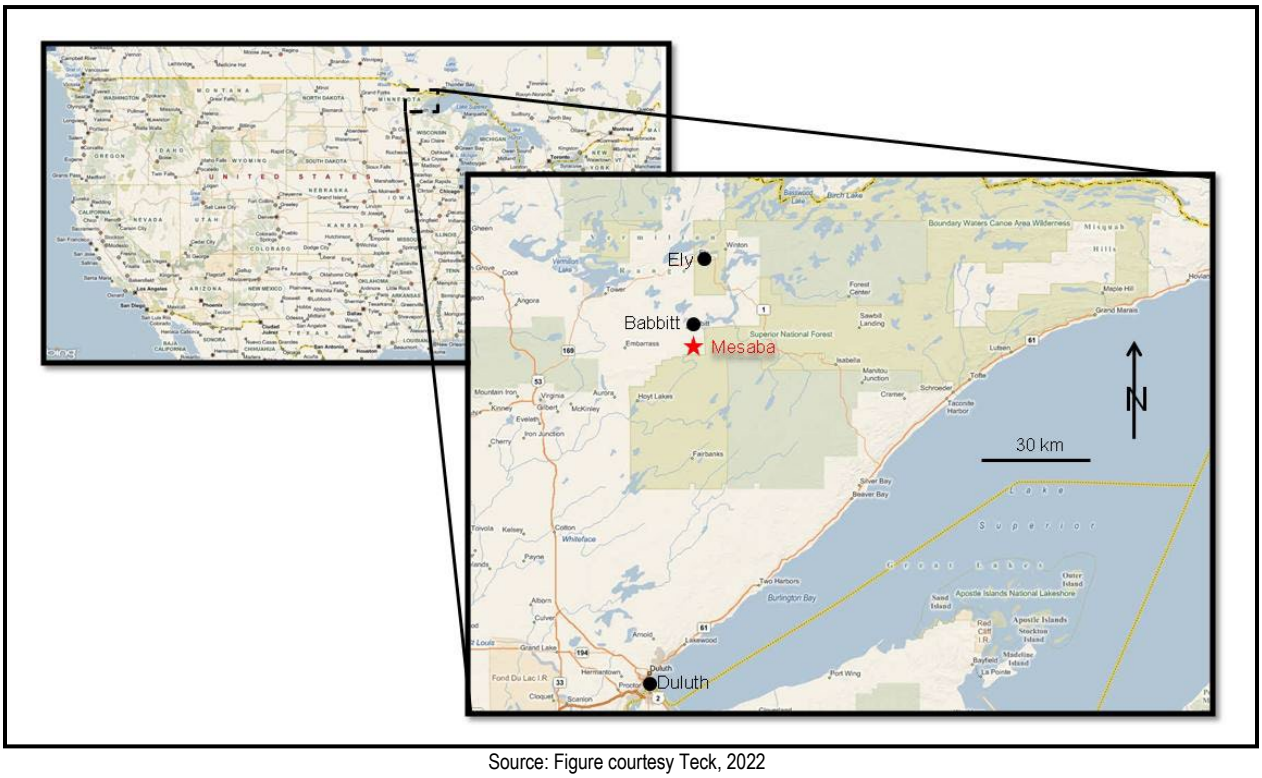
Table 2-1: Qualified Persons

Qualified Person	Registration	Company	Sections of Responsibility	Site Visit
Herb Welhener	SME-RM	IMC	1-12, 14-27	September 7, 2022
Shane Tad Crowie	P.Eng	JDS	1.13, 13	N/A

2.4 SITE VISITS AND SCOPE OF PERSONAL INSPECTION

Herb Welhener, SME-RM of IMC made a site visit to the Mesaba deposit on September 7, 2022. He was accompanied by Andrew Ware of PolyMet and they met with Cullen Phillips of Teck. The visit started in the Teck offices and core storage facilities in Babbitt, Minnesota during the morning and proceeded to the Mesaba site in the afternoon. During the visit, the following items were reviewed and discussed:

- the geology of the deposit and methods used to assign it to the resource block model;
- the procedure for collecting the drill core at the drill rig, transporting it to the Babbitt facility, logging the core, photographing the core, splitting the core and preparing samples for assay;
- the procedure for inserting blanks and standards into the sample stream going for assay;
- general overview of the storage facility and the historic coarse samples being prepared for reassay;
- reviewed two recent drillholes being logged and prepared for sampling; and
- toured the site and viewed a couple of drill hole collar locations.



Source: Figure courtesy Teck, 2022

Figure 2-1: Project Location Plan

2.5 EFFECTIVE DATES

The Report has a number of effective dates including:

- Date of database close-out for information used in the Mineral Resource estimate: June 10, 2020;

- Data of most recent information on ongoing geotechnical and metallurgical drilling: April 20,2022;
- Date of Mineral Resource estimate: November 28, 2022.

The overall effective date of the Report is November 28, 2022, which is the date of the Mineral Resource estimate.

2.6 INFORMATION SOURCES AND REFERENCES

The reports and documents listed in Section 27 of this Report were also used to support the preparation of the Report.

Additional information was sought from PolyMet and Teck personnel where required.

2.7 PREVIOUS TECHNICAL REPORTS

No party previously has filed a NI 43-101 technical report on the Project.

3 RELIANCE ON OTHER EXPERTS

The authors of this Report are not experts in legal matters and have not reviewed the mineral leases and surface ownership. The authors of this Report have relied on Teck and PolyMet for the information in Section 4.

4 PROPERTY DESCRIPTION AND LOCATION

4.1 INTRODUCTION

The Mesaba Project is located in St. Louis County, Minnesota, approximately five miles (8 km) south of the town of Babbitt and 60 miles (97 km) north of Duluth.

The Project is approximately centred on UTM coordinates (using NAD 1983 UTM Zone 15 N):

- Northing: 5277330;
- Easting: 582573.

4.2 PROPERTY OWNERSHIP

The Mesaba Project is 100% indirectly owned by Teck.

Pursuant to the Combination Agreement, the Company, Poly Met Mining, Inc., a wholly-owned subsidiary of the Company, Teck, and Teck American Inc., a subsidiary of Teck, the parties have agreed to form a 50:50 joint venture that will place the Mesaba Project and the Company's NorthMet Project under single management. PolyMet and Teck will become equal owners in Poly Met Mining, Inc., which will be renamed NewRange Copper Nickel LLC upon completion of the Transaction. Therefore, until the completion of the Transaction, the Company will not have any ownership or other equity interest in the Mesaba Project Mineral Tenure.

4.3 MINERAL RIGHTS IN MINNESOTA

4.3.1 Overview

Real property in Minnesota can include separate surface and mineral estates which commonly have ownership held in one of two ways:

- one owner (or a group of owners) owns both the surface and mineral estates (a unified estate); and
- minerals contained in, on, or under the property are owned separately from the surface rights (a split estate).

When the surface and mineral rights of any given property are owned separately, this is called a split estate. These "severed mineral interests" (i.e., severed from the surface ownership) in a property must be purchased, leased, or otherwise acquired in transactions that are separate from an acquisition of the surface estate for the property. The common law principles of real property regarding split estates generally apply whether the estates are owned or otherwise controlled by private parties or federal or state governmental entities, although certain different requirements may be applicable depending on whether there is private or public ownership.

The federal government owns extensive surface and mineral rights in northern Minnesota, some of which are unified and some of which are split estates. The Mesaba Project currently includes mineral rights from the State of Minnesota and private parties but has no federal mineral rights, and any acquisition of federal mineral rights in the area would, pursuant to applicable federal statutes and regulations, require prospecting permits and preference right leases to be issued by the Bureau of Land Management ("**BLM**").

With respect to federal surface, Teck holds leases that include severed mineral rights (non-federal) underlying federal surface managed by USFS. USFS has generally authority under federal law to review activities involving mineral exploration and development on USFS-managed surface lands. With respect to federal surface overlying private minerals leased by Teck, USFS has issued concurrence determinations in response to notice by Teck of a plan of operations for mineral exploration activities. For federal surface where Teck does not have any underlying mineral rights, USFS can issue various use authorizations, including road use permits and special use authorizations. In

some circumstances, particularly with private severed minerals, USFS may agree to a land exchange in which it conveys ownership of federal surface lands over a mineral estate in exchange for other surface lands owned by the mineral holder.

State-owned lands in Minnesota are managed by MDNR and are generally available to lease for mineral exploration and development subject to the applicable requirements of federal and state law. As is the case with private lands, the State may hold severed mineral or surface interests as well as owning lands with unified estates. Mining leases issued by MDNR generally provide surface use and access if the State owns the mineral and surface estates. If a third party owns the surface lands over State minerals, then split-estate principles similar to those relevant to private lands will be applicable. While the State leases provide for access to the private surface through notice, it is common practice for a lessee of State minerals to seek to enter into an agreement granting surface access and use rights with the surface owner.

The Mesaba Project also includes split estates for which a third party has surface rights overlying Teck's leases for private severed mineral rights. These leases convey rights consistent with the underlying severance and conveyance deeds, including rights to use the surface of the overlying lands for purposes, including mineral exploration, development, and mining. The same common law real property principles will apply to interpretation of the applicable deeds, leases, and other real property rights for these split estates.

4.3.2 Mineral Leases

Teck's mineral lease position for the Mesaba Project comprises portions of Sections 15, 20, 22, 24-35, T60N, R12W and Section 36, T60N, R13W, 4th Principal Meridian, St. Louis County, Minnesota. This Report uses the terms mineral lease and mining lease interchangeably unless otherwise indicated. Teck holds its mineral interests in the Mesaba Project under four mining leases with three entities:

- a lease with Longyear Mesaba Company;
- a negotiated State Metallic Minerals lease ("**MM-9831N**") with the State of Minnesota;
- a standard State Metallic Minerals lease ("**MM-9857**") with the State of Minnesota; and
- a lease with DuNord Land Company.

Certain terms of these four mining leases are summarized in Table 4-1.

Table 4-1: Mineral Lease Status

	Longyear Mesaba	MM-9831N	MM-9857	DuNord
Type of lease	Private mineral lease	Negotiated metallic minerals lease	Metallic minerals lease	Private mineral lease
Name of lessor	Longyear Mesaba Company	State of Minnesota	State of Minnesota	DuNord Land Company LLC
Name of lessee	Teck American Incorporated	Teck American Incorporated	Teck American Incorporated	Teck American Incorporated
Scope of lease	Metallic minerals	Metallic minerals	Metallic minerals	Metallic minerals
Specific exclusions from lease	Non-metallic materials Restrictions on iron ore, taconite	Iron ore, taconite	Iron ore, taconite	Taconite, coal, oil, gas
Date in effect	October 1, 1998	June 7, 2001	September 6, 2001	December 24, 2012
Term	20 years	50 years	50 years	40 years
Initial expiration date	October 1, 2018	June 6, 2051	September 5, 2051	December 12, 2052

	Longyear Mesaba	MM-9831N	MM-9857	DuNord
Renewable after term	Auto renewal on payment of annual advance minimum royalty	State review upon expiration	State review upon expiration	May extend term indefinitely by making required payments
Number of acres	2,092	2,344	891	1,400
Lease cost to 2017 (US$/annum)	500,000	70,314	26,715	35,000
Lease cost in 2018 and in the future (US$/annum)	1,000,000	70,314	26,715	The cost is currently $42,000/a. It will increase by $7,000/a in 2024 and 2025 for a total increase of $14,000/a.
Property taxes (US$/annum)	1182	938	356	592
Surface Access and use rights	Includes certain rights to enter and use surface in connection with exploration and mining. Teck does not own any surface lands in lease area.	Includes rights of access and use of State surface, which is all land subject to lease.	Includes rights of access and use over portion of lease where State owns surface rights; requires notice to any private owners.	Includes certain rights to enter and use surface in connection with exploration and mining. Teck owns certain of the surface lands in the lease area.
Work commitments	US$5 M before 2008 (completed)	US$5 M before 2008 (completed). Mine/mill plan by 2011 (deferred). Production by 2036[1] and US$100,000 royalty paid by then.	None during exploration. Production by 2036 and US$100,000 royalty paid by then.	None during exploration
Royalty: All royalties calculated according to the royalty provisions of the State of Minnesota's Lease to Explore for, Mine and Remove Metallic Minerals	The production royalty is the base rate of no less than 4% multiplied by the net return value of the metallic minerals and associated products recovered.	A production royalty shall be paid to the state for metallic minerals and associated mineral products recovered from each ton of ore mined. The royalty shall be the sum of the base rate (3.95% to 20%) plus 0.55% multiplied by the net return value of the metallic minerals and associated products recovered.	A production royalty shall be paid to the state for metallic minerals and associated mineral products recovered from each ton of ore mined. The royalty shall be the sum of the base rate (3.95% to 20%) plus 0.55% multiplied by the net return value of the metallic minerals and associated products recovered.	The production royalty is the sum of the base rate (3.95% to 20%) plus 0.55% multiplied by the net return value of the minerals recovered from each ton of dried crude ore.
Surface rights holder	Northshore Mining Company, federal government, and others	State of Minnesota	State of Minnesota and others	Teck, some Northshore Mining Company, others

Note 1: The State of Minnesota amended Minn. Stat. § 93.25, subd. 2, specifically providing: "No lease shall be cancelled by the state for failure to meet production requirements prior to the 36th year of the lease." 2017 Minn. Laws Ch. 93 § 55. The law explicitly states that it is "effective the day following final enactment and applies to leases in effect or issued on or after that date." Id. Neither the original statute nor the new law distinguishes between mineral leases acquired pursuant to the state's bidding process, those obtained through negotiations, and those obtained through the preference right process.

Figure 4-1 shows the surface and lease areas controlled by Teck. Annual property taxes are payable for the four leases, and in 2022 totalled US$3,068.

4.3.3 State Mineral Lease Acquisition and Provisions

Mineral rights on State land are often acquired through a public competitive sealed bid offering, which is referred to as the Metallic Minerals Lease Sale and which is conducted by MDNR. The State's lands are divided into mining units by the MDNR and nominated for the Metallics Minerals Lease Sale based on requests submitted by interested parties. The Metallic Minerals Lease Sale is by sealed bid where the bidder may offer an additional royalty percentage above the minimum base royalty set by Minnesota law on production from the leased property. The successful bidder is, subject to approval by MDNR and the State Executive Council, granted a lease with a 50-year term with rights to explore and mine for specified minerals within the leased area (e.g., Teck's Mesaba leases are for metallic minerals but exclude iron ore and certain other minerals not relevant to the Mesaba Project). The bidder pays rent, in addition to royalties, at rates generally set by Minnesota law.

If an entity holds rights to minerals in close proximity to State minerals or otherwise meets certain regulatory requirements, it may request to negotiate with MDNR a mining lease on these State mineral lands without being subject to the Metallics Minerals Lease Sale. The Mesaba Project includes minerals subject to negotiated State lease, which includes certain requirements that in some instances exceed those of the standard metallic minerals lease as summarized in Table 4-2. As noted in the table, the negotiated State lease MM-9831N includes access and use of the surface which is all owned by the State of Minnesota, and the State lease MM-9857 provides for access and use over the portion of the leased acreage where the State owns the surface.

Table 4-2: General Provisions of Minnesota State Mineral Leases

Item	Terms
Term	50 years
Rental	US$1.50/acre/year; first two+ years in advance US$5/acre/year, Years 3–5 US$15/acre/year, Years 6–10 US$30/acre/year thereafter
Royalty	Minimum 3.95%, maximum 20%, varies with net return value of metallic minerals and associated minerals recovered per ton of ore mined
Work and payment	None during exploration for standard leases Negotiated leases require additional terms for production and operation
Reports	Annual data transfer; ¼ portion of all samples to MDNR
Taxes	Annual personal property as Cu–Ni lease
Surface	Right to use State surface lands; requires notice to overlying surface owner if not State; lease does not authorize invasion or trespass upon other interests; lessee liable for damages to other interests

4.3.4 Private Mineral Leases

The two private mineral leases for the Mesaba Project are the Longyear Mesaba lease and the DuNord lease. The Longyear Mesaba lease grants Teck mineral rights and does not include any grant of surface rights. The underlying mineral severance deed, however, reserves to the mineral owned the right to use of the surface for exploration and mining purposes. The surface use language in the Longyear Mesaba lease can be found in the Longyear Mesaba deed containing this mineral reservation. The DuNord lease also grants mineral rights consistent with the deed conveying mineral rights to DuNord. Teck owns the surface over most of the leased acreage in the DuNord lease, and

the underlying severance deed and associated conveyance documents support surface access for mineral exploration, development, and mining.

4.3.5 Water Rights Associated with Land

In Minnesota, rights to take and use surface waters and groundwater are subject to numerous state statutes and regulations. These statutes and regulations define the terms and conditions controlling the consumption of water in Minnesota, including requirements with respect to conserving water, prioritizing various uses, imposing volumetric limits and other restrictions, and creating mechanisms for addressing any use conflicts or prohibiting (or reducing) uses when necessary (e.g., if drought conditions were to arise). Generally, a surface owner or lessee has riparian rights to take surface waters of the State that cross or abut the property. Surface and mineral owners or lessees generally may appropriate groundwater from the lands in which they hold their property rights. Most appropriation and use of surface and groundwater require permits from MDNR which will establish conditions to ensure compliance with the various requirements of Minnesota law. There are specific state statutes and regulations restricting the appropriation and use of water in mining operations. Also, installation of wells may be subject to requirements of the Minnesota Department of Health. On federal surface lands managed by USFS, there also generally will be federal permitting and other regulatory requirements to appropriate and use water. The State of Minnesota also is a party to the Great Lakes Compact (the "**Compact**"), which is an agreement among several Canadian provinces and U.S. states to protect and manage waters in the Great Lakes basin. Minnesota has enacted a state law adopting requirements of the Compact, including requirements that limit diversion water from the Great Lakes basin to other areas. The Mesaba Project lies partially within the Great Lakes basin, and therefore, may be subject to diversion restrictions and other requirements imposed by the Compact.

Teck has sourced all water for drilling activities associated with the Project from the adjacent municipality. If the Mesaba Project needs additional water, additional requirements summarized above in this Section may be applicable, including certain permitting requirements.

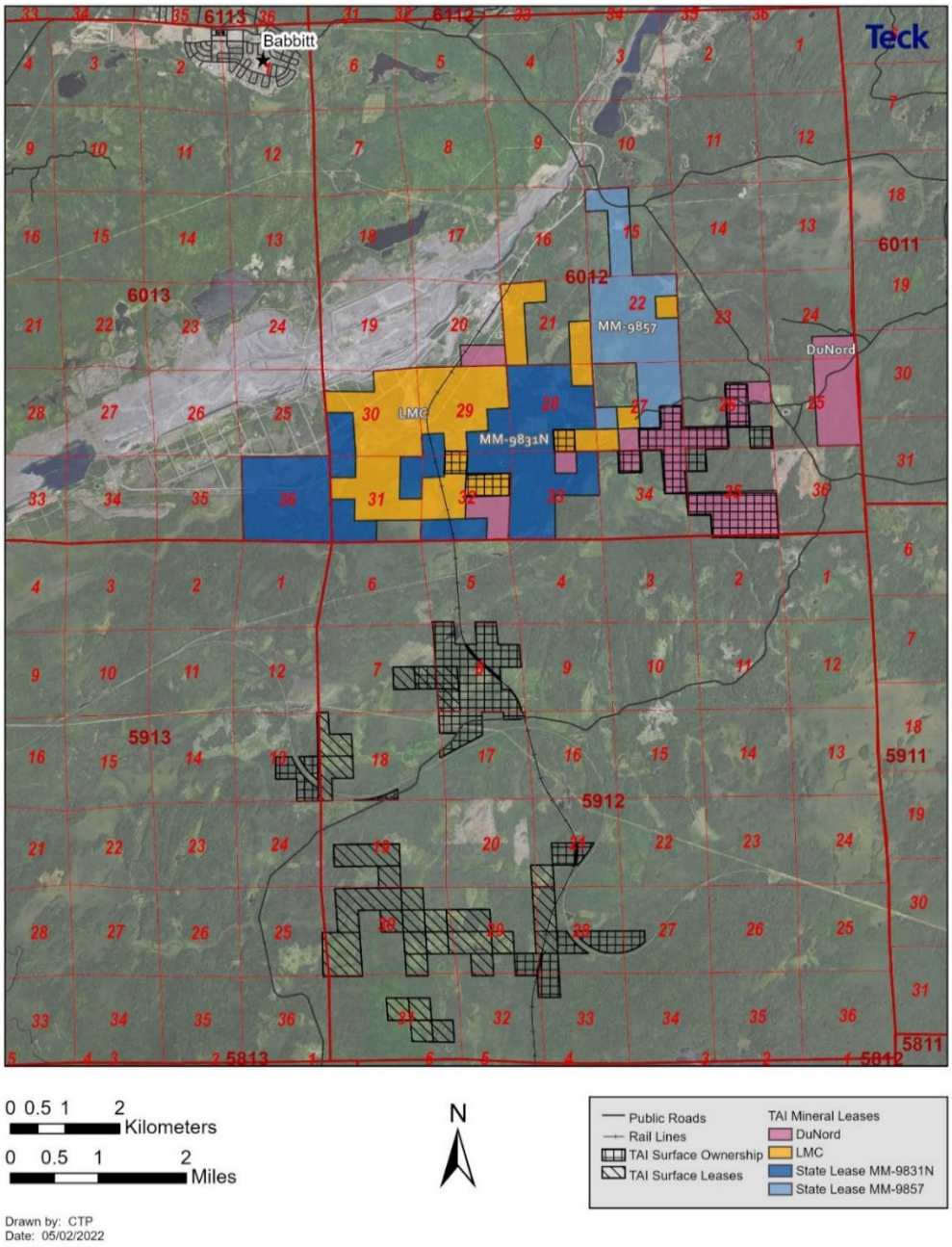
4.4 SURFACE RIGHTS

Surface lands in the Mesaba Project area consists of:

- lands owned by private parties, including both individuals and corporations or other business entities;
- federal holdings administered by USFS; and
- State of Minnesota holdings administered by MDNR.

Teck owns the surface rights to a total of 1,866 acres in St. Louis County and 704 acres in Lake County. Teck also leases 1,623 acres for surface use only, in St. Louis County.

Teck does not own the surface rights associated with the majority of its mineral leases. Surface acquisitions to date include approximately 920 acres overlying mineral leases. Teck's other surface ownership includes a warehouse and office in Babbitt and scattered parcels of land south of the deposit that could be used for potential surface facilities, stockpiles, or WRSFs.



Source: Figure courtesy Teck, 2022

Figure 4-1: Mineral Leases and Surface Ownership

The surface tenure, other than the facilities in Babbitt, consists largely of forested tracts, some of which have wetlands features. Acreages purchased in 2014 and 2018 have easements for railroad and utilities across them. All of the purchased surface acreage has severed mineral rights that are owned by third parties. A total of 704 acres in Lake County with potential value for future mitigation or land exchange was acquired in 2018.

The majority of Teck's surface ownership falls into the category of undeveloped agricultural or forest land, and is reported to County governments annually. In 2022, annual property taxes on Teck surface lands, including the Babbitt office property and structures, totalled US$42,156. Property taxes are due annually in May to St. Louis County on all surface parcels.

Ownership of undeveloped agricultural or forest land in the United States by a foreign corporation requires annual reporting under the Agricultural Foreign Investment Disclosure Act. For purposes of this act, Teck American Incorporated ("**TAI**") is considered a foreign corporation because it is a wholly owned subsidiary of a Canadian corporation, Teck Resources, Ltd. There is no fee required for reporting under the act unless a penalty for non-compliance is assessed.

Project development may require securing additional surface rights over the Mesaba deposit area to facilitate mining. Also, additional surface rights to allow construction and operation of a process plant, a tailings facility, stockpiles, and/or other surface infrastructure may need to be obtained.

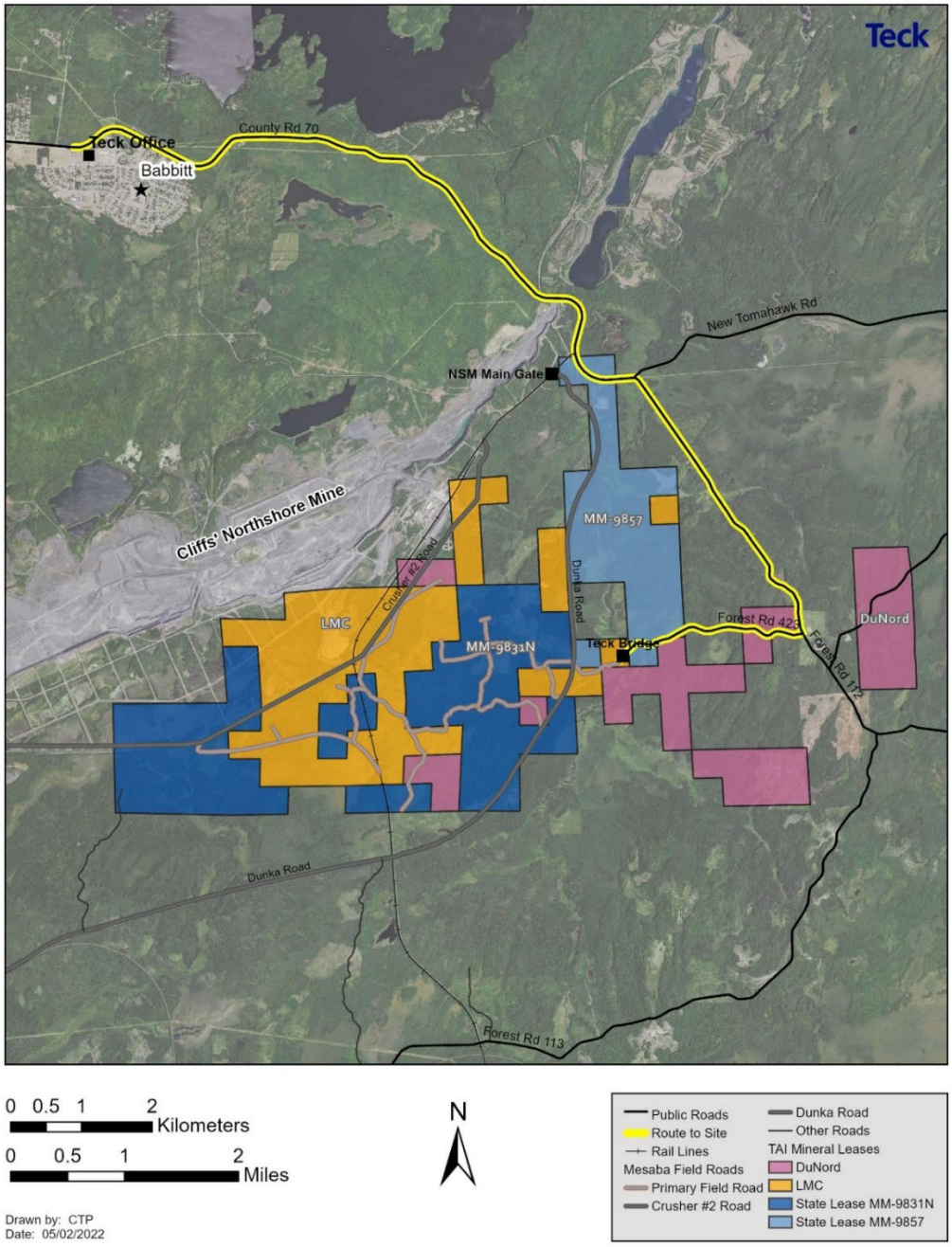
4.5 CORRIDORS AND EASEMENTS

Corridors for transportation and infrastructure will likely need to be established by entering into commercial agreements and/or securing governmental approvals for reaching Teck's mineral lease area using the existing roadway network or constructing new roads. Such arrangements may involve purchasing or surface rights or entering into easements, licenses, or other surface-use arrangements with private and/or governmental landowners.

Power line rights-of-way must be verified and/or obtained.

4.6 PROPERTY AGREEMENTS

Teck has advised PolyMet that the mining lease between Longyear Mesaba Company and TAI, dated May 10, 2001 (effective October 1, 1998), is in good standing with all of TAI's obligations having been met. The original term of this agreement was 20 years. TAI may extend the term from year-to-year by making the advance royalty payments which are credited against production royalties after mining commences. Teck also has stated that TAI has made all advance royalty payments due so as to extend the lease term.



Source: Figure courtesy Teck, 2022

Figure 4-2: Existing Access Infrastructure

Teck has advised PolyMet that MM-9831-N Lease to Explore, Mine and Remove Metallic Minerals between TAI and MDNR, dated and effective June 7, 2001, is in good standing with all obligations of TAI having been met. The term of this negotiated lease is 50 years. TAI pays an annual rental fee in the calculated amount of US$30 per acre.

Teck has advised PolyMet that State lease MM-9857 s between TAI and MDNR, dated and effective September 6, 2001, is in good standing with all obligations of TAI having been met. The term of this negotiated lease is 50 years. TAI pays an annual rental fee in the calculated amount of US$30 per acre.

Teck has advised PolyMet that the mining lease between DuNord and TAI, dated and effective December 24, 2012, is in good standing with all obligations of TAI having been met. The original term of the agreement is 40 years. On the fifth anniversary of the effective date and each fifth anniversary thereafter, the yearly payment amounts are required to be escalated. Payments shall be considered advance production royalties and credited against royalties earned at any time thereafter.

4.7 ROYALTIES AND ENCUMBRANCES

Production royalties are due on metallic minerals on three of the four Mesaba leases held by Teck (the two State of Minnesota leases and the DuNord lease) based on the State of Minnesota Base Royalty Rate Table for net return value (minimum royalty of 3.95%) plus a premium of 0.55%. Teck's mining lease with Longyear Mesaba Company has a minimum royalty of 4% of net return value and no additional premium, provided that the Longyear Mesaba lease has a "most favored nations" clause that in some circumstances would require payment of royalties at the rate due under the State mining leases if the State rate were to exceed the royalty set in the Longyear Mesaba lease. Advance royalties are payable on the Longyear Mesaba and DuNord leases. These advance royalty payments will be credited against future production royalties after mining commences in the areas subject to these leases.

4.8 ENVIRONMENTAL REVIEW AND PERMITTING CONSIDERATIONS

The Project will be required to undergo an environmental review process culminating in publication of a Final Environmental Impact Statement ("**FEIS**"). The FEIS will determine if the Project can be constructed and operated in a manner that will meet federal, state, and if applicable, tribal environmental standards and other requirements under applicable laws relating to protection of environmental and natural resources and human health. The FEIS will provide a detailed description of the Project, its potential impacts, and associated mitigation measures.

The Project also will require numerous federal, state, and local permits to guide the construction, operation, reclamation, closure, and post-closure maintenance activities. The permits required for the Mesaba Project will depend on, among other things, the specific location and design of the Project, but will include a permit to mine from MDNR and also likely will include, among others, state permits relating to air and water pollution controls, wetland impact controls and resulting mitigation requirements, and water appropriation requirements. Certain federal approvals also may be necessary, including a U.S. Clean Water Act permit for wetland impacts and mitigation requirements and potentially special use authorizations from USFS if federal surface lands (including, for example, roads within the Superior National Forest) are included within the Project design.

4.9 SOCIAL LICENSE CONSIDERATIONS

Early in the Project history, extensive community outreach was undertaken. Community consultation is expected to recommence in 2023 and will include dialogues with interested communities. Issues of concern raised by the local community include Indigenous Groups.

Six Bands of Minnesota Ojibwe (Chippewa) hold lands and treaty rights in the vicinity of the Mesaba Project. The Ojibwe Bands closest to the Mesaba Project area are the Bois Forte Band of Chippewa, Grand Portage Band of Lake Superior Chippewa and the Fond du Lac Band of Lake Superior Chippewa; all of which are part of the umbrella Minnesota Chippewa Tribe ("**MCT**") which is comprised of six reservations and is a federally recognized tribal government. Each of these three Bands are also federally recognized tribal governments. These Indigenous People comprise key communities of interest for the Mesaba Project.

Under U.S. and Minnesota law, tribes may elect in some circumstances to act as participating governmental bodies in the environmental review process even if projects are not located on reservation lands or other lands subject to direct tribal governance. Tribes may also formally participate in certain permitting processes if their resources may be affected (for example, they may have rights under the U.S. Clean Water Act if pollutant discharges will adversely affect waters within reservation boundaries), and tribes generally also will have rights to comment on proposed federal and state

permits even if there are no direct impacts within reservation lands. The State of Minnesota and the U.S. Corps of Engineers will engage in government-to-government consultation with these Chippewa Bands in connection with various environmental review and permitting processes and the U.S. Environmental Protection Agency and certain agencies of the State of Minnesota regularly engage in formal and informal dialogue with the Bands in Minnesota.

5 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

5.1 ACCESSIBILITY

The Mesaba Project is readily accessible by paved state and county roads (refer to Figure 4-2). The distance by road from Duluth is approximately 115 miles (185 km) via US-53, MN-169, County Hwy-21, MN-70 and County Hwy-70 through Babbitt to the Project boundary.

An access road was permitted and constructed from 2018–2020, and currently is the primary access to the Mesaba Project site. Access to the site uses US Forest Service Road 112 to US Forest Service Road 423 ("**FR 423**"). At FR 423, Teck must maintain a road use permit issued by the USFS. At the Dunka River, Teck installed an 80 ft (24 m) long bridge and constructed an access road that links to other established field roads in the Project area. Teck obtained regulatory authorizations from the USFS and MDNR required for construction (where necessary), use, and maintenance of this roadway access infrastructure. These authorizations must be renewed periodically, and they are subject to standard requirements relating to protection of surface and environmental resources.

A dedicated mill feed transfer railroad owned by Cleveland Cliffs crosses the surface above the Mesaba deposit in an area that is subject to a portion of Teck's mineral leases. This private rail line and others provide access to Lake Superior port facilities at Duluth-Superior, Taconite Harbor and Silver Bay.

The Port of Duluth-Superior, located on Lake Superior, is the largest and furthest-inland freshwater port in the U.S., with more than 20 docks and 49 miles (79 km) of waterfront. From the Great Lakes, the St. Lawrence Seaway provides access to the Atlantic Ocean. Due to winter climate factors, the Great Lakes Saint Lawrence Seaway navigation season begins March 25 and ends December 26 each year for ocean-going vessels. However, service to industries in the region typically extends into mid-January.

In addition to a regional hub airport in Duluth, there are smaller airports in Chisholm/Hibbing and Eveleth.

5.2 CLIMATE

Minnesota has a continental climate. Mean annual temperatures in northeastern Minnesota range from 36°F (2°C) in the extreme north to approximately 40°F (4°C) near Duluth.

Most of the precipitation in the region occurs between May and September. Northeastern Minnesota generally receives approximately 70 inches (178 cm) of snow per year in the northeast highlands with annual snowfall decreasing to 45 inches (114 cm) per year near the western end of the Arrowhead Region. Northern Minnesota averages 140 days of snow cover each year. Blizzards hit Minnesota on average twice each winter.

Winds are generally to the west–northwest.

Mining operations are expected to be conducted year-round.

5.3 LOCAL RESOURCES AND INFRASTRUCTURE

Babbitt is the nearest community to the Mesaba Project, located five miles north, with a population of 1,507 in 2016. Ely (population 3,390 in 2016), Soudan (446 in 2010) and Biwabik (985 in 2016) are the next closest communities to the Mesaba Project. The larger communities (populations over 5,000) near the Mesaba Project are Virginia, Hibbing, Hermantown, Duluth, and Cloquet.

The local infrastructure related to mining is excellent. Grid electricity, railroad networks, paved state highways, mine equipment suppliers, mining professionals, and labor are available locally to service the six operating Mesabi Range iron ore (taconite) mines to the north and west of the Project. The property lies directly to the south of Cleveland Cliff's Northshore iron ore/taconite mine.

The land immediately around the Mesaba deposit includes the Cleveland Cliffs taconite mine and town of Babbitt to the north, rural homestead and seasonal, recreational properties. Within the Project boundary, ownership is a mix of private, State and USFS holdings.

5.4 PHYSIOGRAPHY

The Project site is located near the east end of the Giants Ridge topographic feature in the eastern portion of the Mesabi Iron Range. Topographic relief is generally low with elevations ranging from 1,500 to 1,640 ft (460 to 500 m). The northern and western portions of the property are poorly drained, with numerous swampy areas; in part due to man-made infrastructure associated with Cleveland Cliff's mining operations located to the north, such as waste rock storage facilities, railroad beds and mine roads. The southeastern portion of the Mesaba Project area is slightly elevated and has better drained, rocky, sandy soils. The overburden can reach as much as 100 ft (30 m) in thickness and contain large boulders of iron formation, granite gneiss and argillite.

Mesaba falls within the headwaters of two major watersheds, the Western Lake Superior watershed (Lake Superior Basin) and the Rainy River watershed (Rainy River Basin).

The Project is along the margins of the Superior National Forest comprising 3 million acres (1.2 M ha) administered by the USFS, including land in the area of the Mesaba deposit. The Superior National Forest is managed by the USFS for both logging and recreational opportunities and has a policy allowing for orderly exploration, development and production of mineral and energy resources on certain lands within the Superior National Forest. The Mesaba Project does not include any federal minerals leased by Teck from the United States either within or outside of the Superior National Forest.

The Boundary Waters Canoe Area Wilderness (BWCAW), a wilderness area that affords recreational and tourist opportunities and is protected by federal and state law, is located about 25 to 30 miles (40–48 km) northeast of the Mesaba Project.

The Mesaba Project area has been disturbed by past activity including logging, diamond drilling, drill and mine service road construction, rail lines installation and third party taconite mine waste dumps construction. Many of the old drill roads are overgrown and logged areas are in varying stages of regeneration. The area contains a variety of vegetation communities, ranging from upland mixed hardwood-conifer to areas of black spruce bogs, open bogs and marshes. Regenerated forested areas contain balsam fir, jack pine, black spruce, poplar, quaking aspen and paper birch.

6 HISTORY

6.1 EXPLORATION HISTORY

Exploration completed on the Mesaba Project to date is summarized in Table 6-1.

6.2 PRODUCTION

There has been no commercial production from the Project.

Table 6-1: Exploration History

Company	Year	Comment
Bear Creek Mining Company (Bear Creek, Kennecott Copper Corporation's exploration subsidiary)	1952–1971	Geologic mapping. Ground and airborne geophysical drilling. Acquisition of state leases. Discovery of Local Boy deposit in 1968. Core drilling of 172 holes (71,205 m)
Reserve Mining Corporation	1959–1966	Core drilling of 6 holes (1,564 m).
American Metal Climax, Inc. (Amax)	1967–1982	Acquires Bear Creek properties in 1973. Renames property to Minnamax and initiates permit for shaft at Local Boy. Metallurgical test work conducted. Low-grade surface bulk sample drilled and collected (472 t); 527 m shaft completed, 1,146 m underground drifting. Underground bulk sample collected from Local Boy. Pilot plant production of bulk concentrate at Lakefield. Undertakes core drilling of 405 core holes (110,705 m). Completes feasibility study in 1980; project found to be uneconomic. Leases revert to Kennecott.
Humble Oil and Refining Co. (Humble)/Exxon Company (Exxon)	1968	Two core holes (1,253 m).
International Nickel Co. (Inco)	1968–1969	2 core holes (1,371 m).
Kennecott Copper Corporation (Kennecott)	1987–1989	Abandons state leases. Cements and caps shaft, and removes buildings.
Minnesota Natural Resources Research Institute (NRRI)	1990–1997	Conducts platinum group element (PGE) sampling campaign of Local Boy drill holes and completes grade/tonnage analysis of mineralization. Drills a potential surface bulk sample site (6 core holes, 71 m). Coleraine bench scale and pilot plant tests of Arimetco bulk sample.
Rhude & Fryberger	1990	Completes evaluation of Local Boy deposit in conjunction with NRRI.
Arimetco International, Inc. (Arimetco)	1993–1997	Acquires state leases. Completes surface bulk sample program, collecting two samples. Goes bankrupt in 1997; leases revert to the state in 1999.
Cominco American/ Teck American/Teck	1998–2021	Signs letter of intent to acquire Longyear Mesaba lease in 1998. Collects 5,000 t surface bulk sample from site drilled by NRRI in 2001. Conducts additional bulk sample in 2008. Commissions CESL hydrometallurgical pilot plant test work. Drills 137 exploration, geostatistical, and metallurgical holes (178,993 ft). Completes scoping study in 2012. Undertakes internal technical studies, including mineral resource estimate updates.

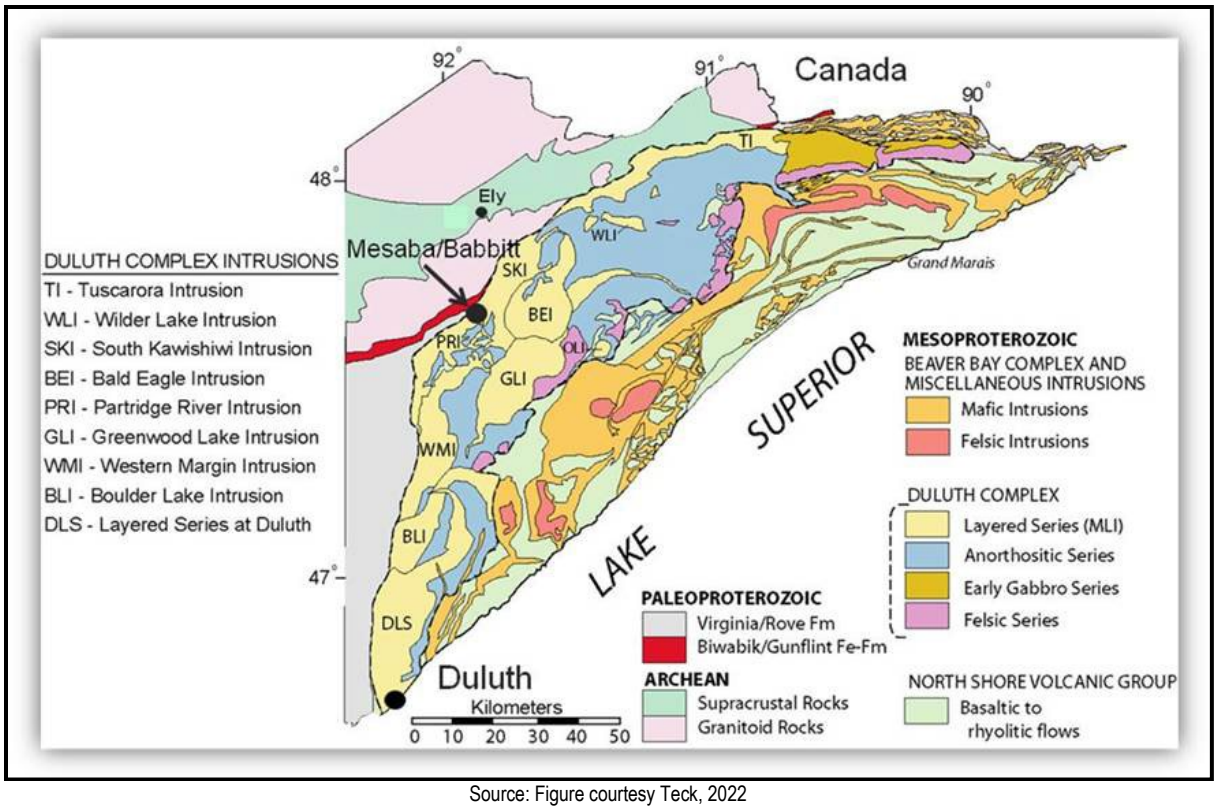
7 GEOLOGICAL SETTING AND MINERALIZATION

7.1 REGIONAL GEOLOGY

The major regional lithologies belong to the Duluth Complex, a series of Keweenawan-age tholeiitic intrusions and coeval flood basalts that formed along a portion of the Midcontinent Rift. The northwest, convex edge of the complex defines its basal contact, which dips to the southeast towards the rift. The complex is underlain by Neoarchean granites (Giants Range granitic rocks) and greenstones (Vermilion District) to the north, and Paleoproterozoic sediments (Virginia Formation and Biwabik Iron Formation) to the south. Roof rocks to the Duluth Complex consist of Mesoproterozoic intrusive and volcanic rocks of the Beaver Bay Complex and North Shore Volcanic Group, respectively.

The Duluth Complex consists of a number of sub-intrusions (Figure 7-1). Four general rock series are distinguished in the Duluth Complex on the basis of age, dominant lithology, internal structure, and structural position. These four series are:

- Felsic series: massive granophyric granite that occur as a semi continuous mass of intrusions that was emplaced during the early stage magmatism (~1,108 Ma);
- Early gabbro series: layered sequences of dominantly gabbroic cumulates that occur along the northeastern contact of the complex which was also emplaced during early stage magmatism (~1,108 Ma);
- Anorthositic series: structurally-complex suite of foliated plagioclase-rich gabbroic cumulates that was emplaced during the main stage magmatism (~1,099 Ma);
- Layered series: suite of stratiform troctolitic to ferrogabbroic cumulates that comprise at least 11 variably differentiated mafic layered intrusions that occur along the base of the Duluth Complex. These intrusions, including the Partridge River (PRI), Bathtub (BTI) and South Kawishiwi (SKI) intrusions, were emplaced during the main stage magmatism, but generally after the anorthositic series (~1,099 Ma).



Source: Figure courtesy Teck, 2022

Figure 7-1: Regional Geology of the Duluth Complex

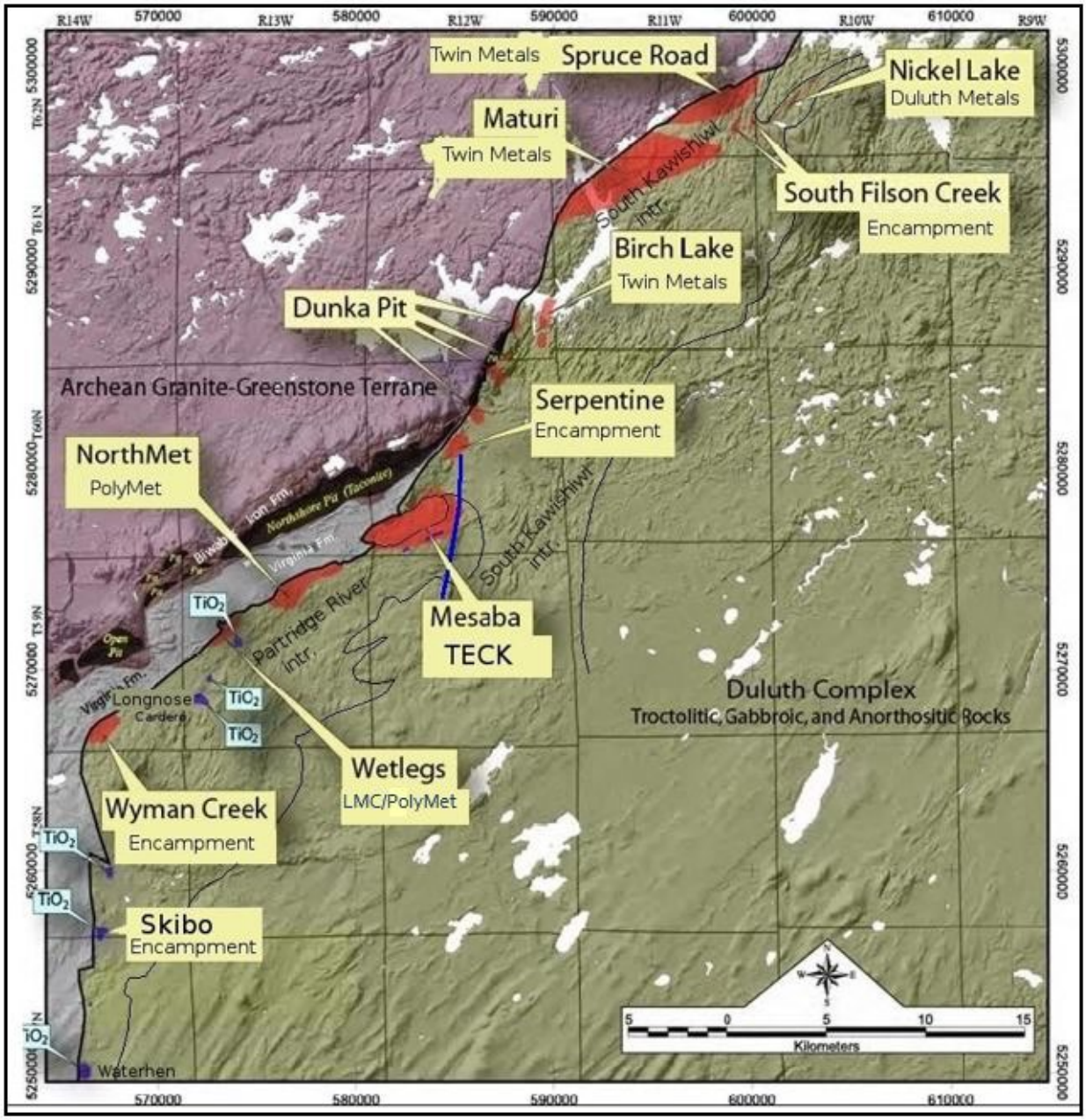
The Duluth Complex hosts a number of known disseminated copper–nickel occurrences (Figure 7-2), all of which are located within the basal portions of the Partridge River, Bathtub and South Kawishiwi sub-intrusions.

7.2 PROJECT GEOLOGY

7.2.1 Lithologies

Mineralization within Teck's Mesaba Project area is hosted within rocks of the Partridge River and Bathtub intrusions. Teck's current lithological classification scheme for the igneous rocks is primarily based on major element geochemistry and is provided in Table 7-1.

The more complex spatial relationships resulting from this model suggest a dynamic magma system that experienced multiple recharge events, and which created a complex framework of eroded, assimilated, and intermixed mafic lithologies. Illustrations showing the deposit geology are provided in Figure 7-3, Figure 7-4, and Figure 7-5.

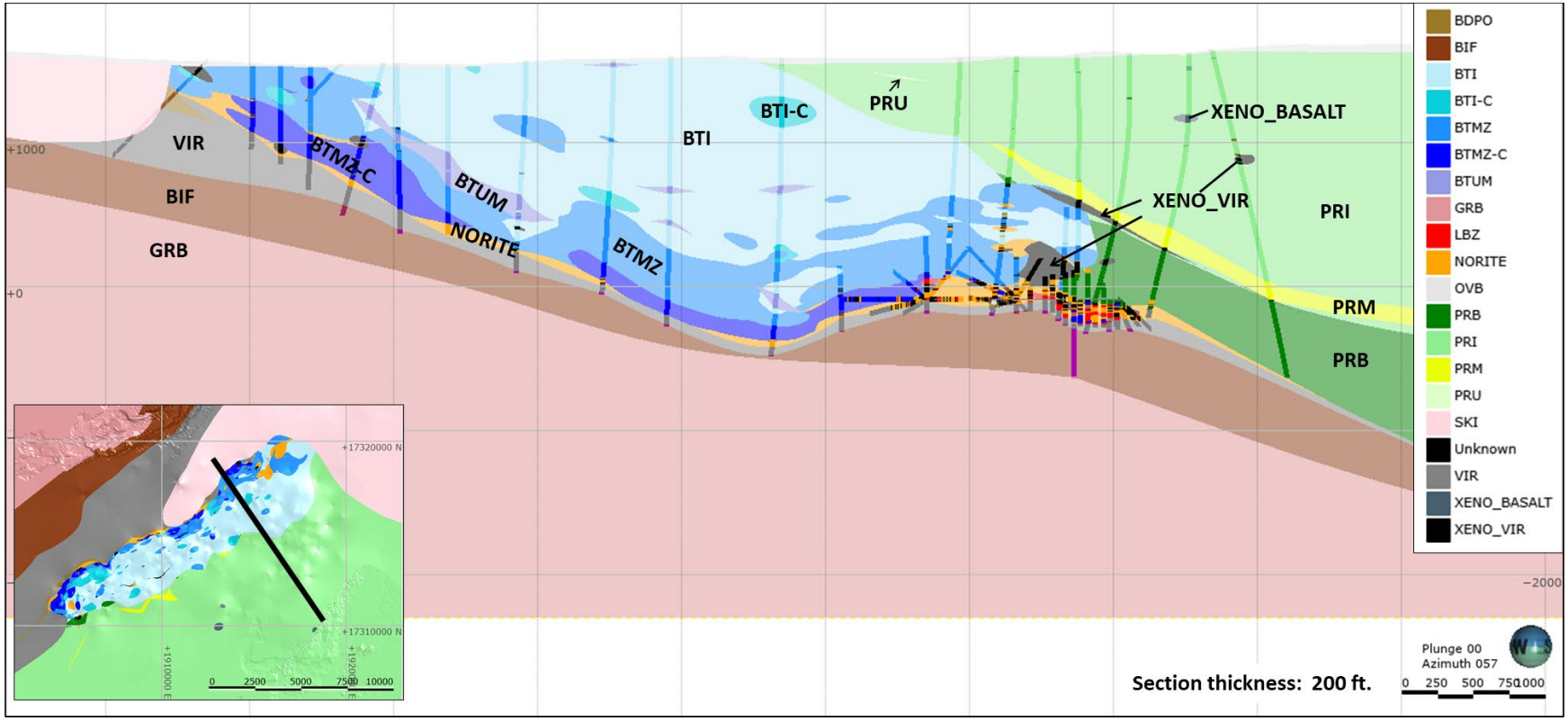


Source: Figure courtesy Teck, 2022

Figure 7-2: Cu–Ni Deposits Associated with the South Kawishiwi, Partridge River, and Bathtub Intrusions

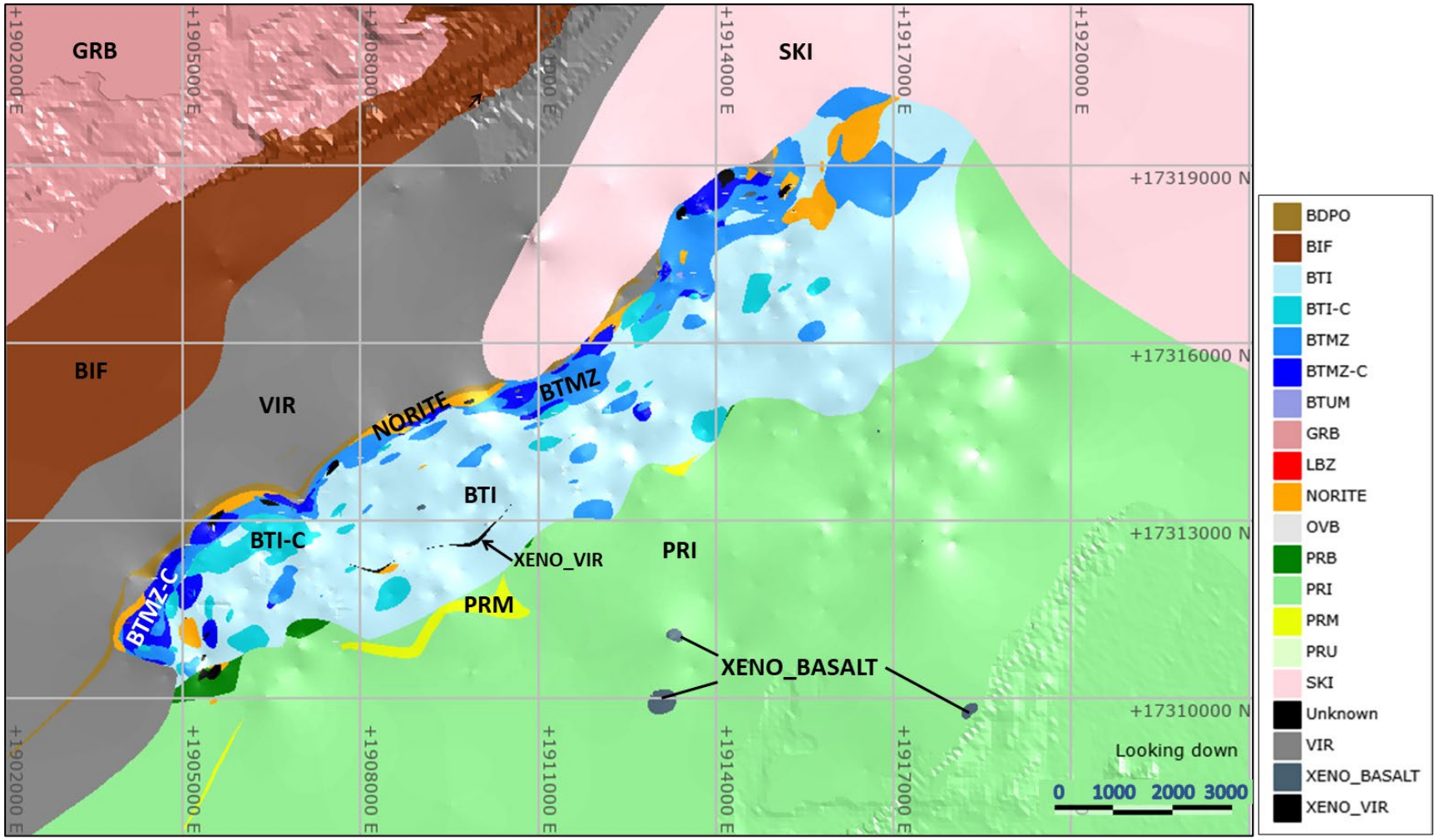
Table 7-1: Lithology Units

Lithology Units	Definition	Description
BTI	Bathtub Intrusion	Various troctolitic (plagioclase + olivine + clinopyroxene bearing) rocks within the Bathtub Intrusion.
BTI-C	Bathtub Intrusion - Contaminated	Contaminated (increased micas + orthopyroxene) rocks within the Bathtub Intrusion. Identified by lithochemistry.
BTMZ	Bathtub Intrusion Mineralized Zone	Sulfide-bearing troctolitic rocks within the Bathtub Intrusion. Same lithochemistry group as BTI, but mineralized.
BTMZ-C	Bathtub Intrusion Mineralized Zone - Contaminated	Sulfide-bearing contaminated rocks within the Bathtub Intrusion. Same lithochemistry group as BTI-C, but mineralized. Identified by lithochemistry.
BTUM	Bathtub Ultramafics	Olivine-rich rocks within the Bathtub Intrusion. Identified by lithochemistry.
NORITE	Norite	Noritic (plagioclase + orthopyroxene + clinopyroxene bearing) rocks. Identified by drill log.
PRI	Partridge River Intrusion	Various troctolitic rocks within the Partridge River Intrusion south of the Bathtub Intrusion.
PRU	Partridge River Intrusion Upper Mineralized Horizon	Discrete, continuous mineralized horizon within the upper portion of the Partridge River Intrusion. Similar to NRRI defined “Magenta Horizon” (chalcopyrite + PGE-rich) but different spatial interpretation.
PRM	Partridge River Intrusion Middle Mineralized Horizon	Discrete, continuous mineralized horizon within the middle portion of the Partridge River Intrusion. Similar to NRRI defined “Magenta Horizon” (chalcopyrite + PGE-rich) but different spatial interpretation.
PRB	Partridge River Intrusion Basal Unit	Basal mineralized zone of the Partridge River Intrusion.
XENO_VIR	Xenoliths of Virginia Formation	Xenoliths of the footwall Virginia Formation. Identified by drill log.
XENO_BASALT	Xenoliths of Basalt	Xenoliths of the hanging wall basalt. Identified by drill log.
LBZ	Local Boy Mineralized Zone	High grade mineralized zone at Local Boy.
VIR	Virginia Formation	Sedimentary footwall – identified by drill log. Subdivided into two informal sub members: a lower argillaceous lithosome and an upper silty and sandy lithosome. Only the lower lithosome is present at the Mesaba deposit. The hornfelsed Virginia Formation is subdivided into at least six informal units based largely on metamorphic attributes, which are each related to varying degrees of partial melting and original mineralogy.
BDPO	Bedded Pyrrhotite	Carbonaceous argillite horizons within the lower lithosome of the Virginia Formation. The unit contains conspicuous and regularly spaced laminae of pyrrhotite (0.5–5.0 mm). Identified by drill log.
BIF	Biwabik Iron Formation	Sedimentary footwall – identified by drill log. Subdivided into four informal lithostratigraphic members that are, from the bottom up: Lower Cherty, Lower Slaty, Upper Cherty, and Upper Slaty. These are informally divided into a further 22 sub-members in the east end of the Mesabi Range, and adjacent to the Mesaba deposit. Most of the drill holes at Mesaba intersect only the top three sub members.
GRB	Giants Range Batholith	Gneissic granitic rocks (rarely encountered at depth at Mesaba).
SKI	South Kawishiwi Intrusion	Duluth Complex intrusive rocks to the north and northeast of Mesaba.
OVB	Overburden	Glacial till.



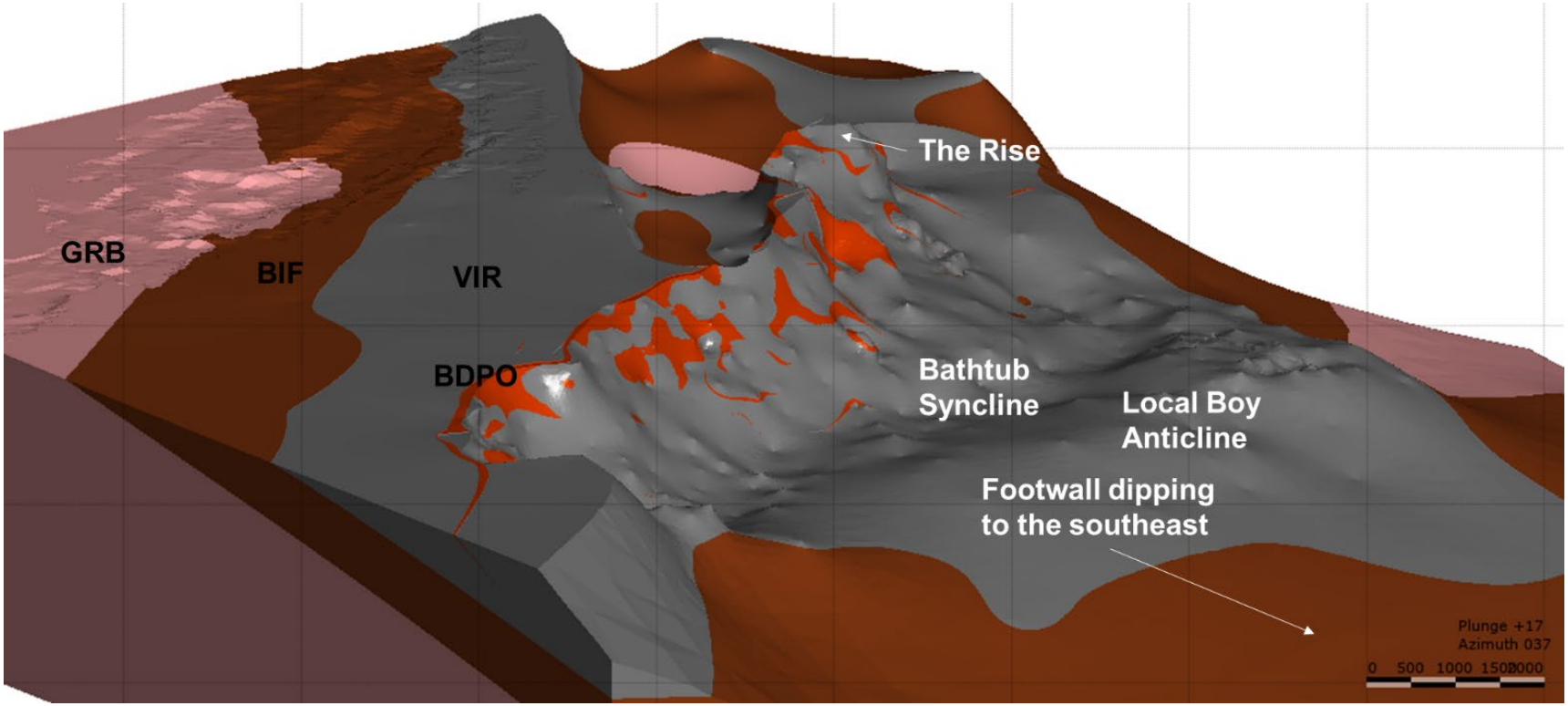
Source: Figure courtesy Teck, 2022; Legend key to abbreviations provided in Table 7-1.

Figure 7-3: Geological Cross-Section, Mesaba Deposit



Source: Figure courtesy Teck, 2022; Legend key to abbreviations provided in Table 7-1; The lower mineralized units (shades of dark blue) intersect bedrock surface along the northern edge of the deposit.

Figure 7-4: Plan View, Mesaba Deposit



Source: Figure courtesy Teck, 2022; Legend key to abbreviations provided in Table 7-1; Major units: Giant Range Batholith (pink), Biwabik Iron Formation (brown), Virginia Formation (grey), bedded pyrrhotite unit (red).

Figure 7-5: Footwall Beneath the Mesaba Deposit

7.2.2 Structure

There are several prominent structural features within the Mesaba Project area that were important to formation of the Bathtub Intrusion and may exert an influence on mineralization trends. These are summarized in Table 7-2.

7.2.3 Alteration

The major alteration types recognized in core logging are summarized in Table 7-3.

7.3 DEPOSIT GEOLOGY

The Bathtub Syncline is often the loci of the strongest mineralization. This concentration into a depression is most probably the result of gravitational settling of sulfides. Short intercepts (0.3–4.6 m) of semi-massive to massive sulfides are encountered at or near the contact with the Virginia Formation footwall; however, with the exception of the Local Boy area in the southeastern part of the deposit, these appear to be discontinuous and do not represent a large proportion of the overall mineralization.

The deposit has an approximately 4.9 km strike length. Mineralization is dominated by a laterally continuous 130–650 ft (40–200 m) thick disseminated sulfide zone within the basal portion of the Norite, Bathtub Intrusion Mineralized Zone (BTMZ), Bathtub Intrusion Mineralized Zone - Contaminated (BTMZ-C), and Partridge River Intrusion Basal Unit (PRB) units.

Mineralization extends down-dip, along the basal contact, for 1,006 m at the southwest end and for 1,981 m at the northeast end of the Bathtub Intrusion (BTI). The thickest and highest-grade portion of this mineralization lies along the axis of the Bathtub syncline. Higher in the intrusive package, within the BTI unit, are thinner zones of erratic and discontinuous disseminated sulfide mineralization referred to as “cloud zones”.

Disseminated sulfides dominate the style of mineralization found in the Mesaba deposit. The sulfides occur as interstitial grains set within a plagioclase–olivine–augite framework. Sulfides as interstitial grains between plagioclase crystals are the dominant variety (estimated to be >90%). Features within and on the edges of the individual sulfides include: exsolution lamellae, symplectic intergrowths at sulfide/silicate borders, scattered amoeboidal clusters consisting of very fine-grained sulfides, anastomosing veins and veinlets to produce net-textures, microscopic veinlets cross-cutting silicates, drop-like inclusions occurring within plagioclase and clinopyroxene crystals, and as very fine sulfides encapsulated by biotite. Sulfide grain size ranges from barely visible with a hand lens to individual crystals up to several inches across in massive sulfide zones. Disseminated sulfide contents commonly range from rare (usually categorized as 0.1% sulfides) to over 10% locally.

Table 7-2: Major Structures

Feature Name	Discussion
Local Boy Anticline and Bathtub Syncline	A pair of east–west-trending parallel folds, defined by contouring the top of the Biwabik Iron Formation that are informally referred to as the Local Boy anticline and Bathtub syncline. Both of these folds probably exerted strong controls on the style of emplacement of the BTI and its basal contact mimics the form of the anticline and syncline. The trend of the Hidden Rise, the possible wall once separating the BTI and PRI, also correlates with these two fold axes.
Grano Fault	Northeast trending fault located on the eastern edge of the Mesaba deposit. The Grano Fault is thought to be the primary feeder structure for the BTI and possibly the massive sulfides at Local Boy.
South Minnamax Fault	An east–west trending fault along the extreme southern edge of the Mesaba deposit. Displacement of the fault, based on correlations and projections of units between only six drill holes, is generally 30–61 m, but in one cross-section a displacement of over 122 m is indicated.
Cross Max structure	A broad monocline on the north limb of the Bathtub syncline defined by the top of the Biwabik Iron Formation, which exhibits a steep rise towards the surface and then levels off again further to the north.

Feature Name	Discussion
	The area of the Cross Max structure coincides with steeper dips in the bedding of the iron-formation as seen in drill core; however, there are exceptions. The basal contact also shows a steep rise in the same area.
North Minnamax Fault	A very weak east-west trending feature located to the north of the Cross Max structure. The existence of the fault is highly questionable.
Swamp fault(s)	A collection of parallel faults that are located at the far western end of the Mesaba deposit. Intensely brecciated, jointed, slickensided rock and localized gouge were intersected in several drill holes that are associated with this fault zone. The placement of these holes defines a northeast trend that coincides with a topographical lineament that is occupied by a swamp.
Basaltic dike	An extremely fine-grained, jet-black basaltic dike has been intersected in eight drill holes that define a northwest trend. When observed in drill core, the dike is extremely fine-grained and is chilled against the troctolitic country rock. The dike was probably intruded along a fault zone but only 15 m of displacement have been documented at the Peter Mitchell mine immediately to the north.
Additional faults	Numerous brecciated, slickensided, and fault gouge zones are intersected in a plethora of drill holes at the Mesaba deposit. This situation suggests that fault zones are common to the deposit. However, as many of these faults show minimal-to-no displacement in the footwall rocks they cannot be traced with certainty.

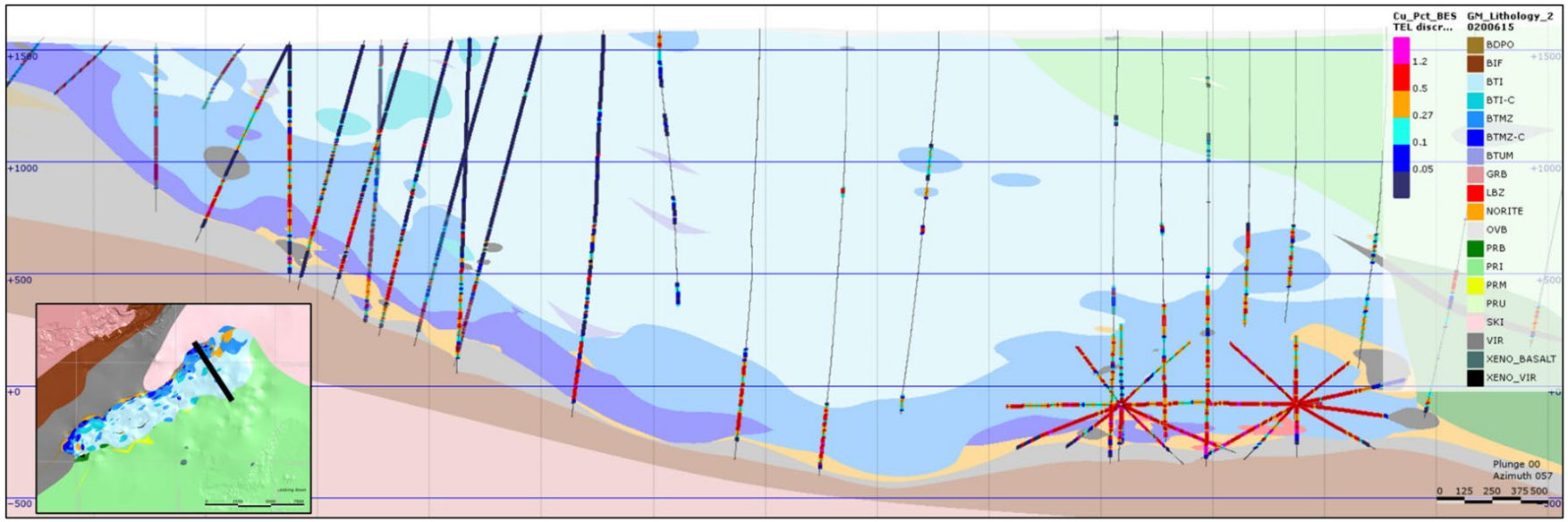
Table 7-3: Alteration Types

Alteration Type	Comment
Uralitization	Replacement of interstitial clinopyroxene, and olivine in extreme cases, by fine-grained radiating bundles of chlorite, hornblende, actinolite, sericite, cummingtonite-grunerite, tremolite, ±minor calcite that often interpenetrate with adjacent plagioclase crystals.
Saussuritization	Partial to complete replacement of plagioclase by fine-grained aggregates of albite, zoisite, epidote, chlorite, sericite, and zeolites.
Serpentinization	Confined to ultramafic layers and patches wherein the olivine exhibits a darker green color than usual, and the rock is magnetic due to the production of serpentine + magnetite (±talc) during the serpentinization event. A serpentinization foliation is almost always present to varying degrees.
Chloritization	Most commonly present as joint coatings, ± adjacent alteration halos, where it is often accompanied by lesser amounts of serpentine, zeolites and minor calcite.
Potassic	Commonly associated with rocks adjacent to pink granitoid veins that are usually related to fault zones. In some cases, near the Grano Fault, the potassic alteration extends for significant distances away from the actual veins and the vein contacts are highly gradational.
Iddingsite	Spotted iddingsite alteration of olivine occurs as “fronts” adjacent to joints.
Vugs	Commonly partially filled. Vug fill material is varied and consists of zeolites (typically acicular natrolite) with lesser amounts of quartz, chlorite, uralite, or calcite.
Chlorine drops	Slimy, rust-colored, fluid drops, which form via a deliquescent process, are locally present on the core surfaces of historic drill holes. In more recently-drilled holes, the first indications of chlorine drops are the formation of brown rust spots, white salt crystals lining cracks and vugs, and the core’s persistence to retain a wet appearance long after it had been washed and logged. Analysis of the brown liquid drops indicates high chlorine values and the presence of the mineral hibbingite ($Fe_2(OH)_3Cl$).

Semi-massive to massive sulfide zones most commonly occur at the basal contact of the intrusive or entirely in the underlying Virginia formation within 3 m of the basal contact. Semi-massive to massive sulfide zones can also occur along contacts of, and within, hornfelsed Virginia Formation xenoliths within the Bathtub intrusion. Veins and lenses are generally <0.9 m in thickness and, with the exception of the Local Boy area, appear to have limited horizontal extent.

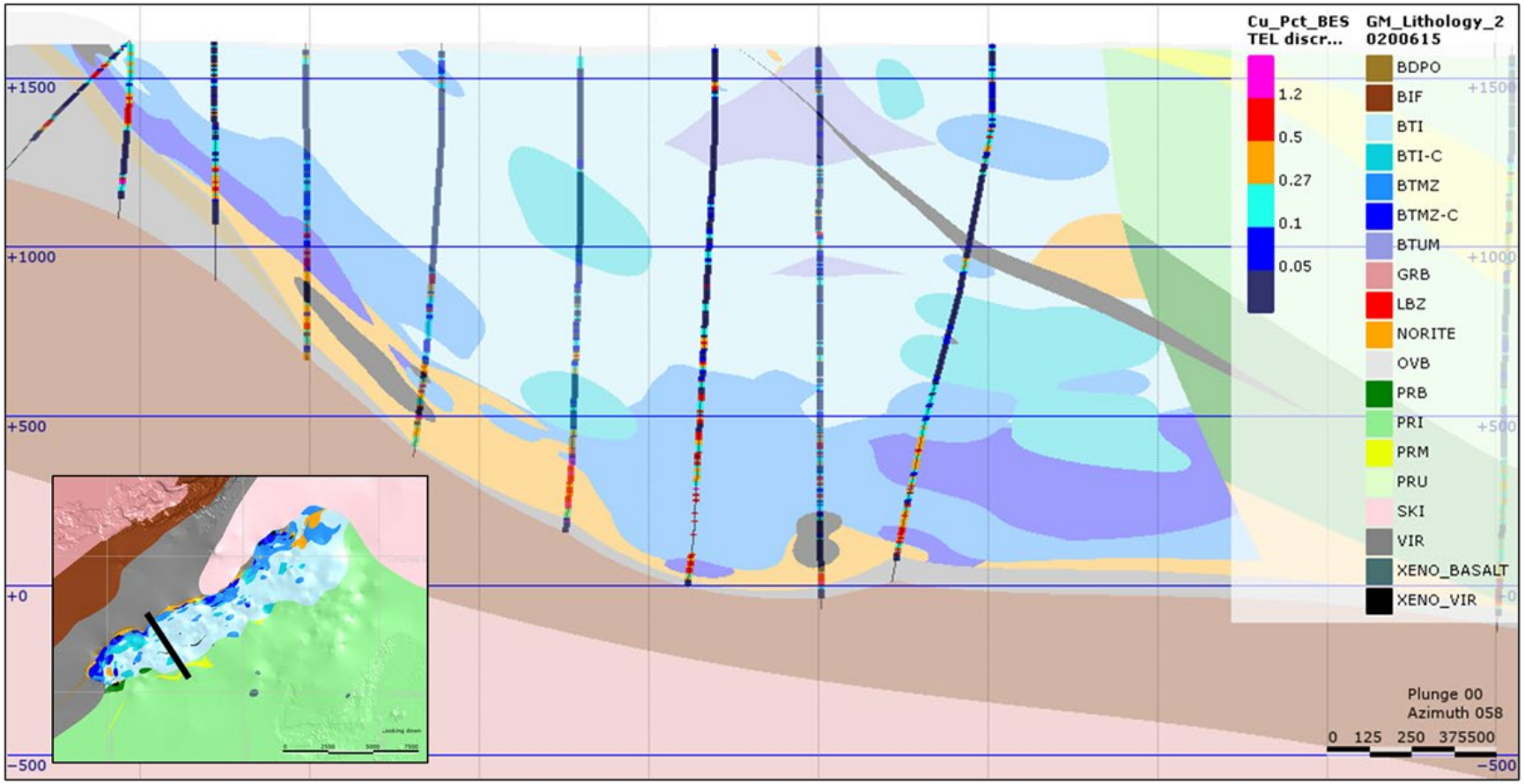
The most common sulfide minerals are chalcopyrite, cubanite, pentlandite, and pyrrhotite with lesser amounts of talnakhite, bornite, chalcocite, digenite, sphalerite, and mackinawite.

Cross-sections through the mineralization are provided as Figure 7-6 and Figure 7-7.



Source: Figure courtesy Teck, 2022; Section looking northeast, showing the distribution of copper in drill holes overlain on the lithological model; Copper grades shown in drill hole traces; Zone of 360-degree oriented drilling shown is Local Boy area.

Figure 7-6: Mineralization Cross-Section



Source: Figure courtesy Teck, 2022; Section looking northeast, showing the distribution of copper in drill holes overlain on the lithological model; Copper grades shown in drill hole traces.

Figure 7-7: Mineralization Cross-Section

8 DEPOSIT TYPES

8.1 OVERVIEW

The Mesaba Project deposits are classified as contact-type magmatic nickel–copper–platinum group element ("**PGE**") deposits which are a broad group of deposits containing nickel, copper, and PGEs occurring as sulfide concentrations associated with a variety of mafic and ultramafic magmatic rocks. The magmas originate in the upper mantle and contain small amounts of nickel, copper, PGE, and variable but minor amounts of sulfur. The magmas ascend through the crust and cool as they encounter cooler crustal rocks. If the original sulfur content of the magma is sufficient, or if sulfur is added by assimilation of crustal wall rocks, a separate sulfide liquid forms as droplets dispersed throughout the magma. Because the partition coefficients of nickel, copper, and PGEs, as well as iron, favor sulfide liquid over silicate liquid, these elements preferentially concentrate in sulfide liquid droplets within the surrounding magma. The sulfide liquid droplets tend to sink toward the base of the magma because of their greater density and can form massive sulfide concentrations.

The mafic and ultramafic magmatic bodies that host the nickel–copper sulfide mineralization are diverse in form and composition, and can be subdivided into the following four subtypes:

- a meteorite-impact mafic melt sheet that contains basal sulfide mineralization (Sudbury, Ontario is the only confirmed example);
- rift and continental flood basalt-associated mafic sills and dike-like bodies (Noril'sk-Talnakh, Russia; Duluth Complex, Minnesota; Muskox, Nunavut);
- komatiitic (magnesium-rich) volcanic flows and related sill-like intrusions (Thompson, Manitoba; Raglan and Marbridge, Quebec); and
- other mafic/ultramafic intrusions (Voisey's Bay, Labrador; Lynn Lake, Manitoba; Giant Mascot, British Columbia; Kotalahti, Finland; Råna, Norway; and Selebi-Phikwe, Botswana).

The Duluth Complex is associated with the Midcontinent Rift and continental flood basalt-associated mafic sills and dike-like bodies. Nickel–copper deposits of the rift and continental flood basalt associated subtype are the products of the magmatism that accompanies intracrustal rifting events. These deposits are associated with large magma systems, and within these systems the nickel–copper sulfide mineralization tend to be associated with conduits or feeders to the larger igneous masses (in this last respect, the Duluth Complex is an exception in which the low-grade nickel–copper sulfides may not be associated with conduits or feeders but rather lobes of sulfide-enriched magmas). Much of the sulfur in the sulfide has been derived by contamination of the magma by incorporation of sulfur from adjoining wall rocks.

9 EXPLORATION

PolyMet has conducted no exploration activities on the Project.

9.1 GRIDS AND SURVEYS

The co-ordinate system used at the Mesaba Project is a modified version of NAS 1983 UTM zone 15N with co-ordinate units in linear feet.

A light imaging and radar detection and ranging (LiDAR) survey was flown over the property by Aerial Services Inc (ASI) in May 2007. This survey provided a high-resolution orthophoto of the property area and detailed digital terrain model (DTM) information at 1 m, 3 m, and 5 m intervals.

9.2 GEOLOGICAL MAPPING

No information remains from geological mapping likely conducted by Amax and Bear Creek.

Geological map data available to Teck consists of a quadrangle scale map completed by James Miller and Mark Severson in 2005 at a 1:24,000 scale and deposit-scale mapping conducted by Mark Severson in 2012.

Digital information obtained from geological mapping is included in the Project acQuire database.

9.3 GEOCHEMICAL SAMPLING

Although geochemical surveys were used very early in the historical exploration programs (refer to Table 6-1), Teck discontinued such sampling due to the likely impact from surrounding mining operations and anthropogenic influence on surface sampling and the relative paucity of outcrop in the Project area. In addition, all surface geochemical data are superseded by drill data.

9.4 GEOPHYSICS

A number of geophysical surveys were completed between 1950 and 1999; however, the data are superseded by the more recent ground and airborne surveys completed under Teck's direction that are summarized in Table 9-1.

Table 9-1: Geophysical Surveys

Year	Type	Contractor	Coverage	Notes
2008	MEGATEM	Fugro	1,352 line kms	Fugro's data interpretation identified areas of EM response indicative of conductors as well as several lineaments that may represent faults and geologic contacts. The EM anomalies were interpreted to be bedrock conductors that are more likely to represent massive sulfide, rather than surficial or cultural responses.
2008	Downhole logging	Colog	9 drill holes	Parameters measured include magnetic susceptibility, self-potential, single point resistance, natural gamma, and resistivity. Induced potential measurements were collected in only two of the holes due to instrumentation issues.
2011	Atomic dielectric resonance	Adrok	14 virtual drill holes, 1 profile	Trial of new technology. Results were difficult to interpret and considered to be inconclusive.
2013	Borehole pulse electromagnetic	Crone	10 drill holes, 3 loops	Visual interpretation of the data did not identify any geologically significant off-hole conductors.
2013	Downhole logging	Teck Exploration	6 drill holes	Parameters measured include magnetic susceptibility, natural gamma, IP and resistivity. In addition to physical properties, an optical televiewer probe was rented, and data were collected in four of the six holes. The upper troctolite units and olivine gabbro/norite units are resistive. At depth, the troctolite units become more chargeable, due to increased sulfides. Hornfels show elevated gamma and increased chargeability. Massive sulfides show increased magnetic susceptibility as well as increased chargeability. Limited structure picks were made with the optical televiewer data; problems with the tool during data collection made the data unreliable in several of the holes

9.5 BULK SAMPLING

9.5.1 2001 Bulk Sample

In 2001, Teck collected approximately 5,500 st (4,990 t) of mineralized troctolitic material from the basal mineralized zone. The rock was crushed on site to approximately 0.25 inch (6.4 mm) and 5,500 st (4,990 t) were then shipped by rail to a mill in Montana for processing through to a concentrate.

Approximately 107 st (97 t) of concentrate was produced from the crushed bulk sample. A small portion of the crushed bulk sample was shipped to G&T Metallurgical Laboratories ("**G&T**") to be used in a flotation test program (KM1167) and the remaining 1,000 st (907 t) was stored on Cleveland Cliff's property. This stockpiled material was later processed at the Coleraine Minerals Research Laboratory ("**Coleraine**") to produce concentrate for copper pressure leaching technology ("**CESL**") testing in 2008.

9.5.2 2008 Bulk Sample

Approximately 1,380 st (1,252 t) of mineralized material was mined in September 2008. This material was transported to a pad on the Cleveland Cliff property for subsequent processing. The bulk sample was crushed to a maximum 0.25 inches (6.4 mm). Part of this sample was shipped to Teck's ART Centre for bench scale flotation test work. The remainder of the crushed material was transported to Coleraine for milling and concentration to produce a concentrate for CESL hydrometallurgical testing.

Between September and December 2008, the pilot scale plant at Coleraine was operated to produce the concentrate for CESL test work. The plant ran at a nominal 5.5 st/h (5 t/h) rate, treating bulk sample material from both 2001 and 2008. The operation encountered equipment and process control issues. A total of 10 st (9 t) of concentrate was produced with an average grade of 19% Cu, 2.1% Ni, 21.5% S, 30% Fe and 3.7 g/t PGEs. The performance of the equipment was not optimized, and no attempt was made to provide a reconciled balance for the duration of the operation.

9.6 EXPLORATION POTENTIAL

The Mesaba deposit remains open at depth to the south, and potential remains to increase the known disseminated mineralization extent.

Exploration potential that remains in the Project area includes:

- potential for high-grade massive sulfide zones such as the Local Boy zone to be present in the poorly-drilled areas to the south;
- potential for high-grade massive sulfide zones within structures such as the Grano and South Minnamax faults which may be feeder zones to the larger disseminated mineralization; and
- potential for thick zones of high tenor copper and PGE-enriched disseminated sulfides higher in the stratigraphic sequence of the Partridge River Intrusion as observed in the sparse drilling south–southeast of Local Boy.

10 DRILLING

PolyMet has conducted no drilling on the Project.

10.1 INTRODUCTION

Prior to Teck's involvement in 1998, a total of 624 surface and underground holes (613,524 ft [187,002 m]) were drilled. Historical drilling on the Project is summarized by year from 1958 to 2000 in Table 10-1. Of the drill sample intervals used for resource estimation, 58.5% are from drill holes completed prior to Teck's Project involvement.

Teck has completed 221 holes in the period 2007 through 2022 totaling 196,373 feet (59,854m). Teck drilling programs, completed in 2007, 2008, and 2013, were designed to gather geological, geostatistical, geometallurgical, geotechnical, and hydrogeotechnical information. Thirteen of the holes drilled in 2021 and 2022 were excluded as they were drilled after the resource cutoff date of December 2020. The thirteen excluded holes, totaling 13,830 feet (4,215 meters) focused on providing materials for metallurgical variability samples (four drill holes), and geotechnical drilling (seven drill holes). Two drill holes were conducted for exploration purposes.

The Teck drill programs are summarized in Table 10-2.

Drill collar locations for all programs are shown in Figure 10-1.

10.2 DRILL METHODS

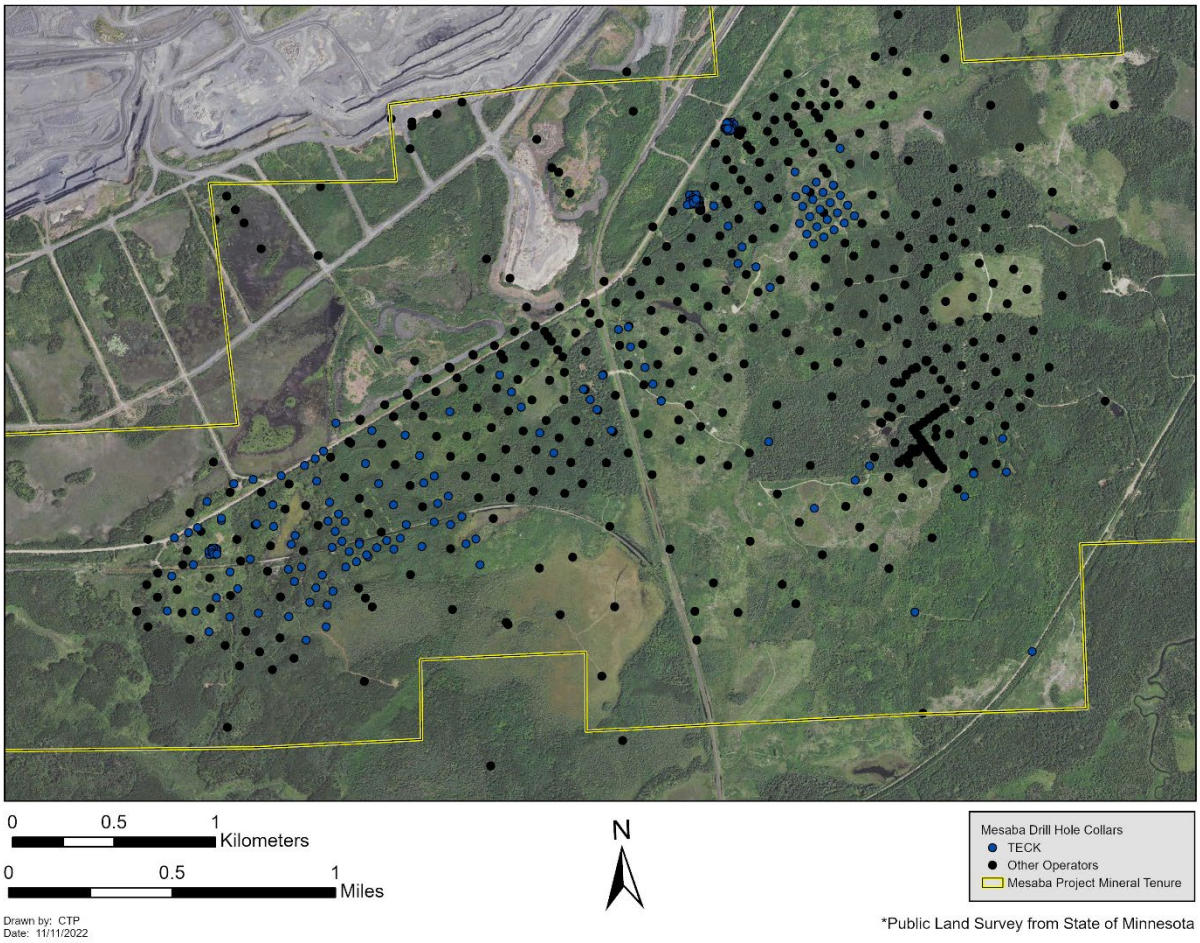
Drill programs were primarily completed using HQ (63.5 mm core diameter) methods. The 2008 bulk sample drill holes were at BQ (36.5 mm) size. Only core drilling has been performed to date.

Table 10-1: Historical Drill Programs

Year	Operator	# of Drill Holes	Length (ft)
1958	Bear Creek	2	1,426
1959	Bear Creek	33	25,187
1959	Reserve Mining	1	631
1960	Bear Creek	20	16,147
1964	Reserve Mining	1	675
1965	Reserve Mining	3	1687.5
1966	Reserve Mining	5	4,363
1967	Bear Creek	12	20,749
1968	Amax-Exxon	1	3,325
1968	Bear Creek	34	49,007
1968	Humble Oil (Exxon)	1	3,574
1968	Inco	1	2,954
1968	Reserve Mining	3	925
1969	Bear Creek	21	38,847
1970	Bear Creek	23	45,105
1971	Bear Creek	29	33,331
1971	Reserve Mining	2	576
1974	AMAX	22	38,984
1975	AMAX	34	64,901
1976	AMAX	91	107,624
1977	AMAX	84	91,308
1978	AMAX	219	64105
1996	NRRI	6	235
	Totals	***648***	***615,666***

Table 10-2: Teck Drill Programs

Year	Purpose	Number of Drill Holes	Length (ft)
2007–2008	Infill and metallurgical	64	68,392.5
2008	Bulk sample site	71	3,550
2013	Geometallurgical	25	33,312
	Local Boy	10	24,270.5
	Geostatistical	38	53,018
2021	Geometallurgical	4	3,766
	Exploration	2	3,309
2022	Geotechnical	7	6,755
Totals		***221***	***196,373***



Source: Figure courtesy Teck, 2022

Figure 10-1: Drill Collar Location Plan

10.3 LOGGING AND HANDLING PROCEDURES

10.3.1 Historical

The long exploration history and the involvement of many different Bear Creek Mining or Amax geologists resulted in inconsistent geological logs and lithologies. Each company logged using their own geological nomenclature and coding system that was different from Teck's current system.

The NRRI used a system close to that used by Teck in 2008–2009. These inconsistencies between the old logs and Teck's current system for new holes sometimes were resolved by recoding the old information; however, in most cases it required relogging.

The logging captured estimates for the percentages of plagioclase, olivine, clinopyroxene, orthopyroxene, biotite, and sulfides. The type of alteration and alteration minerals such as serpentine, talc, chlorite, uralite, sausserite, sericite, and clay was recorded. The log included estimates of cubanite-chalcopyrite, talnakhite, pyrrhotite and other sulfides as a percentage of total sulfides present. Estimates of the percentage of oxide minerals such as magnetite and ilmenite were also recorded. The logs were completed by hand on paper and information was then transferred to a digital format for entry into the commercially-available acQuire software.

10.3.2 Teck

Core was placed in waxed cardboard core trays and transported to Teck's core facility in Babbitt for logging. Prior to logging, core was aligned so that pieces fitted together along a common axis. Drill core logging was done by site geologists and information collected included:

- Core photographs;
- Drill hole number;
- Structural information;
- Lithology;
- Textural type;
- Sulfide speciation;
- Alteration by type and percentage;
- Fracture frequency;
- Mineralogy;
- Rock quality designation (RQD) and core recovery;
- Density and magnetic susceptibility;
- Equotip hardness measurement.

Core recovery and RQD, or solid core recovery, measurements were taken after the core for the entire hole was aligned. RQD measurements consisting of totaling the amount of core, between run blocks, which was ≥4 inches (10 cm) long (i.e. two times the core diameter).

The fracture frequency was recorded according to their orientation (categorized as being in one of three possible bins = 60–90°, 30–60° and 0–30°). The fractures were also described regarding their shape, type of fill material, and degree of roughness.

Magnetic susceptibility readings were recorded at 1 ft (30 cm) intervals with an Exploranium Kappameter KT-9.

Core logging of lithological units was accomplished by using a classification scheme previously used by Teck and the NRRI. Visual estimations of the percentages of plagioclase, olivine, augite, orthopyroxene, sulfides, and oxides were made during this phase. In some cases, attempts were made to determine if the amounts of chalcopyrite (± talnakhite) were greater or lesser than the cubanite amounts through the use of one or more > or < symbols. The type and degree

of alteration, as well as texture and grain size, were also recorded for all rock types encountered in the drill hole. Data were recorded on paper logs and were then transferred into acQuire on a drill hole by drill hole basis.

Core photographs were taken in both dry and wet conditions (two photographs per core box). These digital photographs were labelled by drill hole and depth and archived on the office computer.

Equotip hardness measurements were initially collected every 2 ft (60 cm). However, it was later determined that these measurements were not useful for comminution purposes, and the practice was discontinued.

10.4 ROCK QUALITY DESIGNATION AND RECOVERY

RQD and core recovery data were collected by Teck for 140 core holes including 64 from the 2007–2008 drill program, 73 from the 2013 drill program, and three historic drill holes.

Overall, core recoveries are high at Mesaba for all lithology units and average 99.55%.

The RQD is high for all units but some general trends are present in the data. The metasedimentary footwall rocks with bedding planes (BDPO, VIR, BIF) have the lowest RQD, followed by ultramafic rocks (BTUM) which tend to have foliations as planes of weakness, xenoliths of the Virginia Fm (XENO_VIR), increasing to the contaminated intrusive rocks (NORITE, BTI-C, BTMZ-C), then increasing to non-contaminated Bathtub Intrusion units (BTI & BTMZ), and then Partridge River Intrusion units (PRI, PRB, PRM, PRU) are even more cohesive. Very little drilling intersects the basement Giants Range granite, but it has predictably high RQD as well.

A preliminary attempt was made to determine if zones with low %RQD values could be mapped out in Leapfrog. This attempt failed because it only showed a scattering of the Teck holes, with detailed measurements, that were intermixed among an overwhelming number of historic holes (B1-series holes) that had very little recorded RQD data.

10.5 COLLAR SURVEYS

Historical collar survey information, where available, has been converted from paper copies to digital, or has been converted from the original digital data to modern format, and is included in the Project acQuire database.

The position of the hole collars was marked either by the drill casing (which were eventually removed and marked by a small monument in 2017) or by a wooden marker. All known collars were surveyed by a differential GPS in late October 2008.

All known collar locations were re-surveyed by third-party consultants Short Elliot Hendrickson (SEH) in 2012. This includes both historical drill holes (Bear Creek, Amax, Inco) and Teck drill holes MB-07-001 to MB-08-065 (inclusive).

The 2013 Teck drill program drill hole collars were surveyed by Benchmark Engineering out of Mountain Iron Minnesota.

All Teck-generated drill holes (including 2013 drilling programs have since been permanently capped and monuments markers placed accordingly. Due to land access constraints, monument markers have not been placed on 2007–2008 drill holes (65 drill holes) and the 2013 Local Boy exploration drilling program (10 drill holes).

10.6 DOWN HOLE SURVEYS

Digital information obtained from historical down hole surveys is included in the Project acQuire database.

Down hole surveys for the 2007–2008 drill programs were completed by Benchmark Engineering of Mountain Iron, MN. Downhole surveys were taken using a gyroscopic instrument (gyro) for five holes. However, the gyro instrument proved to be ineffective for vertical holes due to the requirement to establish an azimuth for the first reading. The gyro

readings were also suspect for inclined holes because the operator used a Brunton compass to determine north for the first reading. The presence of the highly-magnetic Biwabik Iron Formation to the north, and possible presence of iron formation boulders in the overburden, are thought to affect the compass reading for the gyro orientation. Because of the perceived issues with the gyro, the balance of the downhole surveys was completed using a Flexit EZshot magnetic-based survey instrument. Any readings where the total magnetic field or magnetic dip did not match those acceptable for the area were discarded. Readings within iron formation were also discarded.

Downhole surveys for the 2013 Teck drill programs were conducted by MINEX, a subdivision of Idea Drilling LLC. MINEX used a Reflex-Gyro survey tool, as this tool operates inside the drill rods and is not affected by magnetic issues.

Readings were conducted every 20 ft down hole, to include azimuth and dip data. The original collar azimuth of the drill hole was obtained by leveling a laser-emitting tool on the drill rod as it entered the hole. This laser beam extends horizontally in the precise azimuth of the hole. The beam direction was then measured with a land surveyor quality Trimble GPS, using two stations 20 ft apart. The instrument was accurate to 0.1 ft.

Idea Drilling LLC, in addition to the MINEX downhole survey(s), provided a Flexit EZshot magnetic-based downhole survey, at the completion of each 2013 drill hole. Readings were conducted every 20 ft. Although magnetic-based, the Flexit readings were used in subsequent studies in combination with non-magnetic downhole surveys.

10.7 GEOTECHNICAL AND HYDROLOGICAL DRILLING

Seven geotechnical holes were drilled during the period January to March, 2022.

A hydrological drill program was completed in February 2022. A total of 30 boreholes were drilled for hydrogeological purposes in 16 locations. In 2011, four wells were installed in overburden in order to evaluate the hydraulic characteristics of the saturated material at those locations. From 2020 to 2022, 26 environmental wells were drilled in 12 locations. The general plan for each drill program during 2020 to 2022 was to install monitoring wells to measure groundwater levels and chemistry in three geologic intervals at each drill pad: overburden, shallow bedrock, and deep bedrock; however, real-time field events dictated ultimate completions. Bedrock monitoring well depth was informed by observations during drilling and from downhole geophysical analysis. Some boreholes have been left open because observation and downhole geophysics indicated insufficient groundwater flow to support a monitoring well. There are 22 boreholes with well screens installed and eight boreholes that have been left open over the Project area.

10.8 METALLURGICAL DRILLING

In the first quarter of 2013, 25 HQ-sized holes were drilled on five sections with drill holes spaced about 400 ft apart in order to provide sufficient material for metallurgical test work and to generate sufficient bulk concentrate for CESL process technology testing at a pilot scale. In the winter of 2021, four additional metallurgical holes were drilled to provide material for metallurgical variability samples. These holes were drilled after the effective date of this Report.

10.9 SAMPLE LENGTH/TRUE THICKNESS

The relationship between true widths, drill intercepts, lithologies and mineralization grades for drill hole intervals in selected drill holes is shown on the cross-section included as Figure 7-7: Mineralization Cross-Section. Depending on the dip of the drill hole, and the dip of the mineralization, drill intercept widths are typically greater than true widths.

10.10 DRILLING COMPLETED AFTER THE DATABASE CLOSE-OUT DATE FOR MINERAL RESOURCE ESTIMATION

Thirteen drill holes were completed after the database close-out date for Mineral Resource estimation, primarily for geotechnical and metallurgical purposes. All holes were logged, sampled, and assayed from top to bottom. QA/QC on the collected data has not been completed.

Inspection of visual mineralization estimates and available assay results suggests that the mineralization in all of the drill holes located in the Mineral Resource estimate area are generally consistent with surrounding drill data. Although a few of the newer drill holes may show minor local grade changes locally, the drill holes that are situated within the existing model should, in the QP's view, have no material effect on the overall tonnages and average grade of the current Mineral Resource estimate.

11 SAMPLE PREPARATION, ANALYSES AND SECURITY

PolyMet has conducted no sampling, sample preparation, or analytical programs on the Project.

11.1 SAMPLING METHODS

11.1.1 Historical

Limited information is available on the historical sampling programs. Available information is discussed in Section 12 as part of the data verification process.

11.1.2 Teck Resampling of Historical Drill Holes

In most cases, Bear Creek and Amax only sampled core if it contained visible sulfides of obvious economic potential.

In the course of Teck staff interpreting data on section, numerous sampling gaps in the upper portions of historic holes became apparent. Reasons for the lack of sampling appeared to be that the intervals either contained no significant, visible sulfide or were deemed too low grade to be of interest. However, Teck found that these areas could contain economic Ni–Cu values. The gaps also made it difficult for Teck to characterize and model the waste in terms of acid rock drainage (ARD) potential. The Teck drilling indicated that there were numerous short sections within the upper part of the intrusion that had low-grade, 0.2–0.3% Cu values. These low-grade intercepts were often in portions of drill holes that had not been historically sampled.

A program of relogging and sampling of historic surface holes started in July 2008. At the end of 2018, a total of 483,272 ft (147,301 m) in 409 drill holes had been re-logged and 290,743 ft (83,936 m) sampled. Unsampled sections were half sawn while previously sampled intervals were quarter sawn to maintain a representative quarter section of core as mandated by the MN DNR. Of the footage sampled, 162,538 ft (44,859 m) has been assayed. The remaining footage, which is mostly barren, has yet to be assayed.

11.1.3 Teck Drilling

11.1.3.1 2007–2012

All Teck drill core was sawn in half, with one-half retained in the core box, and one-half sent for assay. The water used to saw the core was not recirculated. No lubricants were used in the sawing process. Specific gravity (SG) measurements using water displacement methods, were performed at intervals ranging from 15–100 ft (4.6–30 m). Magnetic susceptibility measurements were completed at 2 ft (0.6 m) intervals. All the physical and geotechnical measurements were recorded and stored in acQuire.

Core samples were generally taken on 5 ft (1.5 m) intervals with breaks at major lithological contacts. The minimum sampling interval was 0.3 ft (0.09 m) and the maximum was 15 ft (4.6 m). The entire intrusive interval was sampled. Sampling continued into the footwall sediments for a minimum of 50 ft (15 m) and deeper if copper or nickel sulfides were present. The banded iron-formation was the marker within the footwall sediments at which most drill holes were terminated. Generally, the iron formation was not sampled.

Multi-tab, bar-coded tags were used to identify the samples and sample intervals. One tab was placed in the core box at the top of the sample interval, two tabs were placed in the bag with the split core, a tab was attached to the outside of the sample bag and details of the hole and sample interval were recorded on the tab left in the sample book.

In addition to coarse crush and quarter core, numerous short 2–5 inch (5–12.7 cm) slabs of mineralized core were sent to Teck's Applied Research and Technology (ART) Centre in Trail, British Columbia, for mineralogical and petrographic studies. Selected cores from three drill holes were quartered and sent to ART to determine sulfide species and chalcopyrite to cubanite ratios.

11.1.3.2 2013–2017

The core was aligned with a marker line drawn down the core axis. The initial position of this line was chosen at random at the top of the hole and was then traced downward throughout the entire hole, even across run blocks that were placed approximately every 10 ft (3 m). The line was traced as best as possible through highly broken-up core zones. The core from Local Boy and the geostatistical drill holes was cut in half with ½ core for assays and geochemical analysis and the other ½ core preserved in the core box for future reference.

11.1.3.3 2010–2012 Metallurgical Sampling

The original methodology for obtaining metallurgical samples for ART in Trail was to take the coarse reject material from the assay sample preparation that was sent to ALS Chemex. The individual coarse rejects were placed in plastic bags and vacuum-sealed by ALS Chemex. ALS crated the samples and shipped them to Trail. Upon receipt of interval assays, ART personnel composited samples as required.

However, ART found the coarse reject material to be crushed too fine for some of the metallurgical tests and requested a second round of sampling. As a result, selected intervals of half core were quartered to satisfy ART's metallurgical sampling requirements.

11.1.3.4 2013–2017 Geometallurgical Sampling

Sample intervals were selected along the length of drill core with a target length of 30 ft (9 m) every 90 ft (27 m) and were marked down the hole with starting and end depth. Each interval was assigned a unique ID number. The sample intervals could be shifted anywhere within the 90 ft (27 m) interval so that they were most representative of the interval. Preliminary sample interval selection was based on information obtained from core logging. Final selection was done during a site visit (geologist/metallurgist) after viewing the drill core. The samples for metallurgical test work and geochemical analysis were selected from these intervals to allow the results to be linked back to the exact location in a three-dimensional (3D) space across the deposit. Caution was taken to select the intervals such that they did not cross the geological boundaries as defined by core logging. It was estimated that approximately six intervals were selected per drill hole for a total of 150 sample intervals from 25 HQ holes. This estimation is based on a conceptual strip ratio of 1.1 or that approximately 47% mineralized material will be above a cut-off grade of 0.312% Cu.

Core from the geometallurgical holes was cut from the start to the finish of drill hole. First the complete core was cut in half, and then one of the half cores was further sawn in half to produce two ¼ cores. The drill core was cut such that ½ core was for metallurgical test work, ¼ core was for assays and geochemical analysis and the remaining ¼ core was preserved in the core box for future reference.

For the lithogeochemical samples, a composite was made for each 30 ft (9 m) sample interval using one reserve charge per 10 ft (3 m) assay sample, and the sample was sent for whole rock lithogeochemical and trace element analysis.

For the mineralogy samples, a composite was made for each sample interval using one reserve charge per 10 ft (3 m) assay sample and submitted for mineralogical analysis using a QEMSCAN/MLA particle mapping method. The sample was packed and labelled with the drill hole ID, sample ID and interval footage.

Metallurgical samples were composited for each 30 ft (9 m) sample by ART personnel using the some of the above lithogeochemical and geometallurgical test samples as anchors. These samples were selected after assay results were known. For the most part, the selected composited intervals did not cross major geologic contacts. Both upper and lower contacts of the intervals corresponded to previous assay interval breaks such that the assay information could be directly related to the larger metallurgical and geochemistry intervals. Composites were assigned unique sample IDs and shipped to the assigned laboratory for metallurgical tests.

11.2 DENSITY DETERMINATIONS

Specific gravity (SG) measurements using the simple Archimedes principle (weight in water versus weight in air), were performed on over 4,007 pieces of core from the 2007–2008 drill program and re-logged historic holes. No wax was required as the rock is very dense with no significant porosity. The SG measurements were taken at intervals ranging from 16–98 ft (4.9–29.9 m) based on the complexity of the lithology. A summary of the results by lithology is provided in Table 11-1. The key to the lithology codes was included in Table 7-1.

11.3 ANALYTICAL AND TEST LABORATORIES

Analytical laboratories used during the Project history are provided in Table 11-2.

11.4 SAMPLE PREPARATION AND ANALYSIS

11.4.1 Sample Preparation

11.4.1.1 Historical

Preserved documents at the DNR indicate that Bear Creek had their own crushing equipment and shipped their sampled intervals as crushed core starting with hole B1-056. Bear Creek eventually added more crushing equipment and sent in pulverized samples starting with drill hole B1-069.

No other information on historical sample preparation is available.

11.4.1.2 Teck

11.4.1.2.1 2007–2009

All core samples from the 2007–2008 drilling and old core relogging were sent to the ALS Chemex preparation facility in Thunder Bay. Batches of samples were placed in large, sealed, plywood, crates and transported by Manitoulin Transport. Individual samples weighed between 7 lb (3 kg) and 22 lb (10 kg) depending on the sample interval. In total, 13,235 samples were collected from the 2007-2008 drilling and an additional 2,590 samples of historic core were collected. ALS Chemex crushed the entire sample to 70% passing 0.078 inch (2 mm) and made a 35 oz (1,000 g) split for pulverization. The 35 oz (1,000 g) split was pulverized to 85% 75 µm. A 5 oz (150 g) pulp split was sent to ALS Chemex in Vancouver for fire assay and ICP analyses. A 0.7 oz (20 g) split was also prepared by ALS Chemex that was sent either to Global Discovery Laboratories (GDL) or to ACME Laboratories (ACME), in Vancouver, for base metal assays.

11.4.1.2.2 2010–2012

A sample preparation room was constructed in the Babbitt facility in early 2010. The preparation facility used one Terminator crusher and a pulveriser. Samples were crushed and pulverized on site and only a 3.5 oz (100 gram) pulp split from each sample was sent to ACME in Vancouver for analysis. Reject material was retained in Babbitt.

Table 11-1: Specific Gravity by Lithology

Lithology Unit	Average Specific Gravity	Count
LBZ	3.50	163
BIF	3.20	1,009
BTMZ-C	3.11	2,395
BTUM	3.08	1,216
NORITE	3.07	3,992
BTMZ	3.02	8,420
XENO_BASALT	3.02	472
BTI-C	3.00	2,018
PRB	3.00	2,471
SKI	2.99	300
BTI	2.97	16,578
PRM	2.97	910
PRI	2.95	8,061
PRU	2.92	102
XENO_VIR	2.91	2,338
VIR	2.89	2,989
GRB	2.82	19
BDPO	2.77	336
All Lithologies	**2.99**	**53,789**

Table 11-2: Laboratories Used Over Project History

Company	Laboratory	Purpose	Independent	Accreditations
Bear Creek	Union Assay Office, Inc. (Union), Salt Lake City, Utah	Analysis	Yes	Not known
	Geophysics Division (Denver-Spec), Denver, Colorado	Analysis	No	Not known
	Lerch, Hibbing, MN	Analysis	Yes	Not known
Amax	Amax Denver	Analysis	No	Not known
	Lerch	Analysis	Yes	Not known
Teck	Babbitt core facility	Sample preparation	No	Not accredited
	ALS Chemex, Thunder Bay	Sample preparation	Yes	ISO 9002
	NRRI Coleraine Minerals Research Laboratory	Sample preparation for metallurgical testing	Yes	Not known
	ALS Chemex, Vancouver	Analysis	Yes	ISO9001 ISO17025
	Global Discovery Laboratories (GDL)*	Analysis	Yes	ISO9001
	Acme Laboratories (Acme), Vancouver, Canada; later acquired by Bureau Veritas	Analysis	Yes	ISO9001
	Applied Research and Technology Group (ART), Trail, Canada	Metallurgy	No	Not accredited

Note: Until 2009, GDL was the Teck Cominco Exploration Laboratory. It was purchased by Acme (now Bureau Veritas) in mid-2009.

Core samples from the 2010–2012 historic core relogging programs were processed on site by Teck staff in the Babbitt core facility. After sawing, the entire sample was crushed sufficiently to allow 80–90% of the material to pass through a 10-mesh filtering screen. The entire sample was riffled to produce a 500 g coarse reject (test) sample for further pulverizing. The 500 g test sample was pulverized sufficiently to allow 85–90% of the material to pass through a 200-mesh filtering screen, for producing a pulp (laboratory) sample. The 100 g pulp sample was extracted from the remaining 500 g of pulverized material, placed in an envelope, and shipped to Acme for analysis. Remaining pulp and coarse reject material was individually segregated, repackaged, and stored at Teck's core facility in Babbitt until it was returned to the MDNR.

11.4.1.2.3 2013

Similar crushing and pulverization steps as outlined for the 2010–2012 program were used for the 2013 geometallurgical drilling program and the exploration program conducted at Local Boy in 2013.

Remaining pulp and coarse reject material is stored at Teck's core facility in Babbitt.

11.4.1.2.4 2013 Geometallurgical Samples

An additional 156 samples, referred to as geometallurgical test samples, were selected by ART personnel after assay results were known.

A sample of the crushed material was taken from both the lithogeochemical and the geometallurgical test samples for mineralogical analysis.

A representative piece (<1 inch; 2.5 cm) from some of the preserved ¼ core was removed for petrographic analysis.

Selected intervals of the halved core portion of the cut core, from some of the 30 ft composited intervals, were chosen by ART for additional work. These intervals were not processed at site but were packaged and sent to the appropriate laboratory. Comminution and flotation tests were carried out on this material.

Samples of run-of-mine-grade intervals with variable amounts of graphite were collected for pilot plant test work. ART classified this material as "Low, Medium, and High" depending on the carbon content (0–0.40%, 0.41–1.00% and 1.00–7.45% C, respectively). Selected intervals of the halved core, from corresponding coarse-crushed material were combined to form composite samples for the Low category (1,808 sampled intervals) and Medium category (65 sampled intervals). The High category was packaged (48 sampled intervals) at Babbitt but the samples were never sent.

Four desulfurization samples were made at Babbitt and sent to ART. The samples consisted of composited intervals of coarse crushed material that were combined to form a ~661 lb (~300 kg) sample each from the BT4, top of BT1, bottom of BT1, and BT1-c lithologies.

11.4.1.2.5 2014–2017

Core from the 2013 geostatistical drilling program was processed in 2014. Due to the size and scope of the geostatistical program, Teck staff in Babbitt only completed riffle splitting of the samples. Teck staff produced a 500 g crushed (test) sample and, thereafter, sent that sample directly to Acme, who did the pulverization step. The same process was done for historic core sampling.

11.4.2 Analysis

11.4.2.1 Historical

Information on historical analytical methods and resulting data is included in the discussion on data verification in Section 12.

11.4.2.2 Teck

Analytical procedures are shown in Table 11-3.

As a result of the 2012–2017 program, approximately 73% of the intervals within the total database and 75% of the assay intervals within the Mesaba deposit outline now have gold, platinum and palladium values.

Historical pulps identified in quality assurance and quality control (QA/QC) reviews completed in 2017 as having data for selected elements that was either missing or not optimal for the grade in the deposit, were sent for reanalysis where possible. For many samples, this was a function of the detection limit for either cobalt or silver, or both. For a subset of these samples, there were no PGEs reported and this was completed on the historical pulps. For these re-assays, only elements identified in QA/QC reviews as not being fit for purpose are reported with higher priority than historical assays; meaning the primary copper and nickel assays will stand as there is the chance of some mass change with the oxidation of sulfides over time.

11.5 QUALITY ASSURANCE AND QUALITY CONTROL

11.5.1 Historical QA/QC

Limited information is available on the historical QA/QC programs. The majority of the data have been replaced by reassay programs completed by Teck and discussed in Section 12 as part of the data verification process.

11.5.2 Teck

11.5.2.1 2007–2009

11.5.2.1.1 Overview

The QA/QC for the 2007 to 2009 infill and metallurgical drilling programs, and the historic drill hole resampling program, involved inserting standard reference materials (standards), blanks, core duplicates, and coarse crush duplicates. The standards, blanks, and core duplicates were inserted randomly at a frequency of one per 20 primary core samples based on a spreadsheet that predetermined the location and type of control sample.

Prior to 2010, coarse crush duplicates were created by ALS Chemex at the preparation stage for each 20th sample. The laboratory-reported replicates are considered adequate as pulp duplicates and thus no pulp duplicates were inserted at the sample preparation stage. Only standards and pulp blanks were included with the historical pulps.

Table 11-3: Teck Analytical Procedures

Laboratory	Year	Comment
GDL	2008	A total of 9,622 pulps from 186 holes were fire assayed for Au, Pt, Pd in 2008. All available old pulps have now been fire-assayed for Au, Pt and Pd.
	2008	The cuttings for each test blast hole from the 2008 bulk sample were collected and split to produce an approximate 1 lb sample. Analyses included: Cu, NiT, (where NiT is total nickel, as derived from four-acid total digest), Co, S, Au, Pt, Pd, and Ag. Gold, Pt and Pd were by Pb collection fire assay. Sulphur was by LECO. Cobalt and Ag were by aqua regia AA or ICP-AES.
	2007–2012	Samples analyzed for Cu, Ni, and Co using an aqua regia digest and an atomic absorption (AA) or inductively-coupled plasma (ICP) finish. Total Ni assays were by four-acid digest with an ICP finish.
ALS Chemex	2007–2012	Samples analyzed using four-acid near-total digest with an inductively-coupled plasma mass spectrometry (ICP-MS) finish. Elements analyzed were Ag, Al, As, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cs, Cu, Fe, Ga, Ge, Hf, In, K, La, Li, Mg, Mn, Mo, Na, Nb, Ni, P, Pb, Rb, Re, S, Sb, Sc, Se, Sn, Sr, Ta, Te, Th, Ti, Tl, U, V, W, Y, Zn and Zr. The samples sent to ALS were also analyzed for Au, Pt, and Pd through fire assays from a 1 oz (30 g) aliquot with an ICP-MS or inductively-coupled plasma atomic emission spectroscopy (ICP-AES) finish.

Laboratory	Year	Comment
Acme /Bureau Veritas	2007–2010	Samples analyzed using aqua-regia digest with ICP-ES analysis (7AR-All/AQ370) for Cu, Ni, Co, Ag, Al, As, Bi, Ca, Cd, Cr, Fe, Hg, K, Mg, Mn, Mo, Na, P, Pb, Sr, Sb, W and Zn. Samples also analyzed using four-acid digest with ICP-ES analysis (7TD-All/MA370-Ni) for total Ni.
	2010–2012	Samples analyzed using four-acid digest with ICP-ES analysis (7TD2/MA370) for Mo, Cu, Pb, Zn, Ag, Ni, Co, Mn, Fe, As, Sr, Cd, Sb, Bi, Ca, P, Cr, Mg, Al, Na, K, W, and S. Samples analyzed using fire assay by Pb collection with ICP-ES finish (3B02/FA330) for Au, Pt, and Pd. Total S analysis by Leco (2A13/TC000).
	2012–2013 drill programs	<u>Assay data:</u> Four-acid digestion with analysis by ICP-AES (7TD2/MA370) Fire assay fusion Au, Pt, Pd with analysis by ICP-AES (3B02/FA130) Total S analysis by Leco (2A13/TC000) Elements analyzed included (reported as percentages unless otherwise specified): Cu, Ni, Fe, Co, S, Tot/S, NiS, Pt (ppb), Pd (ppb), Au (ppb), Ag (ppm), Pb, Zn, Cr, As, Mo, Mg, Al, Na, K, Mn, Sr, Cd, Sb, Bi, Ca, P, and W Elements added at a later date included: Ti, total C by Leco (2A08/TC000), and CO_2 (by Leco). <u>Whole rock lithogeochemical analysis of major and trace elements:</u> Elements analyzed include SiO_2, Al_2O_3, Fe_2O_3,MgO, CaO, Na_2O, K_2O, TiO_2, P_2O_5, MnO, Cr_2O_3, Sc, LOI, Ba, Cs, Ga, Hf, Nb, Rb, Sn, Sr, Ta, Th, U, V, W, Zr, Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu. Major oxides by lithium borate fusion with ICP-ES analysis (4A02/LF302) LOI by loss on ignition at 1,000ºC (4A02/LF302) Refractory and rare earth elements determined from total decomposition by lithium borate fusion (4B03/LF100). 1:1 aqua regia digestion with ICP-MS UltraTrace finish (1F30/AQ252) for Mo, Cu, Pb, Zn, Ag, Ni, Co, Mn, As, Au, Cd, Sb, Bi, Cr, B, Tl, Hg, Se, Te, Ge, In, Re, Be, Li, Pd, and Pt. Four-acid digestion; ICP-MS analysis (1EX/MA200) for Ni NaOH fusion analysis by specific ion electrode for F Fire assay fusion Au, Pt, Pd by ICP-AES (3B02/FA330) Mineralogical analysis (MLA/X-ray backscatter analysis)
	2018–2019 reassay program	<u>Core Re-Assay:</u> Four acid digestion with analysis by both ICP-AES and ICP-MS (7TX/MA270) for Mo, Cu, Pb, Zn, Ag, Ni, Co, Mn, Fe, As, U, Th, Sr, Cd, Sb, Bi, V, Ca, P, La, Cr, Mg, Ba, Ti, Al, Na, K, W, Zr, Ce, Sn, Y, Nb, Ta, Be, Sc, Li, S, Rb, Hf, Cs, Dy, Er, Eu, Ga, Gd, Ho, In, Lu, Nd, Pr, Re, Se, Sm, Tb, Te, Tl, Tm, and Yb. Fire assay fusion with analysis by ICP-AES (3B02/FA130) for Au, Pt, and Pd. Total S and C by Leco on selected samples only (2A12/TC003). <u>Pulp Re-Assay</u> Four acid digestion with analysis by ICP-MS (1EX/MA200) for Mo, Cu, Pb, Zn, Ag, Ni, Co, Mn, Fe, As, U, Th, Sr, Cd, Sb, Bi, V, Ca, P, La, Cr, Mg, Ba, Ti, Al, Na, K, W, Zr, Ce, Sn, Y, Nb, Ta, Be, Sc, Li, S, Rb, Hf, In, Re, Se, Te, and Tl. Fire assay fusion with analysis by ICP-AES (3B02/FA130) for Au, Pd, and Pd where required.

11.5.2.1.2 Standards

Matrix-matched copper–nickel standards from Mesaba bulk sample material were prepared by CDN Resource Laboratories (CDN) of Langley, B.C. Standards Mesaba 1 to 4, made from 2001 bulk sample material, were used for all programs. A commercial copper–nickel standard, OREAS 13P, was used at the beginning and late in the drilling program when the stock of property standards was low. Teck also purchased commercial gold–platinum–palladium standards (CDN-PGMS-8 and CDN-PGMS-14) for use with the old pulps.

Standards Mesaba 3 and 4 have been used since 2009 and are exhausted. Anticipating further work in 2009, two more standards, Mesaba 5 and Mesaba 6, were prepared from 2008 bulk sample material in 2009 and are stored at the core facility in Babbitt. Current re-assay programs are relying on the Mesaba 5 and Mesaba 6 standards.

A total of 752 copper–nickel standards were inserted during the infill drilling and resampling of historic core. The protocol upon receipt of the assay results from the laboratories was to check for failures in the copper–nickel standards. A standard was deemed to have failed if the copper or nickel assay values fell outside three standard deviations of the mean for that standard or if values for two consecutive standards within a batch fell outside two standard deviations.

When a standard failure occurred, Teck asked the laboratory to re-run a set of samples on either side of the standard; usually this set of samples included all samples from the previous good standard to the following good standard. Failures occurred in data from all three laboratories that were used during this period (ALS Chemex, Acme and GDL). In every case, failures were corrected and updated results replaced the original values in acQuire.

Four standard failures for copper still exist in the data. Two results from the Mesaba 2 standard are within a batch of samples from the bulk sample site drilling. These were not considered important since the results were not to be used for resource work and due to the presence of numerous other check samples within the batch. Two copper failures also exist in the OREAS-13P standard. One failure was in a long section of waste and not deemed important to re-run. The other failure was re-run and failed a second time.

All nickel standard failures were corrected.

Although standards did not fail on cobalt, gold, platinum and palladium results, these analyses were checked, and re-runs were demanded if there were numerous failures for one element or multiple failures for elements for one standard. No significant problems were encountered with ALS Chemex where most of the gold–platinum–palladium analyses were completed. A calibration problem for gold was detected and corrected at GDL.

11.5.2.1.3 Blanks

A rock blank, sourced from a local outcrop of Pokegama Quartzite, was used with submissions of core samples. The quartzite rock blank had a similar hardness to the intrusive units and made an excellent blank because it forced the crusher to work hard between primary samples.

A commercial pulp blank, (CDN-BL-3) is used with the historical pulp reassay program.

A total of 900 Pokegama Quartzite rock blanks were inserted with the primary samples. These blanks had an ICP chemistry that was distinctive from the intrusive rocks, with aluminum, calcium, potassium, magnesium and titanium values that were orders of magnitude lower. This made mix-ups with standards or primary samples obvious.

A blank failure was deemed to be any value of copper or nickel >20 times background for that element in the blank (0.02% for copper and 0.01 for nickel). If a failure occurred, Teck instructed the laboratory to re-run the blank and generally five primary samples on either side. In most cases, the second analysis resolved the issue. ALS Chemex noted a number of failures caused by incomplete flushing of the ICP aspiration tube after running a high-grade solution laboratory standard. Nine blanks showed elevated values after the second analyses. One anomalous result was obviously a mislabelled standard; four contained elevated levels of copper and nickel; and four blanks showed elevated copper or nickel only. The most likely source of contamination for the eight blanks is in the sample preparation stage.

11.5.2.1.4 Duplicates

Core and coarse crush duplicates were inserted into the sampling stream at a frequency of one per 20 primary samples.

Core duplicates involved quartering the ½ core to make two samples for the selected interval. The core intervals selected for duplication were predetermined in a randomized sample list that approximated one per 20 samples. Core duplicates had unique field sample numbers sequential to the primary sample for which they were a duplicate.

The preparation laboratory created the crush duplicates at a frequency of one per 20 core samples. The crush duplicate was assigned the same sample number as the primary sample, but this number was appended with the suffix "CD".

Laboratory replicate analyses were considered adequate as pulp duplicate data. GDL and Acme reported all replicate analyses as part of the sample analytical report, which made for simple capture of the data into the acQuire database.

ALS Chemex provided duplicate data in a separate file, which required manual downloading of each file from the ALS Chemex website. The ALS Chemex duplicate analyses were not downloaded and consequently the database lacks pulp duplicate analyses all fire assay and ICP data.

The core duplicate data indicate the inherent geological variability, at a 0.2% Cu cut-off, for copper and nickel is 20.8% and 18.8% respectively.

The sampling error at the coarse-crush stage for copper and nickel is 5.6% and 3.2% respectively and the analytical precision is 1.2% and 3.3% respectively.

11.5.2.2 2010–2018

11.5.2.2.1 Overview

The initiation of on-site sample preparation at site in 2010 allowed crush duplicates, as well as the standards, blanks and core duplicates, to be inserted at site. The laboratory-reported replicates are considered adequate as pulp duplicates and thus no pulp duplicates were inserted at the sample preparation stage. Only standards and pulp blanks were included with the old pulps.

11.5.2.2.2 Standards

Matrix-matched copper–nickel standards from Mesaba bulk sample material were prepared by CDN. Standards Mesaba 5 to 9, made from 2009 bulk sample material, were used for all programs. The standard inserted was chosen as the one that most closely matched the surrounding material in grade by visual estimate.

The same check protocols as described for the 2007–2009 program were followed. When a standard failure occurred, Teck asked the laboratory to re-run a set of 10 samples on either side of the standard. In every case, failures were corrected and updated results replaced the original values in the acQuire database.

For copper, nickel, silver, and cobalt, the coefficient of variation (CV) was <5% on standards and the global bias was <5%. The CV% on the standards for gold, platinum and palladium exceeded 5% in some cases because the concentration of the standards was close to the analytical method detection limit.

11.5.2.2.3 Blanks

A rock blank, sourced from a local outcrop of Pokegama Quartzite, was used with submissions of core samples.

As one crusher but two pulverisers were routinely used in the preparation process, the average of the two preceding samples was used to assess for the potential for contamination in either process. The average rate of contamination is <0.5% for both copper and nickel, which is acceptable. There were four apparently contaminated copper samples from a restricted time period and these were rectified.

11.5.2.2.4 Duplicates

Core and coarse crush duplicates were inserted into the sampling stream at a frequency of one per 20 primary samples each.

Core duplicates involved quartering the ½ core to make two samples for the selected interval. The core intervals and crush duplicates selected for duplication were predetermined in a randomized sample list that approximated one per 20 samples. Core and crush duplicates had unique field sample numbers sequential to the primary sample for which they were a duplicate.

Laboratory replicate analyses were considered adequate as pulp duplicate data. Acme reported all replicate analyses as part of the sample analytical report, which made for simple capture of the data into the acQuire database.

The duplicate failure rates are within 10%. This suggests that both the sample preparation and sample selection process were suitable for resource estimation.

11.6 DATABASES

The drill hole and associated sample data for Mesaba is hosted by an acQuire database located on the Vancouver server.

Digital data are subject to regular backups.

11.7 SAMPLE SECURITY

Sample security for the historical drilling programs of Bear Creek, Reserve Mining, AMAX, Humble Oil and Inco is not documented. The majority of the core from these programs is stored in a locked MDNR facility in Hibbing. A limited number of pulp samples generated by AMAX from their programs are also stored at the Hibbing facility.

All core crushed and pulverized samples from the 2007–2013 Teck drilling programs is stored in Teck's office, core processing and storage facility in Babbitt. This facility is leased from the town of Babbitt and is locked at all times except when Teck employees are present.

11.8 SAMPLE STORAGE

Sample pulps and course rejects from Teck's 2007–2008 drilling were returned to the core storage facility in Babbitt. All the pulps were stored in large crates or on pallets in cardboard boxes. With the exception of some selected, higher-grade intervals, most of the coarse rejects during this time were discarded because metallurgists at ART indicated they had no metallurgical test value. Coarse rejects from 2008 onwards are stored in the core storage facility in Babbitt.

Excess crushed material derived from core from the 2007–2009 drilling and old core relogging programs was returned by ALS Chemex to Teck's Babbitt storage facility, in sealed plywood crates. Pulverized samples that were sent by ALS Chemex to GDL and ACME laboratories for further analysis were returned to Babbitt for storage once assays were complete and verified.

Excess crushed material derived from core from the 2010–2012 historic core logging programs was temporarily stored in Babbitt. Once assays were complete and verified, this crushed material and the pulp material returned by ACME was transported to the MDNR storage facility in Hibbing.

Core samples from the 2013–2017 historic core logging programs have not been assayed. These samples are stored in plastic bags at the Babbitt facility.

Sample pulps and coarse rejects from the historic core sampling are returned to the MDNR for storage in the core storage facility in Hibbing. Old sample pulps were returned to the MDNR. In many cases, the total pulp was used for assay and only an empty sample bag was returned.

12 DATA VERIFICATION

IMC has reviewed the documentation of the data verification work completed by Teck and described in the following sections. It is IMC's opinion that the level of this work is adequate for the information to be incorporated into a statement of the mineral resource.

12.1 HISTORICAL DOWN HOLE SURVEYS

A data check was performed by Teck personnel on all historical down hole survey data in 2015–2016. Scanned historical drill hole survey logs were used to validate the digital downhole survey database and update where necessary. The original logs were compared to a NRRI compilation completed in 1994, to a 1978 set of Amax-created, computer-generated, property-wide drill trace plan maps, and to Teck's own down hole survey database.

All pre-Teck survey depths were verified against original drill logs. While checking the original logs, additional information was captured including: survey type, company, year (of drilling), year (of re-surveying if applicable), and other pertinent information such as assumptions and notes. Several additional data fields were added in order to preserve the original NRRI and Teck data errors that were found.

The 1978 Amax drill trace plan maps were used to check for possible errors in drill azimuth errors that may have crept into earlier data sets. Data from these holes were checked and generally found to be correct. There is no consistency in the few remaining drill traces that do not perfectly align. With no documentation or original data to corroborate their assumptions, these differences have been disregarded.

12.2 TECK DOWN HOLE SURVEYS

Post-1994 Teck survey data were collected electronically. Spurious readings were rejected at the time of drilling/surveying. All accepted survey data was copied into the new worksheet as-is with no detailed checks. All drill traces appear reasonable with no reason to suspect errors.

12.3 DATABASE REVIEW BY TECK

A random check of 10% of the Mesaba holes in the NRRI database (74 holes checked) conducted in 2016 indicated that while the NRRI had made very few entry mistakes (<1%), the NRRI had however, entered what Amax had deemed to be appropriate values for copper, nickel and sulfur that were listed on what Amax called "Final Assay Sheet – Accepted Values" (Minnamax form #9). In reality, a very high percentage of the numbers listed on those sheets were averaged values derived from two or more assay results on the same drill core interval.

Teck concluded that inclusion of multiple averaged values would require that the entire historic database be reconstructed. All of the known assay results were entered into a new database that included parent results, crusher duplicate results, laboratory replicate results, and results for all of the internal standards inserted by Amax. Although Teck uses the primary assay results, both types of data (primary and averaged) were entered into the new database to provide future reference to the historical data.

12.4 BEAR CREEK DATA REVIEW BY TECK

12.4.1 Sample Preparation and Assay

Bear Creek, a division of the Kennecott Copper Corporation, conducted the original drilling on what was then called the Babbitt deposit during several drilling campaigns during 1958–1960 and 1967–1971 (drill holes B1-001 through B1-204). Preserved documents at the DNR indicate that Bear Creek had their own crushing equipment and shipped their sampled intervals as crushed core starting with hole B1-056. Bear Creek eventually added more crushing equipment and sent in pulverized samples starting with drill hole B1-069.

Samples were initially sent to the Union Assay Office, Inc. ("**Union**") in Salt Lake City, Utah where they were assayed for Cu, Ni and S (assay method is not documented). However, Ni was not routinely run for all of the samples for portions of drill holes B1-008 through B1-051.

Bear Creek also sent some samples "leaner material" (typically <0.10% Cu with some exceptions) to their own internal Geophysics Division (called Denver-Spec) in Denver, Colorado. The Denver-Spec samples were from portions of drill holes B1-001 intermittently through B1-032 and were analyzed for only copper and nickel using fluorescent X-ray spectrographic analyses. Some of the Denver-Spec copper values were excessively high, compared to the Union values for the same intervals, and the Denver-Spec copper values were often ignored.

Bear Creek started using Lerch in Hibbing, MN on a trial basis starting with drill hole B1-046, probably due to the laboratory proximity to the Project. By drill hole B1-061 (drilled in the summer of 1967), Bear Creek had switched over and used Lerch almost exclusively except for occasional consistency checks on crusher duplicates that were sent to Union.

The assay method used by Lerch was not documented for the Bear Creek samples but has been documented as atomic absorption (AA) for the later Lerch samples submitted by Amax in the 1970s.

12.4.2 Crusher Duplicate Samples

As part of a check on the quality of the assay results, Bear Creek also sent in crusher duplicate samples. This checking program started with drill hole B1-003 and the crusher duplicates were sent only to Denver-Spec for holes B1-003 through B1-007. Denver-Spec was eventually not used in the quality checks after hole B1-023. Crusher duplicates were also sent to Union beginning with drill hole B1-008 up to the end of Bear Creek's tenure on the property (B1-203).

These crusher duplicate samples were generally selected from every 10th sample but variations of every eighth to every 25th sample are locally present in some drill holes; in fact, some holes had very few to no crusher duplicates. Lerch Brothers were also used for crusher duplicate analyses starting with drill hole B1-050. By drill hole B1-061 it appears that Lerch was used almost exclusively for all crusher duplicate analyses except for occasional crusher duplicate checks by Union. The latter Union duplicate checks were part of a quality consistency check wherein two crusher duplicates from the same interval were sent to both Union and Lerch from the same interval (thus three assays in total for specific intervals).

12.4.3 1972 Data Reviews

In 1972, a visual comparison of the results for 85 samples from 25 holes was made and noted that Union was consistently higher for both copper and nickel for the crusher duplicates submitted from 1967–1972. A second check noted:

- Lerch consistently repeated its original copper values within acceptable limits;
- Union consistently reported significantly higher copper values than Lerch, and on average, Union's copper values were 11% higher;
- Lerch did not repeat its own nickel values. Although the differences were not constant the reported values for the check samples averaged from 4.2–13.3% less than the values reported for the original samples;
- Union consistently reported significantly higher nickel values than Lerch. On average, Union's nickel values were 19% higher than those reported by Lerch on the original samples.

Bear Creek requested an analysis of the consistency check results, from Kennecott's Technical Computing Center (TCC), to determine whether the observed laboratory differences were related to time or grade. It was suggested that a test be conducted wherein a set of samples be prepared and then sent to several laboratories and the results compared.

Bear Creek prepared 39 composite samples that represented both disseminated sulfide (31 composites) and massive sulfide (eight composites) mineralization. These composites were prepared by rolling and homogenizing saved pulp material, quartering it, and then combining the quarters volumetrically in proportion to drill hole footage to form the various composites (representing a total of 2,910 ft [887 m] of core). Three samples of each of the composites were then sent to Lerch, Union, and Bondar Clegg for analyses with the remaining quarter of each composite retained for future use. The results of these three laboratories were compared to the combined original Lerch assay results for the same intervals (thus four assays for each composite were evaluated). At the time it was noted that although there were many opportunities for sampling error, Union's copper values were again 7–11% higher than those reported by Lerch. In the lower copper grade ranges, Bondar Clegg's analyses more closely matched with the Lerch assay results, while in the higher-grade ranges, the Bondar Clegg results were closer to those reported by Union. It was also noted that the differences in nickel values between the assayers were less, showing a range of 3–7% above the Lerch values.

At the time, use of the Lerch values for grade estimates was considered to be a conservative approach, and that differences between the laboratories were not sufficiently large to warrant further investigations or changes to grade estimates.

12.5 AMAX DATA REVIEW BY TECK

12.5.1 Bear Creek

Amax assayed many of the Bear Creek intervals that lacked nickel assays (starting with drill hole B1-014 with intermittent sampling of zones up through B1-051). This program involved re-submitting any saved materials (coarse rejects and/or pulps?) or resampling the existing core by quarter-splitting the remaining half. Both sampling processes were intermittently mixed throughout this Amax campaign. Amax ran only nickel in some instances and copper, nickel and sulfur in other instances.

There are several intervals where Amax quarter-split the core but did not honor the sample interval previously established by Bear Creek. In these instances, the Amax intervals stagger the Bear Creek intervals and are off by generally multiples of 5 ft (drill holes B1-018, -033, -043, -044, -045, -048, -049, and B1-050). Not all of the Bear Creek intervals that lacked nickel assays were resampled by Amax, and there are still some early Bear Creek holes that totally lack nickel values in thick extensively-continuously-mineralized intervals (e.g. B1-041 and B1-051).

Amax also conducted later in-fill sampling of weakly-mineralized zones that had not been previously sampled by Bear Creek.

12.5.2 Sample Preparation and Analysis

In November 1973, Amax-prepared standards were submitted for copper analysis to Lerch, Western Analytical, Union, and American Analytical (AAL) laboratories. AAL exhibited the best precision and accuracy; whereas Lerch was considered less than acceptable in this first test. In February 1974, another set of standards were submitted for nickel analysis to Lerch, Union, AAL, and X-Ray Assay (X-Ray) laboratories. The values returned by Lerch were within acceptable limits. As a final test, another set of copper and nickel standards were sent to Lerch and X-Ray. It was considered that Lerch had good results, being slightly low but acceptable; whereas X-Ray was consistently high. In May 1974, a decision was made to use Lerch on a trial basis even though the earlier Bear Creek checking indicated that Lerch delivered inherently low Cu and Ni values.

12.5.3 QA/QC

Amax used a QA/QC program from May 1974, consisting of crusher duplicate samples, insertion of standards with known values that were inserted roughly every 10th sample (with exceptions as low as every second and as high as every 24th sample), re-assaying of previously-assayed pulps where needed, replicate assays of coarse-crushed samples, and check assays by the Amax Denver laboratory, and by other commercial laboratories.

Amax standards were interspersed in sufficient quantity so as to appear in each group prepared for analysis. In order that the ranges of standard values were comparable to that of the deposit, a number of new standards were continuously prepared at the Amax Denver laboratory from previously-drilled Bear Creek holes and Amax drill holes. Throughout the ensuing drilling campaigns, Amax constantly reviewed the assay results and worked with Lerch to make appropriate modifications to their laboratory procedures and sample preparation.

Amax requested that their samples be run only at times when there was a graduate chemist available to supervise the work. Amax standards were sent in coin envelopes provided by Lerch so that they could be sent on to the laboratory with no repackaging.

12.6 BEAR CREEK AND AMAX REPEAT AND DUPLICATE ANALYSIS INVESTIGATION

12.6.1 Review

The historical results from the Bear Creek and Amax generations of drilling were compiled by the NRRI.

Significant effort was expended by Teck to compile all the historical assay data from primary data sources. This was primarily because when a representative sample of the NRRI compilation was compared to the primary data sources, several inconsistencies were noted in how these data were established, in particular, for repeat and duplicate analysis. Where assays were duplicated, at times the results were averaged and at times, a particular analysis was selected. It was also unclear at what stage the duplication was made; for example, whether it was a ½ core or pulp duplicate.

The historical primary assay data source review compilation contained several columns of data that were attributed as X_pct_1 through X_pct_4 where X was either copper, nickel or sulfur. Investigation by Teck has shown that X_pct_2 (where X is copper, nickel or sulfur) is most likely a sample duplicate of the primary sample X_pct_1. X_pct_3 is a pulp duplicate or repeat of X_pct_1 and X_pct_4 is a pulp duplicate repeat of X_pct_2. However, it remains unclear whether X_pct_2 is a crusher duplicate of X_pct_1 or if it was a genuine sample duplicate.

In the Amax generation data, reference materials were used, however it is unclear whether these were certified. The only data source for the copper, nickel or sulfur values is a scanned document summarizing all the recommended values, rather than a formal certificate. If the outliers (most likely standard ID mix-ups) are removed, the CV% of each standard for copper and nickel is <5% and the global bias is also <5%.

12.6.2 Conclusions

The overall review showed that there is no systematic bias of one dataset against another. If the data are treated as a duplicate dataset of unknown type and the implied failure rate is evaluated, results show a <10% failure rate for copper and nickel irrespective of whether these are sample duplicates or crush duplicates. It can be concluded that the sampling program was sufficiently precise to allow for the production of reproducible data.

When viewed as an isolated dataset, the X_pct_1 column for copper, nickel or sulfur was sufficiently accurate and precise (as shown by reference materials) and the sampling protocols were sufficiently robust to produce repeatable data.

Teck recommended that the initial sample be used as the primary assay source and that all subsequent assays be treated as duplicates, not as replacements for the primary data. This data source was considered by the QP to be acceptable for use in resource estimation.

12.7 TECK REPEAT AND DUPLICATE ANALYSIS INVESTIGATION

12.7.1 Review

When Teck first drilled the deposit in 2007, a variety of matrix-matched standards were manufactured and certified for copper, nickel, sulfur and PGE. These standards have been used for several drill programs and reassay programs. These materials were prepared by CDN and certified by Barry Smee.

For copper and nickel, the coefficient of variation in the standards is <5% and there is no bias against the mean.

The coefficient of variation can be evaluated for sulfur; however, bias cannot be reviewed as the standards were never certified for sulfur. The sulfur analyses on reference materials have an acceptably low coefficient of variation and when different sulfur methods are used on the same samples, no bias is indicated, suggesting accuracy. This indicates that the data are suitable for resource estimation.

PGEs were certified in the Mesaba matrix-matched standards and the results of these show occasional failures even with the relatively loose limits imposed on the certificates. While the coefficient of variation is >5% for most of the PGE analysis in the standards, the concentration is low (near the analytical detection limits) and this imposes additional variability on the results. The accuracy of the PGE analysis indicates that the data are suitable for resource estimation. The repeatability of PGE sampling is also suitable for resource estimation.

Many of the assay methods used for the resource estimation of silver are unsuitable given the low concentration in the rock and the high analytical detection limits. The low-level geochemical techniques used provide good quality analytical data to assess the repeatability of silver analyses. The standards were never certified for Ag, so it is not possible to comment on the accuracy. However, laboratory-certified reference materials show the accuracy of the data to be good. The assay grade analyses can be seen to be biased against the more repeatable, lower detection limit geochemical methods. The export of silver for resource estimation allows for the inclusion of high detection limit assay methods for silver. In the case of cobalt, the assay data provides accurate but quantized data and the geochemical data can be used either to supplement these data or to confirm their accuracy as a comparison of assay versus geochemical methods indicates no bias.

12.7.2 Conclusions

In more recent analyses, the matrix-matched standards show good agreement for copper, nickel and sulfur. The PGE data, while low level, are also suitable for use in resource estimation. The silver data are suitable for resource estimation only in the low detection limit geochemical methods and the cobalt data, while quantized, are also sufficiently accurate and precise for use in resource estimation.

12.8 TECK QA/QC REVIEW

During 2017, a QA/QC review was conducted on the copper, nickel, sulfur, cobalt, iron, silver, arsenic, selenium, uranium, vanadium, gold and PGE data (Dalrymple, 2017). Results are provided in Table 12-1. Dalrymple (2017) concluded that:

- The three elements with the greatest spatial representivity are copper, nickel and sulfur;
- The PGEs have nearly as good spatial coverage with approximately ⅔ of the samples with a valid Ni assay the dataset also having a valid PGE assay. There may be an opportunity to increase the confidence in areas with missing PGE data through a reassaying program, if the samples are available;
- The distributions of cobalt and silver may be important, as both should report to a concentrate. The spatial coverage of these elements is poor and a geostatistician would need to review the spatial continuity to determine if it is suitable for resource estimation. Both silver and cobalt have a reasonably strong correlation

with Cu and Ni respectively and it may be possible to estimate them with co-kriging to improve their spatial resolution;

- The spatial distributions of selenium, vanadium and uranium are poor and should only be used for sectional interpretation.

Table 12-1: 2017 QA/QC Evaluation

Element	Note
Nickel	There are different Ni analytical methods in the database which either performed at the time the core was drilled, or during resampling programs. Nickel data were separated into two subgroups: one designated total nickel (NiT), and one designated sulfide nickel (NiS). The latter is a mixture of aqua regia assays and a specific sulfide nickel digestion; however, the QA/QC analysis treated all of these as a single group. The mixed acid digestion methods generally show good agreement with certified means. Other than situations where the wrong standard has been submitted to the laboratory, there are very few failures against either the internal standard 3SD limit or against the published limits (other than in the case of the OREAS standards). For both assay and geochemical methods when at higher grades and near higher grades, the CV% for Ni is below five, which is the limit for acceptable variance on a standard recommended by AMEC (Simon, 2014). The bias plots for all total methods show an acceptable bias. The exception to the is the ALS OG-62 method that has a bias of 4.5% which is just within the acceptable limit of 5%. The aqua regia digestions show an unacceptable bias when judged against a total Ni certification (that is to say, the amount of Ni in the standard) which reflects the fact that they are not total for silicate Ni. The historical Ni assays in Ni_AMAX and Ni_BC have good agreement with the best value of standards and with other methods. The bias technically fails at >5% but this is strongly influenced by a single standard. If this standard is removed, the bias is acceptable. The duplicates for Ni are generally acceptable. The majority of methods have <10% failures and the only exceptions are some of the historical methods (pulp duplicates in the Amax data for instance) where there is doubt about the nature of the duplicates. There is a possibility that some of the pulp duplicates are crush or sample duplicates that have higher failure criteria. There are numerous samples with Ni analyses by multiple methods. Comparisons of mixed acid digestion data show excellent agreement between methods (whether geochemical or assay). Likewise, when aqua regia digestion is re-assayed with an aqua regia digestion, there is good agreement. It was recommended that the BEST classification be altered for Ni to include the aqua regia Ni assays and that the calculation of NiS use only the NiS_G810_pct method.
Copper	There are different Cu analytical methods in the database which were performed either at the time the core was drilled, or during resampling programs. The Cu methods all show good agreement with standard values at acceptable precision, in all digestions and in all assays and all geochemical methods other than the ME-MS61 method, which is uniquely imprecise. This is of limited impact as there is an assay method which is acceptably precise for all the ALS Chemex era data. The historical data (Amax generation) is likewise sufficiently accurate and precise for resource estimation. The duplicates show good agreement between pairs for all methods other than ME-MS61. The various umpire programs confirm the results between analyses when the same method was used and, in some comparisons, indicate a small bias when comparing aqua regia to four-acid digestion data, with the aqua regia generally reporting slightly higher results than the four-acid digestion. This is an analytical artifact related to solution viscosity. There are no data for Cu that need to be excluded from the calculation of “BEST” for Cu.

Element	Note
Platinum	The majority of standards are the in-house Mesaba standard series. These are certified for PGE content, but the certification has uncertainties and there is limited confidence in using only the certificate values to assess precision. The certification should probably be considered "recommended value" rather than a certified value because: the grade is 10–20 times the practical detection limit so analytical and methodological error makes a significant contribution to overall imprecision; and the material in the Mesaba series is significantly more inhomogeneous than for instance the OREAS standards, which is evident comparing the CV% of the OREAS standards to the Mesaba series at the same concentration Using the criteria that AMEC recommend (Simon, 2014), the CV% needs to be <10% in order to be confident that the data is of sufficient quality for resource estimation, then several of the PGE standards fail. However, the Mesaba standards are typically near the detection limit that superimposes additional variability on the standard data. As the concentration increases, this CV% becomes acceptable. There is considerable variability in the analytical data at the average grade of the deposit; however, there is generally acceptable variability bias for Pt in the dataset. The duplicates for the Pt data from Acme are generally acceptable; however, the ALS Chemex data have a high failure rate of 15% on sample duplicates. ALS Chemex reports a lower detection limit of 2 ppb Pt rather than Acme's 3 ppb Pt. If the failure rate for ALS Chemex is recalculated at a practical detection limit of 3 ppb, the data have an acceptable failure rate. As the data comprise 15% of the overall dataset, the values are considered acceptable and can be used in resource estimation. A minor set of Pt analyses were determined using a 0.5 g aqua regia digestion. These are unsuitable for resource estimation and are be removed from the BEST calculations but have no overall impact as the samples also have fire assays. Umpire data between Acme and ALS Chemex shows generally good agreement between laboratories. There is internal umpire work on the GDL generation data, which has some comparisons with historical methods and between two methods from GDL. The comparison with the historical data shows acceptable accuracy but the data comparing the two GDL methods indicates issues. Dalrymple (2017) recommended that any remaining pulps from the GDL time period be sent for fire assay.
Palladium	The majority of the samples are Acme fire assay samples. Assay data prior to 2013 was likely completed on historical samples as Acme did not offer the analytical method prior to 1997. The precision for Pd is marginally better than that for Pt but the ALS Chemex data remain less precise than the Acme data. However, neither analytical method is unacceptably biased. The ALS Chemex failure rate of 12% on duplicates only marginally exceeds the AMEC recommended limit of 10% and once the data are combined into a Pd BEST columns, the overall failure rate is less than 10%. Therefore, these data can be included in the calculated BEST field. As with Pt, the umpire work on ALS and Acme generation data is acceptable. The umpire work on the historical samples shows good agreement with the GDL data and the two GDL methods agree well.
Gold	The accuracy and precision of Au in the project data varies by generation. The Mesaba-X generation standards are generally poorly constrained for Au, as they are for the PGEs. Against the well-homogenized OREAS standards, there is a negative bias against the certified mean in the Acme generation data but there is no global bias for any methods. The CV% on each certified reference material is acceptable when the proximity to the detection limit is considered, and the duplicates are acceptable.
Sulfur	There are effectively three groups of sulfur data in the database: aqua regia S; four-acid digestion sulfur; and sulfur determined by infrared combustion (Leco). In general, Leco data are lower precision than digestion ICP-AES but is total. A mixed acid digestion will volatilise some S, particularly at high concentrations and aqua regia will not be total in the presence of some elements (such as Ba or Pb) and the total solubility of sulfur will be dependant on variables that are not determined in the analysis. It is clear in several lines of evidence that at high total S concentration, there is volatility in the four-acid digestion data against total S methods, which becomes more pronounced at high total S concentrations. Above ~5% total S, the volatility can become quite pronounced. As this is the principal means by which Teck determines pyrrhotite content, there may be variable quality in the input data. There are precise S data for all methods, so while there is volatility in the four-acid digestion methods, there is consistent volatility. Many of the standards used were not certified for S, so determining the accuracy of the S data can only be performed on some datasets. The Leco S data is most accurate (but not necessarily most precise), followed by the aqua regia data and there is a consistent low bias in the four-acid digestion data. Much of this can be effectively dealt with using a judicious selection of BEST to prioritise the analytical method results. The duplicates are acceptable for S in all methods.
Iron	The Fe data are a mixture of four-acid digestion, aqua regia and fusion, which can result in incompatible results. The fusion and four-acid digestion correlate well, but the aqua regia data clearly show two trends: one that corresponds to the total digestion of sulfides, and one that corresponds to the partial digestion of Fe-bearing silicate phases. As the degree of totality is mineralogically dependent, there is no demonstrated way of assessing these two numbers as comparable to each other. Iron by total methods is acceptably accurate and precise with the exception of Fe by ALS Chemex's ME-MS61 method which shows high imprecision and bias. Iron has limited use in the dataset at this stage as calculations of sulfide domains are predominantly derived from Cu and S data.

Element	Note
Cobalt	In the assay methods that report to a detection limit of 0.001%, the Co is accurate and acceptably precise given the proximity to the detection limit. However, the ME-MS61 data from ALS Chemex are not of high quality and are biased low. The bias plots show the fundamental problem with using an assay method to understand the distribution of Co by an inappropriate assay method. The variability is as high in the analysis on a single standard near the detection limit as it is between the standards. On the few samples taken in 2013 for both an assay and a geochemical method at Acme, it can be seen that there is no bias between the methods and the higher fidelity geochemical method provides a much more robust means for understanding Co distribution. There is insufficient geochemical data to replace the assay data in the database. The umpire work shows good agreement between aqua regia and four-acid digestion data from Acme and with GDL_AA results. The GDL_ICP data are relatively imprecise can be used via careful selection in the BEST prioritization.
Arsenic	The arsenic data are not robust as the assay methods commonly used have far too high detection limit to be functional for the ranges of As commonly encountered in the deposit. The only useable data are the 2007–2008 ALS Chemex analyses. During this time period, the standards used were not certified for As, so the dataset accuracy is not known. More than 99% of the As data from the assay methods used report as below detection. The precision of the ME-MS61 As data is acceptable. The level of As is very low through much of the deposit where data are available.
Silver	None of the standards were Ag-certified. There is acceptable data precision for the geochemical methods. The high detection limit used for the assay data means that much of the data are only reported half the detection limit for the method (typically either 0.5 g/t Ag or 1 g/t Ag). The control charts for Acme's 7TD2 and MA370 data show regular but sporadic high results suggesting that there are frequent failures up to 10 g/t Ag in material that is routinely reporting at 1 g/t Ag. There are likely accuracy issues for the remainder of the dataset by these assay methods. There is acceptable repeatability in the sample duplicates but as there are no pulp duplicates, no comment can be made on the analytical precision. There is good agreement between geochemical methods, but not between geochemical methods and assay work. The assays overestimate the Ag concentration relative to the more precise geochemical data. The relationship between the ME-MS61 data and the assay work is concerning; there are both high and low failures in this dataset and the overall imprecision is high. It is unclear whether there is a problem with the assay or the geochemical data as there are no Ag-certified standards submitted with method. There is a strong correlation between Ag and Cu, and it may be possible to estimate the predicted Ag concentration from the Cu assay. It may also be possible to use the Cu data to co-krige Ag and predict the Ag data with more spatial resolution.
Uranium	There are relatively few U analyses reported through the dataset; however, a previous review showed that there is a subset of pyrrhotite rich samples that are also high in U, up to 25 ppm. Most of the valid U analyses are from the ME-MS61 method. There are no certified values against which accuracy can be assessed, but the precision is acceptable, as are the duplicates. There is umpire work that can demonstrate the consensus on ME-MS61 data. There are a small number of aqua regia analyses that show a low bias against a fusion method but that is to be expected. These numbers should be viewed as indicative only.
Vanadium	Comments made for the U data are also applicable to V data. Available information is largely restricted to the ME-MS61 data from 2007 and 2008. The aqua regia data are strongly biased low against the fusion data, and there is no method of assessing the overall accuracy. The precision on the ME-MS61 data is acceptable, as are the duplicates. These numbers should be viewed as indicative only.
Selenium	As with the U data, a previous review identified significant Se associated with some of the pyrrhotite-rich sediment particularly in the Basal Unit and BT1. Most of the Se assays were by the ME-MS61 method, which will volatilise some Se. There are no certified values for Se, so the level of volatility cannot be determined, but could be elevated. These numbers should be viewed as indicative only.

12.8.1 QA/QC review of 2017/2018 reassay program

A QA/QC review was undertaken of data associated with the 2017–2018 re-assay campaigns described in Section 11.1.2. This review was limited to target analytes of the campaign, comprising gold, platinum, palladium, cobalt, silver, nickel, copper, and sulphur. Assay methods were considered to be appropriate for the analytes of interest in the concentration ranges of the samples analyzed.

Results for CRMs included in the re-assay campaign were within acceptable ranges of precision and accuracy, within three standard deviations ("**SD**") of certified values. Low-level failures in platinum, palladium and silver were attributed to the low concentration of these analytes in the selected CRMs and, in the cases of platinum and palladium, to homogenization of the standard material.

Crush and pulp blanks show no significant contamination. Sample and crush duplicates showed good reproducibility for nickel, copper, cobalt, silver, palladium, magnesium and sulphur. Gold and platinum showed poor reproducibility in both duplicate types, attributed to the low concentration of the elements in the samples, and potentially a lack of homogeneity in the sample material. No pulp duplicates were submitted as part of the re-analysis campaign.

Umpire results between Bureau Veritas and ALS show good correlation. Where failures occur, they were attributed to low concentrations of analytes within the sample, particularly gold, platinum and palladium.

Reassayed data are considered fit for use in a resource estimation, however the low concentrations of gold and platinum has resulted in poor reproducibility. Data at low concentrations (<100 ppb) should be estimated with caution as significant variability was quantified between duplicate and umpire pairs.

12.9 DATA VERIFICATION BY IMC

IMC has completed an analysis of the Teck provided QA/QC data for the historic drilling and sampling program for Mesaba. IMC analyzes the Teck QA/QC data that was included in drill programs from 2008 to 2022 and confirms there are no issues with the data added to the mineral resource database.

In this section the current assay method, Four Acid Digest with either ICP-ES or ICP-MS finish will be addressed. Other historic assay methods were not reviewed by IMC but have been reviewed by Teck. Total copper, total nickel and cobalt will be presented in the tables and graphs below.

12.9.1 Teck Quality Assurance and Quality Control Program

In addition to the historic AMAX, Bear Creek, Teck Cominco (Global Discovery Lab) internal QA/QA program, Teck also developed their own current QA/QC program consisting of a regular program of coarse crush duplicate analyses, standards, and blanks. The standards, blanks, and core duplicates were inserted randomly at a frequency of one per 20 primary core samples based on a spreadsheet that predetermined the location and type of control sample.

12.9.2 Coarse Crush Duplicates

Coarse crush duplicates were inserted into the sampling stream of one per 20 primary samples. The crush duplicates are an external check by Teck on the total precision/repeatability at the analytical lab. These are separate to any duplicates that the analytical lab has created as part of their internal process.

In the database supplied to IMC, there are crush duplicates from:

- ACME lab (7tD), 4 Acid with ICP-ES, dated June 2010 to August 2013
- Bureau Veritas (MA370), 4 Acid with ICP-ES, dated March to September 2014
- Bureau Veritas (MA270), 4 Acid with ICP-ES and ICP-MS, dated January to February 2018
- ALS (ME_MS61), 4 Acid with ICP-MS, dated March 2018 to June 2022

There are 17 copper assay intervals where the original ALS (cu_ME_MS61) were above the upper detection limit of 1.0 % Cu. These intervals were then re-assayed by ALS using 4 acid digestion with ICP-ES Analysis (cu_OG_62) which has a higher upper detection limit to 50.0 % Cu. These higher-grade assay results match with the total copper assays in the data base.

There are two total nickel assay intervals where the original ALS (nit_ME_MS61) were above the upper detection limit of 1.0 % Ni. These intervals were then re-assayed by ALS using 4 acid digest with ICP-ES Analysis (nit_OG_62) which has a higher upper detection limit to 30.0 % Cu. These higher-grade assay results match the total Nickel assays in the data base. Overall, the results are quite good, all labs show good correlation between the original assay and the crush duplicate assay for total copper, total nickel, and cobalt.

Table 12-2 is a summary of the crush duplicates by assay lab, by metal for each time period. The original assay mean and the duplicate mean are very close to each other.

Table 12-2: Summary of Crush Duplicates from Teck

Variable	Unit	Assay Lab	Analysis Method	Return Date	Number	Original Mean	Duplicate Mean
co_7td2	PPM	ACME	4 Acid with ICP-ES Finish	June 2010 to August 2013	805	68.848	65.391
cu_7td2	PCT	ACME	4 Acid with ICP-ES Finish	June 2010 to August 2013	803	0.093	0.092
nit_7td2	PCT	ACME	4 Acid with ICP-ES Finish	June 2010 to August 2013	1099	0.047	0.047
co_ma370	PPM	Bureau Veritas	4 Acid with IPC-ES Finish	March to September 2014	544	70.385	69.219
cu_ma370	PCT	Bureau Veritas	4 Acid with IPC-ES Finish	March to September 2014	544	0.151	0.152
nit_ma370	PCT	Bureau Veritas	4 Acid with IPC-ES Finish	March to September 2014	544	0.051	0.051
co_ma270	PPM	Bureau Veritas	4 Acid with ICP-ES and ICP-MS	January and February 2018	225	84.253	84.498
cu_ma270	PCT	Bureau Veritas	4 Acid with ICP-ES and ICP-MS	January and February 2018	225	0.196	0.195
nit_ma270	PCT	Bureau Veritas	4 Acid with ICP-ES and ICP-MS	January and February 2018	225	0.064	0.064
co_me_ms61	PPM	ALS	4 Acid with ICP -MS Finish	March-Dec 2008, Apr 2021 to June 2022	681	77.445	77.618
cu_me_ms61	PCT	ALS	4 Acid with ICP -MS Finish	March-Dec 2008, Apr 2021 to June 2022	681	0.224	0.214
nit_me_ms61	PCT	ALS	4 Acid with ICP -MS Finish	March-Dec 2008, Apr 2021 to June 2022	681	0.063	0.060

12.9.3 Standards

Matrix-matched Cu, Ni and Co standards from Mesaba sample material were prepared by CDN Resource Laboratories (CDN) of Langley, B.C. Standards Mesaba-1 to Mesaba-10, are made from bulk sample material, and were used for all programs. Nine commercial Cu, Ni and Co standards, from OREAS, were used at the beginning and late in the drilling program when the stock of property standards was low. Teck also purchased commercial standards (CDN-ME-9 and CND-ME-14) for use with the old pulps.

GBM Standards or "CRM" (Certified Reference Materials) samples were purchase at Geostats Pty Ltd in Western Australia. These seven GBM standards were used for cobalt and copper and nickel. There are also three standards by CANMET (Natural Resources Canada) for total copper. The values of all the standard are established by a round robin analysis by multiple labs. Those certified values are compared against the results from Teck for the same pulps inserted into the samples sent to the lab.

There are 25 total copper,16 total nickel and 21cobalt standards in use with Teck's current drilling program. Table 12-3 is a summary of the total number of standards assayed by each method by and the unique number of standards in each method by element. Not every standard has CRM values for all three elements of interest. The CRM inserted was chosen as the one that most closely matched the surrounding material in grade by visual estimate.

Figure 12-1 to Figure 12-4 show assay results for the total copper standards. The X axis is the certified value, and the Y axis is the various Teck assays of the standards. It can be seen that most assays are within a reasonable tolerance of the certified value. Some of the larger errors may represent sample swaps in the standards data that was reviewed.

Table 12-3: Summary of Total Copper, Total Nickel, and Cobalt Standards

Variable	Unit	Assay Lab	Analysis Method	Return Date	Total Number Standards	Number of Unique Standards
cu_me_ms61	PPM	ALS	4 Acid with ICP -MS Finish	Feb. to Dec. 2008 and Nov. 2018 to June 2022	1,479	14
cu_ma370	PCT	Bureau Veritas	4 Acid with IPC-ES Finish	March to September 2014	1,414	7
cu_ma270	PPM	Bureau Veritas	4 Acid with ICP-ES and ICP-MS	January 2018 to August 2019	1,526	9
cu_7td2	PCT	ACME	4 Acid with ICP-ES Finish	June 2010 to August 2013	1,984	16
nit_og62	PCT	ALS	4 Acid with ICP -MS Finish	February 2008 to December 2009	196	10
ni_ma370	PCT	Bureau Veritas	4 Acid with IPC-ES Finish	March to September 2014	982	6
ni_7td2	PCT	ACME	4 Acid with ICP-ES Finish	July to Dec. 2008, June 2010 to August 2013	1,778	12
co_me_ms61	PPM	ALS	4 Acid with ICP -MS Finish	Feb. to Dec. 2008 and Nov. 2018 to June 2022	1,974	16
co_ma370	PCT	Bureau Veritas	4 Acid with IPC-ES Finish	March to September 2014	1,414	6
co_7td2	PCT	ACME	4 Acid with ICP-ES Finish	June 2010 to August 2013	1,647	12
co_ma200	PPM	Bureau Veritas	4 Acid with IPC-ES and ICP-MS Finish	February 2018 to February 2019	2,237	8

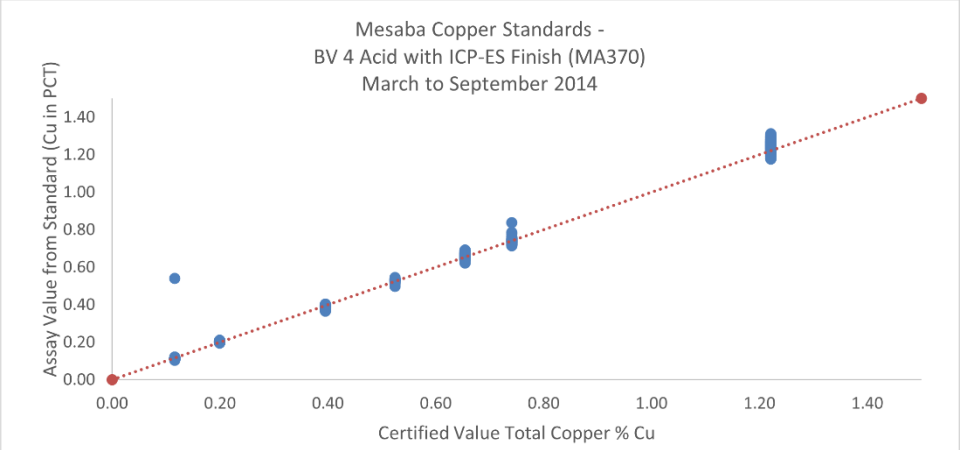


Figure 12-1: Total Copper Standards – ALS Lab 4 Acid with ICP-MS Analysis

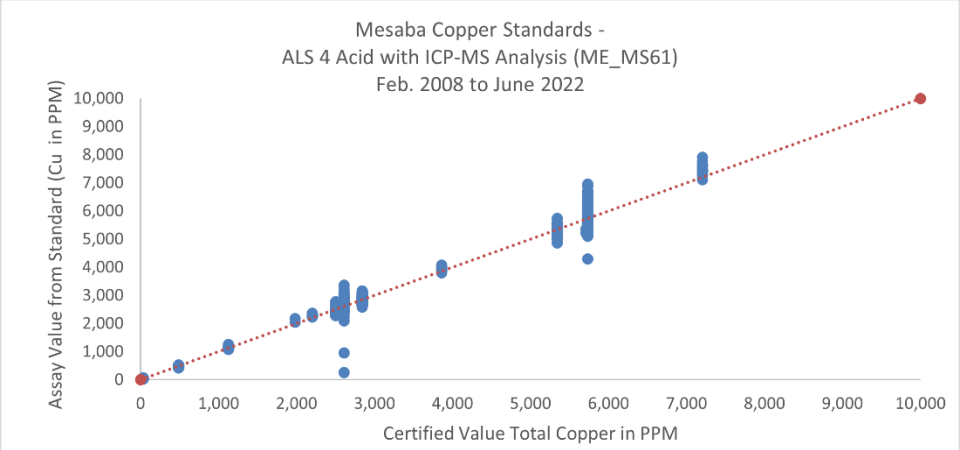


Figure 12-2: Total Copper Standards – BV Lab 4 Acid with ICP-ES Analysis

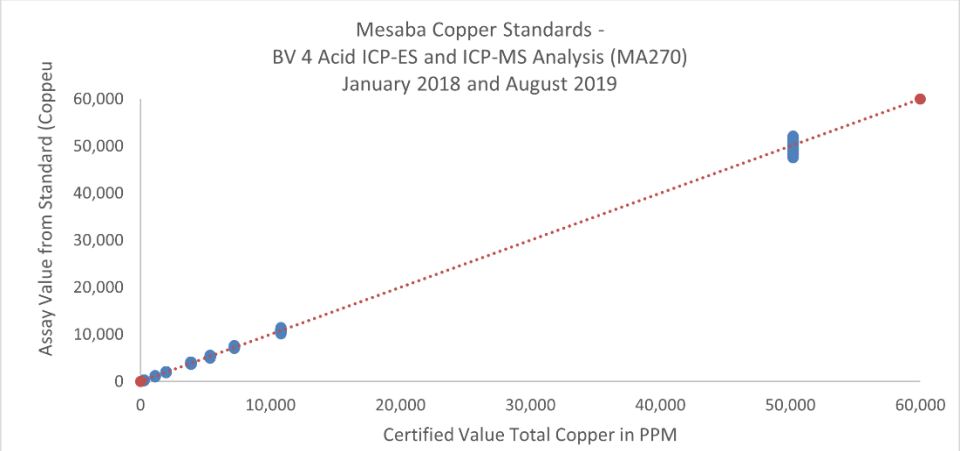


Figure 12-3: Total Copper Standards – BV Lab 4 Acid, ICP-ES and ICP-MS

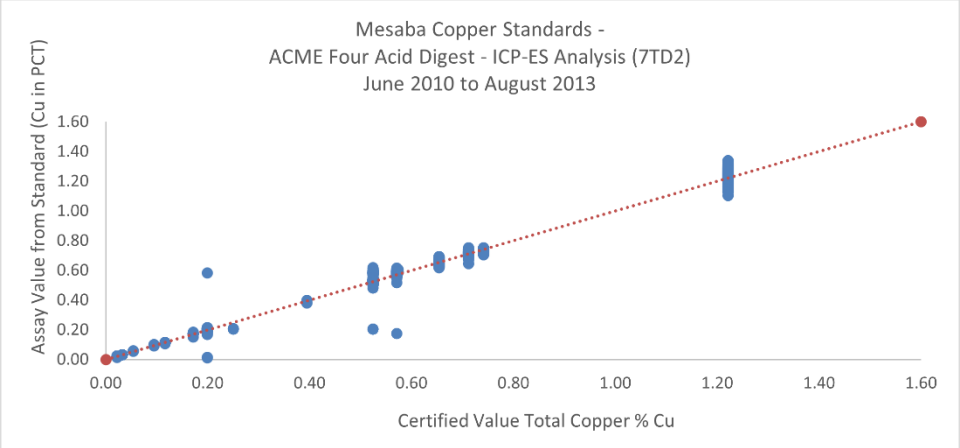


Figure 12-4: Total Copper Standards – ACME Lab 4 Acid, ICP-ES Finish

Figure 12-5 to Figure 12-7 shows the results for total nickel standards in this current drilling program. The plots below show assay lab results versus certified values. Again, there is a good chance the larger errors are related to sending a different standard than intended. Figure 12-5 shows a sample swap with the highest-grade standard returning a lower grade than expected.

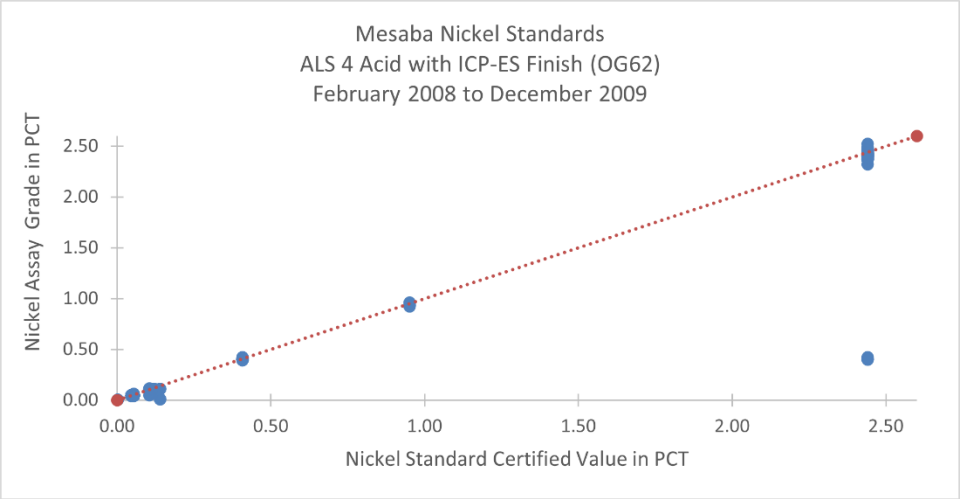


Figure 12-5: Total Nickel Standards – ALS Lab 4 Acid with ICP-MS Finish

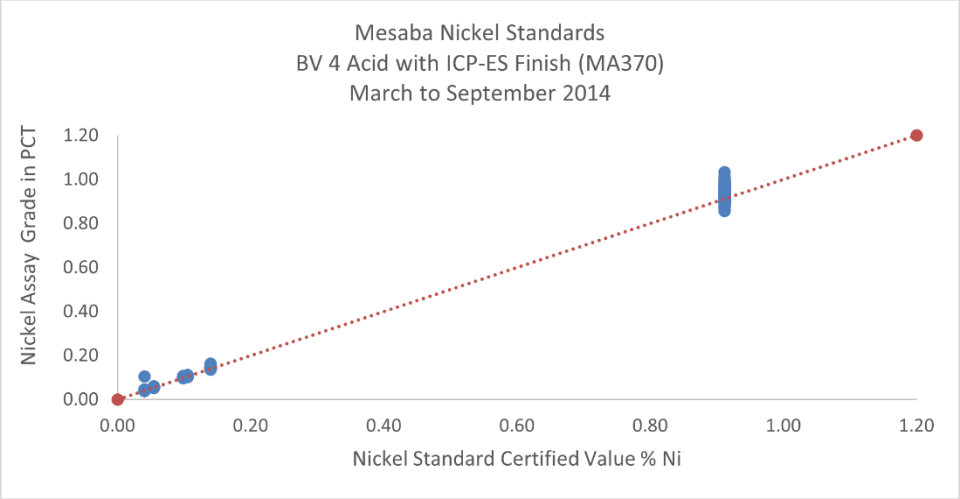


Figure 12-6: Total Nickel Standards – BV Lab 4 Acid with ICP-ES Finish

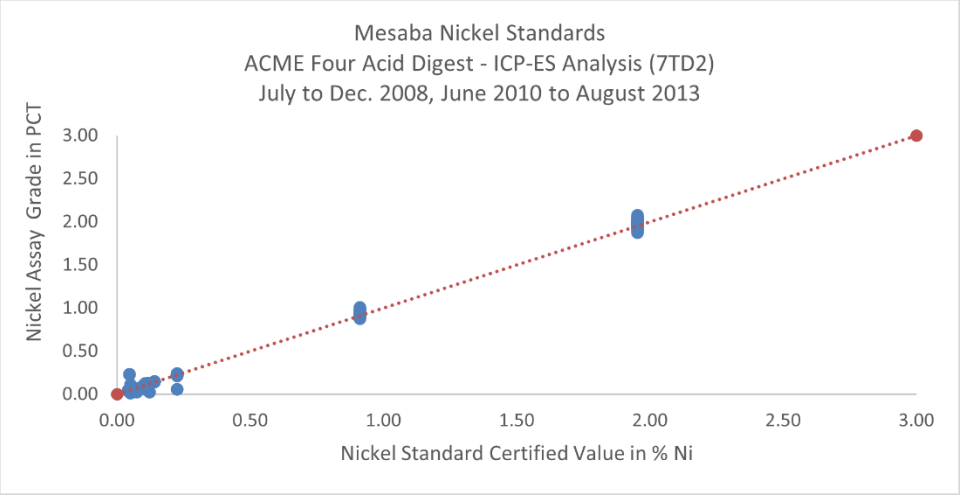


Figure 12-7: Total Nickel Standards – ACME Lab 4 Acid with ICP-ES Finish

Figure 12-8 to Figure 12-11 shows the results for Cobalt standards in this current drilling program. The plots below show assay lab results versus certified values. Cobalt standards show much more scatter than total copper or total nickel standards. There are also indications of a few sample swap issues in cobalt standards assay results.

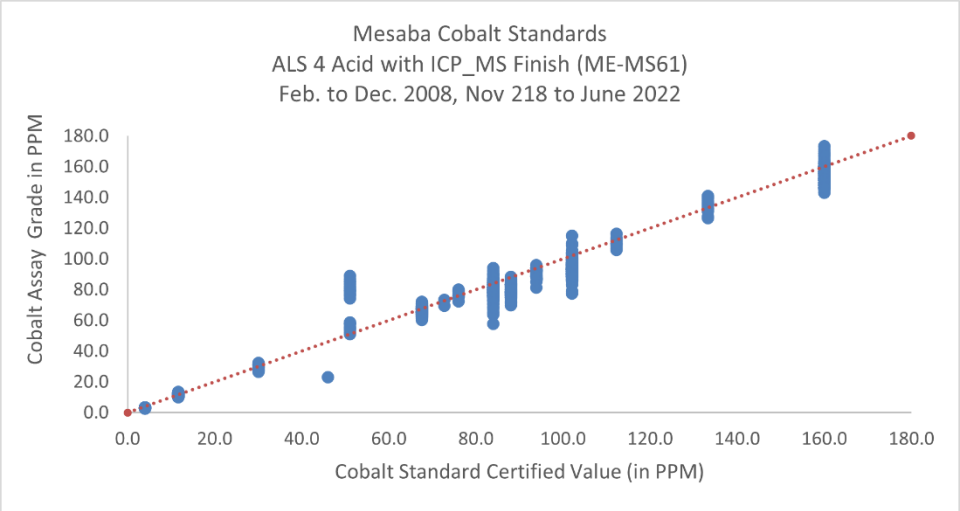


Figure 12-8: Cobalt Standards – ALS Lab 4 Acid with ICP-MS Finish

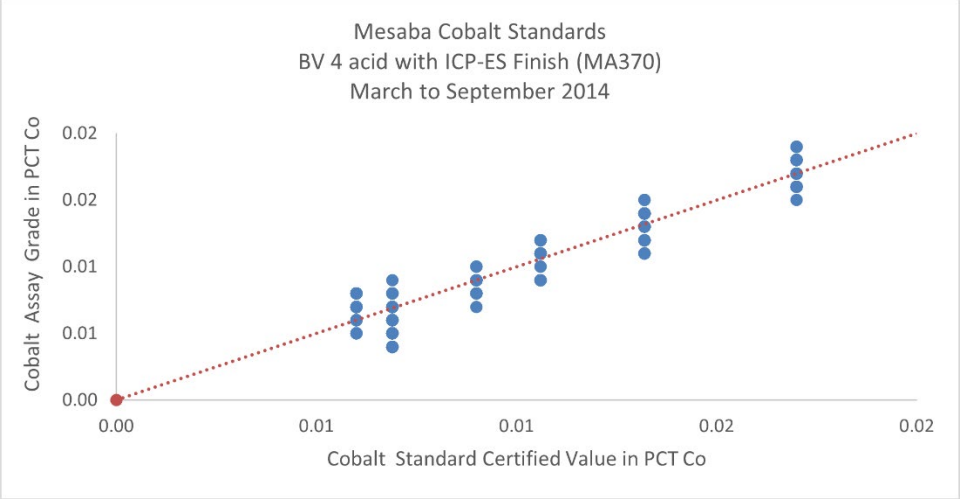


Figure 12-9: Cobalt Standards – BV Lab 4 Acid with ICP-ES Finish

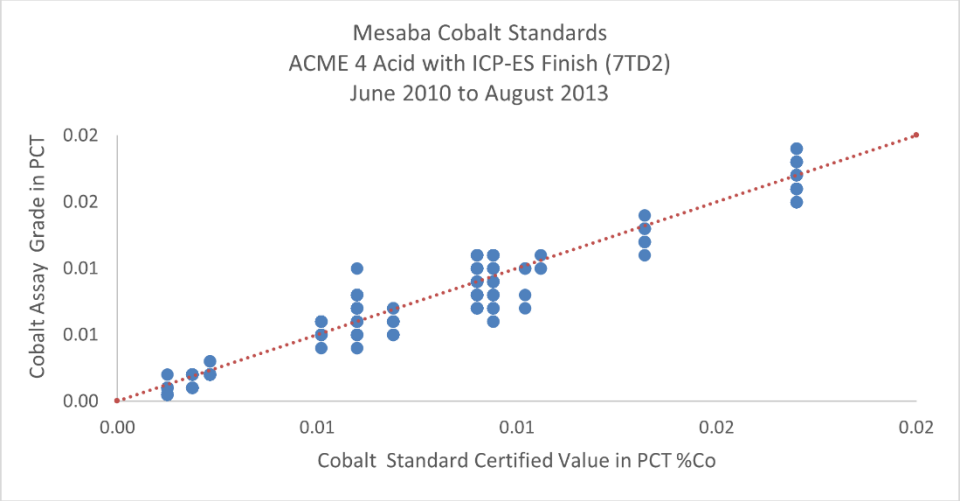


Figure 12-10: Cobalt Standards – ACME Lab 4 Acid with ICP-ES Finish

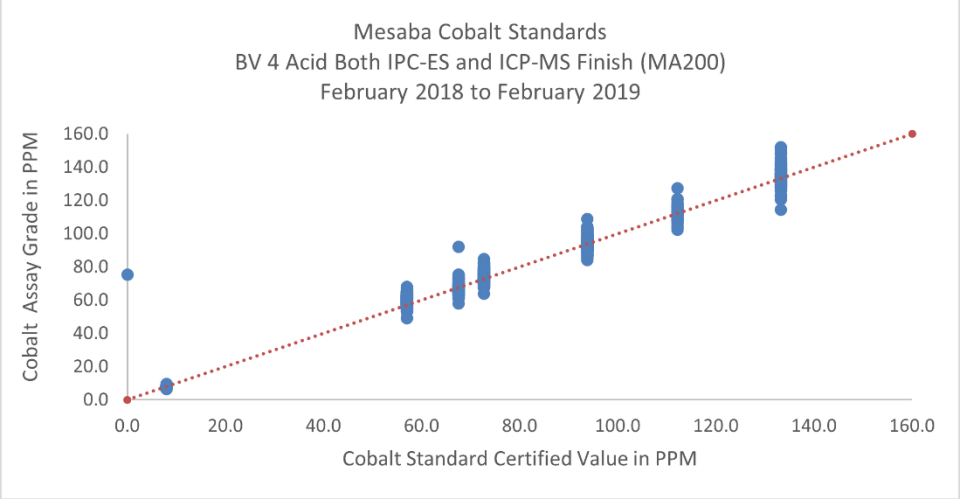


Figure 12-11: Cobalt Standards – BV Lab 4 Acid w/ ICP-ES and ICP-MS Finish

12.9.4 Teck Blanks

Blanks (material with no or below detection limit values) were submitted as part of the Teck insertion of control samples. Blanks were submitted to ALS, Bureau Veritas and ACME Labs. All labs had copper and cobalt blanks, BV 4 Acid with IPC-ES Finish (MA370) and ACME 4 Acid with ICP-ES (7TD2) returned nickel blanks. All the assays for total copper,

nickel and cobalt were below the detection limits. There are 8 total copper blanks that are above the 0.004 % Cu. The highest copper blanks are 0.0105 % Cu. The maximum values of the blanks data are shown below in Table 12-4.

Table 12-4: Maximum values of Copper, Nickel and Cobalt Blanks

Mesaba Blanks - all assay methods		
Copper	Maximum (PCT)	0.0105
Nickel	Maximum (PCT)	0.0010
Coblat	Maximum (PPPM)	6.0000

12.9.5 Assay Certificate Checks

IMC requested the original assay certificates for an IMC random selection of holes drilled by AMAX, Bear Creek, and Teck. These certificates were entered into a new database, and it was compared to the data base provided by Teck for copper and nickel with minor comparisons for sulfur and cobalt. For the drill holes selected, IMC received certificates for all or a portion of the drill hole. Table 12-5 is a summary of the number of drill holes and number of certificates checked against the master drill hole database for copper and total nickel. The assay intervals checked for copper represents 7.1% of the total number of assay interval (78,762) in the total data base.

Table 12-5: Number and Percent of Drill Hole Certificates Checked

	Drill Holes			Assay Intervals				
Company	**Total Drilled**	**Number Selected**	**% of Total**	**In Selected Holes**	**Copper Values Checked**		**Nickel Values Checked**	
					Number	**% of Intervals**	**Number**	**% of Intervals**
AMEX	450	23	5.1%	2,285	1,541	67.4	1,541	67.4
Bear Creek	173	10	5.8%	1,054	753	71.4	708	67.2
Teck	208	52	25.0%	4,711	3,305	70.2	3,453	73.3
Total	831	85	10.2%	8,050	5,599	69.6	5,702	70.8

12.10 ACCEPTANCE OF THE DRILL HOLE DATABASE

The process of data verification for the Project has been performed by Teck, and predecessor company personnel. The QP has reviewed the work as reported along with the IMC review and is of the opinion that the data verification programs completed on the data collected from the Project are consistent with industry best practices and that the database is sufficiently error-free to support the geological interpretations and Mineral Resource estimation.

The drill data as provided by Teck is accepted for use to develop a mineral resource. The checks of the AMAX, Bear Creek and Teck drill hole data showed no significant errors in the development of the digital database. No checks were made on the Reserve Mining, Humble Oil, INCO, or NRRI drill hole data which represent less than 2% of the holes drilled.

13 MINERAL PROCESSING AND METALLURGICAL TESTING

13.1 INTRODUCTION

PolyMet has conducted no metallurgical test work programs on the Project.

13.2 METALLURGICAL TEST WORK

13.2.1 Historical Metallurgical Test work

Test work on the Mesaba Project dates back to the early 1950s, with key programs completed prior to Teck's Project interest summarized in Table 13-1.

Results from historical comminution test work characterized Mesaba mineralized material as being in the medium hardness range with a low steel wear rate. Grinding test work and pilot plant studies targeting grinding circuit performance conducted in the late 1970s indicated that the Mesaba mineralization was amenable to either autogenous grinding in closed circuit with pebble crushing or fully autogenous grinding based on power efficiency and throughputs.

Historical flotation test work indicated that a bulk copper concentrate could be produced at copper recoveries of more than 90% and nickel recovery of approximately 75%. Copper concentrate containing <1% nickel could be produced, but no saleable nickel concentrate could be generated.

13.2.2 2000–2012 Teck historical Metallurgical Test work

13.2.2.1 Mineralogy and Mineral Associations

In 2000, G&T performed optical mineralogical evaluation of a bulk sample that derived from the Arimetco sample evaluated by Coleraine in 1998 and re-examined the same material in 2002. In 2000 examination, at a feed sizing P_{80} of 160 μm, the sulfide minerals were completely liberated from the non-sulfide host. However, the copper, nickel and iron sulfides were still interlocked with each other and regrinding the rougher concentrate to a P_{80} of 50 μm was recommended. Pyrrhotite was the dominant sulfide, but pyrite was also found in measurable quantities. In the 2002 examination, the main sulfide minerals were chalcopyrite, pentlandite, pyrrhotite, and pyrite. The main copper-bearing mineral was chalcopyrite; cubanite was not reported.

Table 13-1: Historical Metallurgical Test work

Year	Laboratory/Test Facility	Comment
1975	Twin Cities Metallurgical Research Center	Series of small bulk flotation tests
1977	Allis-Chalmers	Bond work indices for crushability, rod mill and ball mill
1978	Lakefield Research	Grinding performance from pilot plant test work; autogenous and semi-autogenous testing. Pilot plant runs were done on three bulk samples of disseminated, semi-massive and high pyrrhotite/cubanite mineralization.
1979	Lakefield Research	Bond grindability test work
1980	Amax	"Evaluation" study including pilot plant grinding and flotation test work
1998	Coleraine	Laboratory and pilot plant flotation test work

During 2009, Teck's ART facility completed a series of bulk modal mineralogy mineral liberation analysis ("**MLA**") examinations on selected drill core samples. The mineralization in the core was classified as being either from the upper zone, or from the basal zone.

The upper zone copper mineralization was found to be mostly chalcopyrite with minor pyrrhotite. In the basal zone, the copper mineralization was split between cubanite and chalcopyrite and the dominant sulfide was pyrrhotite. In both cases, pyrite was detected by the MLA, but found in quantities <0.01%.

13.2.2.2 Comminution

In 2011, a sample of the 2008 bulk sample from Mesaba deposit was sent to ART to perform JK drop weight tests. Results are shown in Table 13-2. Bond ball mill work index and bulk density testing were also performed on this sample.

13.2.2.3 Flotation

Teck completed 49 bench-scale flotation tests. The majority of this test work focused on a simple rougher–cleaner circuit, yielding a bulk Cu–Ni concentrate amenable to the CESL process. In 2009, test work was also performed to investigate the production of a marketable copper concentrate (>24% Cu, <0.5% Ni). These programs are summarized in Table 13-3.

The mineral processing test work performed by Teck between 2000 and 2012 formed the basis of previous internal investigation for the development of the deposit up to the AVSS completed. The flowsheets developed during this period were refined during further metallurgical testing performed between 2014 and 2019. The test work during the latter time period was also performed on samples providing a broader spatial coverage. The results of the later test work supersede the results from earlier time periods.

Table 13-2: 2011 Comminution Results

Parameter	A	b	A*b	Ta
	66.6	0.75	50.2	0.45
Density	**Mean**	**Standard Deviation**	**Maximum**	**Minimum**
	2.92	0.32	3.85	2.70

Note: A, b and Ta are JK rock breakage parameters.

Table 13-3: 2001–2009 Flotation Test work

Year	Program	Comment
2000	G&T KM1102; flotation + modal analysis on concentrate and tailings	Used conditions identified by the Coleraine Minerals Research Laboratory (SIPX collector, natural pH, 150 µm rougher feed P80) to produce a flotation concentrate for modal analysis. The float time was set to 14 minutes.
2001	G&T KM1167; rougher kinetics, batch cleaner	Conditions in the roughers were six-minute float time, SIPX as collector, MIBC as frother, pH 9.0 and 150 µm P80. During the final test (KM1167-04), the pH was reduced to 7.0 using hydrochloric acid. The batch cleaner tests used three stages of cleaning with a seven-minute regrind and SIPX addition at the first stage. The regrind P80 was not reported
2001	G&T KM1224; rougher kinetics, batch cleaner	14 composites assembled from 22 historical drill cores; sampled material based on interpreted mineralized zone, and then subdivided into grade ranges for each mineralization type. One rougher test was performed on each composite. Rougher float time varied from 4–6 min; SIPX used as collector, natural pH was natural (8.4–8.9), target rougher feed P_{80} of 111 µm Single-stage bulk cleaning tests at natural pH with no regrind. Rougher kinetic tests demonstrated recovery of >90% Cu and 60–80% in a very short flotation time (4–5 min). Average of 72% Cu recovered into 3.2% of the mass in a one-minute rougher stage. Average of 94.5% recovered into 7.8% of the mass in the combined rougher + scavenger. Copper results generally consistent; the nickel results more variable. Cleaner concentrate grade from all 14 composites averaged 12.4% Cu (6.2–17.5%) and 1.5% Ni (0.9–2.2%). Open circuit cleaner recovery averaged 83.6% Cu and 45.4% Ni to 3.2% of the mass. Tailings copper grade was proportional to the feed copper grade. Nickel recovery was proportional to the feed sulfur grade; higher sulfur containing material tended to contain more recoverable (sulfidic) nickel. Predicted average copper recovery of 93.8%.
2002	G&T KM1349; rougher kinetics, batch cleaner	Used three composites from two drill holes from the western edge of the BTI. Rougher conditions similar to KM1224, with the exception of the natural pH, which (8.7–9.5), and nominal rougher feed of P80 of 120 µm.
2009		Sequential flotation flowsheet producing copper and Cu–Ni concentrates, and a bulk flotation flowsheet producing a copper concentrate and a retreat circuit tailing for processing by CESL. All tests performed using primary grind P80 of about 130 µm. Sequential tests featured pH 11.5–12 and 7 min float time in the copper roughers. Nickel roughers had pH of 9.4, and 6 min float time. Two-stage cleaning performed on the copper and nickel concentrates separately. Copper sulfate added to the first nickel cleaning stage; sodium cyanide added to the second. Reagent scheme for roughers and copper cleaners featured SIPX, MOL and F160-10 frother. Rougher portion of the bulk flotation tests performed at natural pH (8.9), a total float time of 7 min, used the same reagents as the sequential tests. Rougher concentrate reground to a P80 of 30 µm and cleaned in three stages to produce a copper concentrate. Cleaner tailings reported to a second regrind (P80 of 19 µm) and retreat cleaner. Retreat cleaner produced additional copper concentrate in two stages and tailings for CESL leach testing. All cleaner stages conducted at elevated pH (11–12) for Cu–Ni separation
2012		Samples included 2001, 2008 bulk samples; and drill composites compiled from drill core intervals from the 2007 metallurgical drilling campaign. Tests performed at natural pH (7.7–8.9) with SIPX as a collector and Dowfroth 250. Rougher retention time of 15 min. Rougher concentrate reground to 46–56 µm prior to cleaning. Cleaner retention time of 20 minutes; concentrate collected for assay after 1, 3, 7, 12 and 20 min.

13.2.2.4 Hydrometallurgy

CESL process test work on the Mesaba concentrate was carried out during two distinct periods: 2000–2002 and 2007–2010 (Table 13-4).

Between November 2008 and March 2009, 9.2 tons of concentrate produced at Coleraine Minerals Research Laboratory from the 2001 and 2008 bulk samples were processed through the integrated copper and nickel pilot plant during 12 weeks of operations. During the campaign, 1,245 kg of copper cathode and 135 kg of mixed Ni–Co hydroxide

precipitate (MHP) product was produced. Pilot plant operations confirmed the successful processing of low-grade bulk concentrate; >95% of the copper, nickel and cobalt were leached into solution with low (7%) sulfur oxidation. The campaign produced a high-grade MHP for external marketing evaluation and residue samples for environmental stability analyses.

Nine nickel producers were contacted to evaluate the marketability of the high-grade MHP product. Five determined that they would be able to process the MHP product without changes; two would require capital improvement projects to their refineries to handle the product; and the remaining two would be unable to accept the material due to impurity constraints. Based on a preliminary market assessment of the MHP product, 70% payable nickel and cobalt was forecast.

Table 13-4: CESL Test work

Year	Comments
2000	Initial bench test work on concentrate from G&T KM1102 – extractions of 95.8% Cu, 97.6% Ni, and 97.3% Co.
2001–2002	Processed 6 st of Mesaba concentrate (derived from the 2001 bulk sample) through the pilot plant – confirmed Process 4 (leaching of all metals in the autoclave) suitable. The Ni in the recycle solution was built up to 40 g/L. Batch test work performed on the Ni bleed stream; produced a mixed nickel–cobalt hydroxide product with lime. Processed 5.3 st of Mesaba concentrate (derived from the 2001 bulk sample) through the pilot plant. Ni bleed stream was processed through the pilot plant at a design rate of 1.3 kg/d Ni to produce a mixed hydroxide intermediate.
2007	Bench test work on the Mesaba concentrate (derived from the 2001 bulk sample) led to the decision to produce a mixed nickel – cobalt hydroxide product with magnesia.
2007–2008	A mini-pilot plant was constructed and operated to optimize the Ni bleed flowsheet and produce a saleable Ni/Co intermediate. Plant operated from October 2007 to March 2008.
2008–2009	Integrated Cu–Ni pilot plant operated; processed 8.3 st of bulk concentrate, (1.8 st of concentrate from 2001 bulk sample used for commissioning and 8.2 st of concentrate from the 2008 bulk sample) to produce Ni–Co intermediate for marketing samples and residue samples for long-term stability testing.
2009–2010	Semi continuous CESL nickel pilot plant operated; processed synthetic feed consistent with modeled solution for Thompson Pipe Complex.

The modified flowsheet closely reflected what was commercially practiced at several nickel refineries that leach matte to produce nickel and cobalt products. The flowsheet was tested through bench testing, with positive results achieved. Flowsheet confirmation work is required through pilot plant-scale testing.

13.2.3 2014–2019 Teck Metallurgical Test work

Following the conclusion of the AVSS, geometallurgical drilling and testing was completed to confirm the feasibility of producing separate copper and copper–nickel concentrate as well as to generate variability comminution data. The work programs conducted by SGS are summarized in Table 13-5.

A series of 156 rougher tests, open circuit cleaner tests, SMC and Bond ball mill work Index tests were completed in 2014–2015, with results shown in Table 13-6. The Bond Ball mill index was on average 14.8 with a 75th percentile of 15.6.

Table 13-5: Test work Performed at SGS

Consultant	Location	Year	Activity
SGS Burnaby and Lakefield	Burnaby, BC, Canada Lakefield, ON, Canada	2014–2015	Variability testing of drill core intervals to produce copper and bulk concentrate
SGS Burnaby	Burnaby, BC	2019	Locked-cycle testing of geometallurgical composites

Table 13-6: 2014 – 2015 Average Comminution Results

Parameter	A	b	A*b	Ta
	82.0	0.58	46.5	0.4
Bulk density	**Mean**	**Standard Deviation**	**Maximum**	**Minimum**
	3.03	0.09	3.33	2.69

After the conclusion of the 2015 program at SGS, metallurgical testing was paused, and the samples were kept in refrigerated storage. Locked-cycle tests were performed in 2019 at SGS Burnaby on composites formed from material preserved from the 2014–2015 programs.

13.2.3.1 Description of Metallurgical Composites

The composites were assembled from drill core intervals based on their sulfur: copper ratio. The head assays of the composites are shown in Table 13-7. Mineralogical analysis of the composites was also completed.

Table 13-7: Head Assays of the Metallurgical Composites

Composite	Cu (%)	Ni (%)	S (%)	Co (%)	Pt (g/t)	Pd (g/t)	Au (g/t)	Ag (g/t)
Composite 1	0.52	0.14	0.74	0.01	0.03	0.20	0.04	1.2
Composite 2	0.47	0.13	0.98	0.01	0.03	0.13	0.03	1.2
Composite 3	0.54	0.14	1.93	0.01	0.03	0.09	0.03	1.5
Composite 4	0.41	0.13	2.48	0.01	0.03	0.05	0.02	1.0

13.2.3.2 Flowsheet Used in Locked-Cycle Tests

A conventional copper–nickel sequential flotation flowsheet was used. The mineralization was ground in a laboratory rod mill followed by copper rougher flotation, bulk rougher flotation and desulphurization flotation. The copper rougher concentrate was reground and cleaned twice to produce the feed to the copper/nickel separation process. Reagents were added in this step to depress nickel minerals and two stages of cleaning was performed to recover the copper concentrate.

The tailings from the copper nickel separation process reports to the bulk concentrate. The bulk rougher concentrate was reground and cleaned three times to produce a concentrate that was combined with the copper–nickel separation tailings to form the bulk concentrate.

In the desulfurization stage, reagents are added to the bulk rougher flotation tailings to recover sulfur bearing gangue still present in the tailings to produce low-sulphur tailings. The concentrate from the de-sulfurization process is combined with the tailings from the bulk cleaners to form the cleaner tailings stream which has a high sulphur content. The rougher tailings thus produced have a lower sulfur content.

The flotation flowsheet developed and used during testing is shown in Figure 13-1.

13.2.3.3 Results of Locked-Cycle Tests

The recovery and concentrate grade achieved for the copper and bulk concentrate are shown in Table 13-8 and Table 13-9. In these tables, the assay data are shown as percentage units for copper, nickel, and cobalt, and in g/t units for

the precious metals. Recovery data is expressed as percentages. The results of the best locked-cycle tests were used to generate the metallurgical projections.

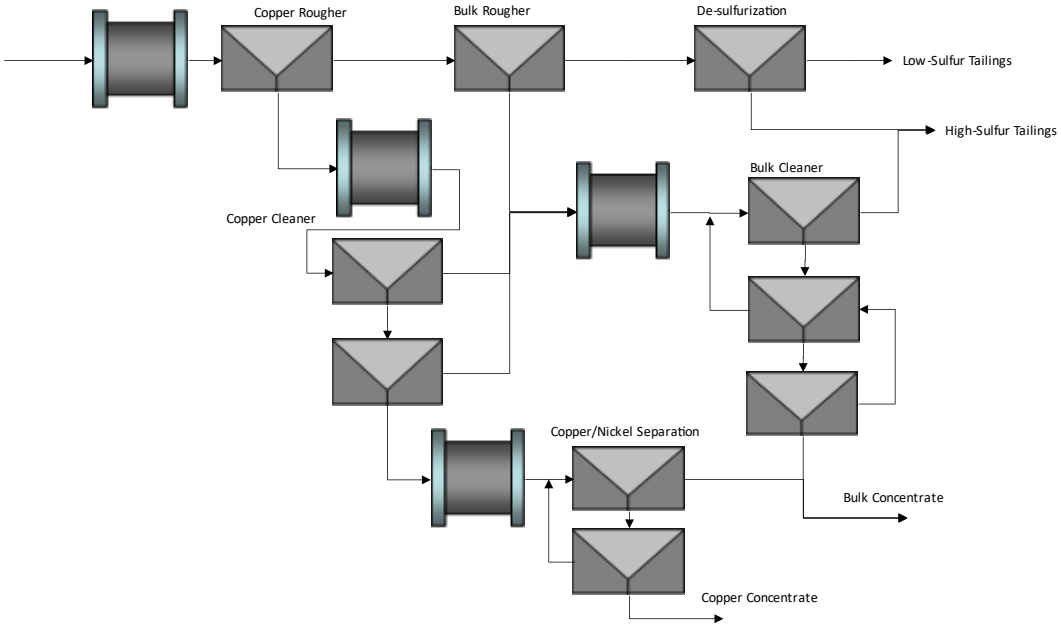
The copper recovery achieved to the combined concentrate varied between 89.2 and 92.3% and the nickel recovery to the copper–nickel concentrate varied between 42.7 and 67.5%. The variability in nickel recovery is caused by the variable content of sulfidic nickel.

13.3 GEOMETALLURGICAL MODELLING

13.3.1 Mineral Liberation Analyzer/X-ray Backscatter Analysis

13.3.1.1 2014

Mineralogical characterization was completed for a suite of 383 drill core intervals from the 2013 Mesaba geometallurgical drilling program. The intervals represent samples from both geometallurgical testing and lithogeochemical programs. The main focus of the study was to determine the spatial variability in copper and nickel sulfide mineralization associated with specific geologic units, and with respect to distance from the basal contact. The amounts of copper sulfides (chalcopyrite ± talnakhite, cubanite, and other copper sulfides), pentlandite, pyrrhotite, and other sulfides (present in trace amounts) were documented in each sample. Test samples were analyzed using MLA and X-ray backscatter electron (XBSE) analysis.



Source: Figure courtesy Teck, 2022

Figure 13-1: Mesaba Flotation Flowsheet

Table 13-8: Copper Concentrate Grade and Recovery Used for Metallurgical Projection

Composite ID	Cu Concentrate Grade (% or g/t)							Cu Concentrate Recovery (%)						
	Cu	Ni	Ag	Au	Pd	Pt	Co	Cu	Ni	Ag	Au	Pd	Pt	Co
1	29.9	1.1	71	2.6	5.4	1.0	0.03	62.7	8.4	38.6	47.3	29.9	17.6	4.7
2	25.7	0.5	65	1.7	2.0	0.4	0.02	65.6	4.8	49.7	54.9	18.7	12.9	3.5
3	24.4	0.3	50	0.9	0.8	0.2	0.02	57.4	2.7	34.7	44.4	11.7	7.8	2.5
4	19.1	0.5	35	0.9	0.6	0.1	0.04	56.2	5.3	29.7	53.6	12.6	6.5	4.6

Table 13-9: Bulk Concentrate Grade and Recovery Used for Metallurgical Projection

Composite ID	Bulk Concentrate Grade (% or g/t)							Bulk Concentrate Recovery (% or g/t)						
	Cu	Ni	Ag	Au	Pd	Pt	Co	Cu	Ni	Ag	Au	Pd	Pt	Co
1	11.3	4.3	41	1.5	6.9	2.8	0.13	29.6	42.7	28.0	35.5	47.9	58.7	25.6
2	7.6	4.2	26	0.4	4.1	1.3	0.18	25.8	54.4	26.6	17.4	51.7	55.0	35.1
3	7.0	3.4	28	0.3	1.8	0.8	0.21	34.1	67.5	40.3	32.5	53.7	59.9	54.0
4	5.4	2.8	16	0.1	1.0	0.4	0.24	33.0	64.3	27.7	15.2	44.6	40.3	51.9

Chalcopyrite and cubanite were the principal economic copper minerals present at Mesaba with lesser amounts of copper–nickel–iron sulfides, bornite, chalcocite, and a copper sulfosalt tentatively identified as famatinite. Talnakhite could not be identified readily using the MLA technique due to detection limits. In terms of general trends, chalcopyrite decreased downhole in favor of cubanite in 19 out of 25 holes; however, there were several exceptions.

Pentlandite was the principal economic nickel mineral. Nickel was also hosted by lesser amounts of copper–nickel–iron sulfide, bravoite (nickel-bearing pyrite) and nickeline or maucherite (nickel arsenides). Pyrrhotite was the main sulfide gangue mineral identified. Pyrite was also identified very locally in samples with <0.2% sulfides but its identity is suspect.

Graphite was identified in a group of 18 samples containing >0.50 wt% C_T. Out of this group, 12 were proximal to the footwall and five were associated with so-called "cloud" zones in BT1 (5) and BT4 (1). The graphite occurred within, and as attachments to, the major silicates, as simple middlings, and as tightly-intergrown arrays with pyrrhotite, chalcopyrite, cubanite, and lesser pentlandite.

13.3.1.2 2020

A total of 345 samples from the 2013 program were reanalyzed using an X-ray modal analysis (XMOD) mode rather than the XBSE mode used in 2013. This mode helped to better identify silicate minerals with similar backscatter signatures such as olive and orthopyroxene. The improved silicate MLA data were used in conjunction with electron microprobe (EPMA) data collected in 2019 to better understand nickel deportment and to produce an updated sulphide model.

13.3.2 Electron Microprobe

A mineral chemistry program was completed in 2019 using an electron microprobe analyzer at the University of Minnesota. The aim of the program was to generate high quality mineral chemistry analyses for major nickel-bearing silicates to better understand nickel deportment and to analyze the major sulfide minerals to better understand their composition. In total, 86 thin sections and four composites were analyzed resulting in a total of 6,551 spot analyses. Of those spot analyses, the major minerals analyzed were olivine, orthopyroxene, biotite, and various sulfides.

13.3.3 Sulfur and Sulfur Forms

Pyrrhotite ($Fe_{1-x}S$), with 39.6% S, is the main sulfide gangue mineral at Mesaba. Both monoclinic (magnetic) and hexagonal (non-magnetic) varieties are present and both often alternate in thick zones within the mineralized horizons and even in the BDPO unit. Pyrrhotite is present everywhere in the BTI, and the footwall Virginia Formation, and shows a significant increase in volume towards the basal contact of the BTI. Pyrite is only locally present as joint coatings mainly in the footwall rocks. Trace amounts of microscopic pyrite in the mineralized zones was also documented.

13.3.4 Carbon and Carbon Forms

Graphite is by far the dominant source of carbon at Mesaba with some carbon contribution from calc-silicate (CSIL) pods in the footwall rocks and in inclusions, and as very thin calcite coatings along joint surfaces reported in the tops of many holes drilled in 2013. Graphite can occur in a myriad of forms that include: a major constituent of the BDPO unit, massive to semi-massive graphite zones up to several feet thick with a maximum of 60 ft (18 m); irregular pods and veins up to a few centimeters thick; graphite "beans;" and extremely fine-grained disseminations in the footwall rocks and inclusions.

13.3.5 Geometallurgical Domains

A model was developed in 2020 to define a sulfide model, recovery equations for copper and nickel, and geometallurgical domains, using 6,551 EPMA and 350 XMOD MLA analyses. This deportment study demonstrated that nickel deportment to non-recoverable minerals is a strong function of lithology, because of the significantly different partition coefficients for nickel in orthopyroxene vs. olivine.

The exploratory data analysis resulted in several key observations:

- Nickel rougher recovery is highest for the orthopyroxene-rich norites and lowest for the olivine-rich ultramafic units (BUTM), because nickel partitions into olivine much more strongly than it does into orthopyroxene. The EPMA analyses show that the nickel concentration in olivine is 4-20 times higher than the nickel concentration in orthopyroxene;
- The nickel rougher recover is approximately 10% higher for rocks that contain >1% S than those containing <1% sulfur;
- The copper concentrate grade is largely invariant with the model code. Lower copper rougher recoveries are associated with model codes for the non-mineralized units BTI, BTI-c and PRB.
- Copper deportment to cubanite is generally greater in rocks containing >1% S.

This resulted in definition of five geometallurgical units (Table 13-10).

Table 13-10: Geometallurgical Units

Geometallurgical Unit/Zone	Abbreviation	Comment
Norite zone	GM10	Includes the model codes NORITE and Norite_Basal. A high abundance of orthopyroxene-rich norites and prevalence of sulfur sources in the footwall result in the largest nickel deportment to sulfides, elevated copper deportment to cubanite, and reduced copper deportment to chalcopyrite
High sulfur	GM20	Mineralized model units BTMZ, BTMZ-C, Basal BTMZ-C and PRM subject to the condition that they contain >1% sulfur. Moderate abundances of nickel-bearing olivine result in moderate nickel deportment to sulfides. The presence of excess sulfur induces elevated copper deportment to cubanite.
Low sulfur	GM30	Mineralized mining blocks containing <1% sulfur. The gangue mineralogy is similar to the high sulfur domain (GM20), meaning that this domain is characterized by moderate nickel deportment to sulfides. Less excess sulfur in this domain results in elevated copper deportment to chalcopyrite relative to cubanite.
Ultramafic	GM40	Includes rocks that are rich in olivine, which is a major host of non-recoverable nickel. The nickel deportment to sulfides is low, and the copper deportment to chalcopyrite relative to cubanite is high.
Non-mineralized	GM50	Recovery equations were calculated for non-mineralized zones to support estimation work close to the cut-off value. Owing to an overall lack of sulfur, nickel deportment to

Geometallurgical Unit/Zone	Abbreviation	Comment
		sulfides is low, although the copper deportment to chalcopyrite is high relative to cubanite.

13.3.6 Sulfide Model

The dominant sulfide minerals at Mesaba include chalcopyrite, cubanite, pentlandite and pyrrhotite. In nature, both pentlandite and pyrrhotite exhibit significant compositional variability. The EPMA and MLA datasets for Mesaba show that the molar ratio of iron to nickel in pentlandite is approximately one, and that pyrrhotite generally takes the stochiometric form FeS. Because significant quantities of iron and nickel occur in silicate and sulfide minerals at Mesaba, it is not possible to model the modal abundances of the key sulfide phases directly from the whole rock geochemistry. Instead, the model must be based on the following sulfur balance:

$$S_{Total} = S_{Pentlandite} + S_{Chalcopyrite} + S_{Cubanite} + S_{Pyrrhotite}$$

Following calculation of $S_{Pentlandite}$, $S_{Chalcopyrite}$, and $S_{Cubanite}$ using regression models, the sum of these quantities is subtracted from S_{Total}, which is obtained from whole rock geochemical analyses, to enable estimation of the modal abundance of pyrrhotite.

13.3.6.1 Pentlandite

Separate approaches were required to model the modal abundance of pentlandite in the mineralized (GM10, GM20, GM30), the ultramafic (GM40) and non-mineralized (GM50) geometallurgical domains. Simple linear regression models are sufficient to model the nickel deportment to pentlandite as a function of total nickel.

The recovery domains GM10, GM20, and GM30 are dominated by mineralized rocks, domain GM40 comprises mineralized and non-mineralized versions of ultramafic rocks. Results of the MLA and EPMA studies show that olivine in ultramafic rocks is a significant host of non-recoverable nickel. As a result, rocks within GM40 can contain significant amounts of nickel even when little sulfur is present.

The MLA dataset comprises only 13 samples from domain GM40, and all of these are mineralized to some degree. Experimentation with the data demonstrated that a pentlandite model based on regression analysis of MLA samples from GM40 results in overestimation of pentlandite abundances in weakly mineralized rock. This deportment model assumes that:

- Ultramafic rocks at Mesaba can contain appreciable pentlandite only when the total sulfur concentration is greater than 0.1%;
- The bulk non-recoverable silicate and oxide portion of the ultramafic rocks contains approximately 500 ppm Ni;
- All remaining nickel deports to recoverable sulfides.

The second bullet point assumption is justified by the existing MLA data, which indicates that GM40 contains approximately 35% olivine and serpentine and that the nickel concentration in these combined phases is approximately 0.14%.

Nickel deportment to sulfides in the non-mineralized recovery domain (GM50) is more complex. The proportional nickel deportment to non-recoverable silicates and oxides varies systematically as a function of the total sulfur.

The weight percent abundances of pentlandite in each geometallurgical recovery domain, X_{Pn}, was estimated using a general equation:

$$X_{Pn} = \left[\max\left(0, \min\left(\mathrm{Ni}_{\mathrm{Pn,GMX}}, \mathrm{Ni}_{\mathrm{Total}}\right)\right)\right] \cdot \frac{100}{31.12},$$

where Ni_{PnGMX} is nickel in pentlandite in recovery domain X, expressed in terms of weight percent of the whole rock, and the constant 31.12 is the average concentration of nickel in pentlandite, expressed as weight percent, that was measured during the MLA deportment study.

The absolute sulfur deportment to pentlandite is given by:

$$S_{Pn} = X_{Pn} \cdot \frac{34.31}{100},$$

where 34.31 is the concentration of sulfur in pentlandite in weight percent, measured during the MLA deportment study.

13.3.6.2 Copper Sulfides

The dominant copper sulfide minerals at Mesaba include chalcopyrite, talnakhite and cubanite. Smaller amounts of bornite, tennantite, famatinite and chalcocite were also measured by during the copper deportment study, but these phases host a relatively small portion of the total copper content. Owing to their similar chemistry, the MLA did not distinguish between chalcopyrite and talnakhite, and essentially treated them as the same mineral with a stoichiometry close to $CuFeS_2$. The chemistry of chalcopyrite is significantly different to that of cubanite. Spatial variation in the relative abundances of chalcopyrite and cubanite is of economic significance to the Project and hence important to account for in the sulfide model.

The recovery domains GM10 and GM20 are characterized by elevated copper deportment to cubanite. Stronger copper deportment to chalcopyrite characterizes the other recovery domains.

The modal abundances of chalcopyrite (X_{Ccp}) and cubanite (X_{Cbn}) for each mining block or sample, expressed as a weight percent, can be obtained using the following equations:

$$\mathrm{X}_{\mathrm{Ccp}} = \mathrm{Cu}_{\mathrm{Total}} \left[\frac{100 - \tilde{x}_{Cbn,GMX}}{100}\right] \frac{\mathrm{M}_{\mathrm{Ccp}}}{\mathrm{M}_{\mathrm{Cu}}},$$

$$\mathrm{X}_{\mathrm{Cbn}} = \mathrm{Cu}_{\mathrm{Total}} \frac{\tilde{x}_{Cbn,GMX}}{100} \frac{\mathrm{M}_{\mathrm{Cbn}}}{\mathrm{M}_{\mathrm{Cu}}},$$

where Cu_{Total} is total copper, expressed in terms of weight percent, $\tilde{x}_{Cbn,GMX}$ is the relative copper deportment to cubanite in domain GM_X, M_{Ccp} is the molar mass of chalcopyrite (183.511 g/mol), M_{Cbn} is the molar mass of cubanite (271.416 g/mol), and M_{Cu} is the molar mass of copper (63.546 g/mol).

Similarly, the sulfur deportment to each copper sulfide phase can be calculated using:

$$\mathrm{S}_{\mathrm{Ccp}} = \mathrm{Cu}_{\mathrm{Total}} \left[\frac{100 - \tilde{x}_{Cbn,GMX}}{100}\right] \left[\frac{\mathrm{M}_{\mathrm{S}}}{\mathrm{M}_{\mathrm{Cu}}}\right],$$

$$\mathrm{S}_{\mathrm{Cbn}} = \mathrm{Cu}_{\mathrm{Total}} \frac{\tilde{x}_{Cbn,GMX}}{100} \frac{\mathrm{M}_{\mathrm{S}}}{\mathrm{M}_{\mathrm{Cu}}},$$

where S_{Ccp} and S_{Cbn} are the weight percent abundances of sulfur in chalcopyrite and cubanite respectively and MS is the molar mass of sulfur (32.06 g/mol).

13.3.6.3 Pyrrhotite

Once the modal abundances for pentlandite and copper sulfides were established, the pyrrhotite abundance could be estimated using the sulfur model. In the deportment study, the best fit between whole rock geochemistry assays and calculations of whole rock geochemistry from the MLA data was achieved by assuming that most pyrrhotite takes the stochiometric form FeS, and the following equation was developed:

$$X_{Po} = \max\left(0, S_{Total} - S_{Pn} - S_{Ccp} - S_{Cbn}\right)\frac{M_{Po}}{M_S},$$

where M_{Po} is the molar mass of pyrrhotite (87.905 g/mol) and MS is the molar mass of sulfur (32.06 g/mol).

Generally, the performance of the pyrrhotite model is best at higher concentrations of sulfur and larger abundances of pyrrhotite. The poorer fit at lower abundances of pyrrhotite, particularly at abundances <0.2%, is likely to result in part from the increased analytical uncertainty on sulfur at concentrations close to the detection limit.

13.3.6.4 Model Limitations

The weight percent abundance of pentlandite, chalcopyrite, cubanite, and pyrrhotite are captured in the sub-block model discussed in Section 14.

The most significant weakness of the sulfide model is due to the relatively small number and spatial distribution of the MLA samples used in the sulfide modelling, in particular:

- The samples are confined to the westward extending “Bathtub” portion of the deposit;
- The metal deportment for domain GM40 is constrained by only 13 samples.

An expanded quantitative mineralogy and metal deportment study is recommended to produce a more comprehensive and robust sulfide model.

13.4 RECOVERY ESTIMATES

The metallurgical projections developed for the Mesaba 2021 mine plan are based on the results of these locked-cycle tests performed on composites in 2019 combined with results from previous programs of rougher and open circuit cleaner tests performed in 2014 and 2015. The results are interpreted through the geometallurgical unit identified during development of the sulfide model performed in the first half of 2021 (Weatherly, 2021).

13.4.1 Copper Concentrate

13.4.1.1 Concentrate Grade

The copper grade assumption of the copper concentrate for each geometallurgical unit is shown in Table 13-11. The grade assumption was derived from analysis of variability open circuit cleaner tests performed during the 2014–2015 SGS program.

Table 13-11: Copper Concentrate of the Copper Concentrate for each Geometallurgical Unit

Geometallurgical Unit	Concentrate Grade (%Cu)
10	24
20	23
30	29
40	29
50	29

The mass recovery to the copper concentrate is calculated using the concentrate grade, the copper head grade and the copper recovery to the copper concentrate. The nickel and precious metal grade of the copper concentrate is calculated using the mass recovery and recovery assumptions for each element.

13.4.1.2 Copper, Nickel and Precious Metal Recovery

A fixed copper recovery to the copper concentrate of 60% was used for each geometallurgical unit. The recovery of nickel and precious metals to the copper concentrate shown in Table 13-12 are averages of the recoveries achieved during the locked-cycle tests.

13.4.2 Bulk Concentrate

13.4.2.1 Concentrate Grade

A regression was developed from the locked-cycle tests to calculate the mass deportment to the bulk concentrate based on the combined copper, nickel and sulfur grade of the mineralization (Figure 13-2). The relationship captured dilution by pyrrhotite of the bulk concentrate. The grade of the bulk concentrate was subsequently calculated using the mass recovery and the recovery of the different elements.

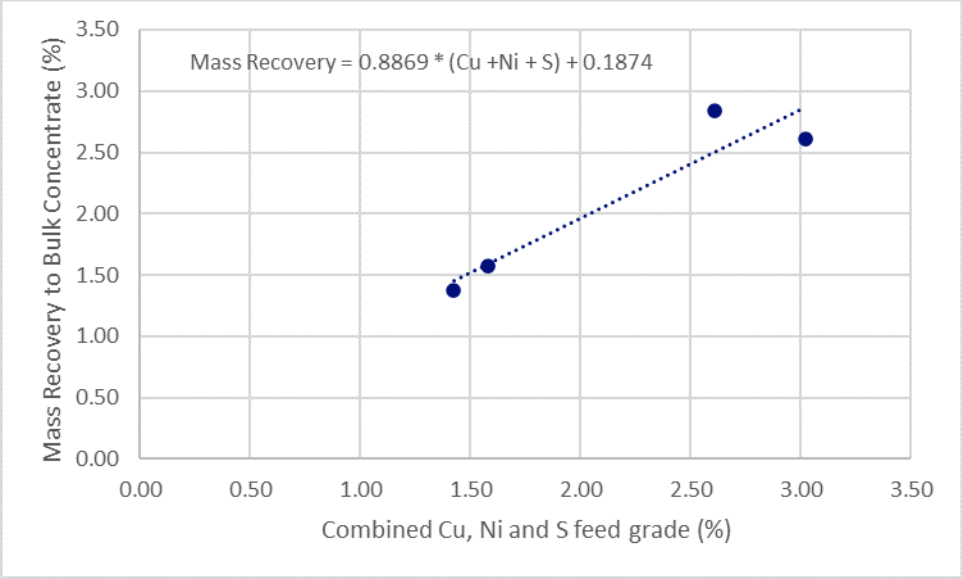
13.4.2.2 Copper Recovery

The copper recovery to the combined rougher concentrate was first calculated for the variability tests performed in the 2014–2015 program and an asymptotic equation was fitted to the dataset (SGS, 2016). A constant (3.2%) was subtracted to account for cleaner losses seen in the locked-cycle tests. The copper recovery to copper concentrate (60%) is also subtracted to calculate the copper recovery to the bulk concentrate. The resulting equation is:

$$Copper\ Recovery\ to\ Bulk\ Concentrate = 94.3\ x\ (\ 1 - e^{-14.4*Cu}) - 3.2 - 60$$

Table 13-12: Pit Optimization Parameter for Recovery to Copper Concentrate

Geometallurgical Unit ID	Cu Concentrate Recovery (%)					
	Cu	Ni	Ag	Au	Pd	Pt
All	60	4.3	38.2	50.1	18.2	11.2



Source: Figure courtesy Teck, 2022

Figure 13-2: Mass Recovery to Bulk Concentrate

The equation predicts a copper recovery ranging from 86% for material grading in the 0.2% Cu cut-off grade range and plateaus at 91.1%. and plateaus at 91.1%. The range of recovery observed in the locked-cycle tests was 89–92%.

13.4.2.3 Nickel Recovery

The nickel recovery is calculated from the sulfidic nickel content from the sulfide model developed from mineralogical work performed in 2019. The mineralogical study consisted of EPMA/SEM analysis to determine nickel deportment between sulfide and silicates. The work performed during this study demonstrated that the fraction of nickel contains in sulfide is proportional to the sulfur content of the mineralization and inversely proportional the magnesium content. The predicted nickel recovery to the bulk concentrate for blocks above the 0.2% Cu cut-off varies from 47–64% (25th to 75th percentile) which corresponds well with the range observed in the locked-cycle tests shown in Table 13-9 (43–68%).

The geometallurgical characterization identified an equation for the GM50 that determines the amount of non recoverable nickel in the mineralized zone:

$$\varphi\mathrm{NiNR} = \frac{L}{1 + \exp[-\mathrm{k}\,(\mathrm{x} - \mathrm{x0})]}$$

Where φNiNR indicates the percentage of the total nickel budget that is hosted in non-recoverable phases; L = 95.17805; k = -2.912162; x_0 = -0.4592633; and x = $\log_{10}(S_{Total})$, where S_{Total} is expressed in weight percent. The regression constants L, k and x_0 were fit using a nonlinear least squares method provided by the R programming language (R Core Team, 2020).

13.4.2.4 Cobalt and Precious Metal Recovery

The recovery assumption used for cobalt and precious metal is based on the average of the 2019 locked-cycle tests. The values are shown in Table 13-13.

Table 13-13: Pit Optimization Parameter for Recovery to Bulk Concentrate

Geometallurgical Unit ID	Cu–Ni Concentrate Recovery (%)				
	Co	Ag	Au	Pd	Pt
All	41.7	30.7	25.1	49.5	53.5

13.5 METALLURGICAL VARIABILITY

Samples selected for metallurgical testing were representative of the various styles of mineralization and were obtained from two bulk sample sites. Sufficient samples were taken, and tests were performed using sufficient sample mass for the respective tests undertaken.

Copper recovery will be subject to variability due to varying mineralization responses, and nickel recovery will be subject to variability due to presence of nickel in pyrrhotite and silicate nickel.

13.6 DELETERIOUS ELEMENTS

No elements reach penalty limits in the nickel concentrate that was produced during the test work programs.

A penalty would be payable on the copper concentrate should the nickel content exceed 0.5% Ni. Depending on market conditions, Teck would have the option of reducing copper recoveries to the copper concentrate to reduce the nickel reporting to that concentrate or could elect to maximize copper recovery and pay the penalty.

13.7 COMMENTS ON SECTION 13

Tad Crowie, QP of metallurgy, has reviewed the test work and finds it acceptable for input to the definition of the Mesaba mineral resource. Mr. Crowie's recommendations for continued metallurgical test work are included in Section 26.

14 MINERAL RESOURCE ESTIMATES

IMC assembled a conventional computer-based block model for the purpose of determining the mineral resource. IMC was provided a block model that had been assembled by Teck in 2020. That model had incorporated sub-blocking and a process called Local Variable Anisotropy (LVA) for grade estimation. Teck provided Polymet regularized block model from the sub-blocked model. The regularized model has a block size of 100 x 100 ft in plan, with a 50 ft bench height and this is the basis for assembly of the IMC block model. The regularized block model will be referred to as the Teck_2020 model within this text.

IMC used the following attributes from the Tech 2020 model:

- The lithology model and codes,
- The geometallurgy model and codes (used for metal recovery calculations),
- The specific gravity model used by IMC to calculate tons per model block.

14.1 MODEL LOCATION

The block size and location of the Teck_2020 model and the corresponding IMC block model is summarized in Table 14-1. The coordinate system for the Mesaba project is the NAD 1983 UTM Zone 15 N.

Table 14-1: Block Model Location

Model Location	From Coordinate	To Coordinate	Number of Blocks
Easting Limit	17,306,000	17,324,000	180
Northing Limit	1,902,000	1,923,000	210
Elevation Limits	-2,300	2,200	90
Block Size			100 x 100 x 50 ft

Coordinates are the Outside Edges of the Blocks

14.2 GEOLOGIC MODELLING

The Mesaba Project deposits are classified as contact-type magmatic Ni–Cu–PGE deposits, which are a broad group of deposits containing Ni, Cu, and PGEs, occurring as sulfide concentrations associated with a variety of mafic and ultramafic magmatic rocks. The magmas originate in the upper mantle and contain small amounts of Ni, Cu, PGE, and variable but minor amounts of sulfur. The magmas ascend through the crust and cool as they encounter cooler crustal rocks. If the original sulfur content of the magma is sufficient, or if sulfur is added by assimilation of crustal wall rocks, a separate sulfide liquid forms as droplets dispersed throughout the magma.

Mineralization within the Mesaba project area is hosted within rocks of the Partridge River and Bathtub intrusions. The intrusions have been subdivided into sub-units based on rock type, texture, and the presence of basal ultramafic layers. Teck had adopted this interpreted geologic framework until recently, when a new geochemical classification system was used to define the lithologic units of the Bathtub Intrusion.

During 2020, Teck utilized a new approach to lithological modelling for the Mesaba deposit. This new lithological classification scheme aimed to produce a more quantitative modelling framework, relying on an extensive database of four-acid geochemical analyses. A new dataset for lith modelling at Mesaba using major element geochemistry was developed using 59,000 samples from across the deposit. For the benefit of modelling, the geochemical data was clustered into discrete groups of similar geochemistry. The principal component indexes that were developed, link major element chemistry to silicate mineralogy based on calcium and magnesium.

Wireframes used in the 2020 resource model were constructed in Leapfrog GEO software (version 6.0.4, with final product upgraded to 2021.1.3) using implicit modeling techniques including surfaces, intrusion, and vein tools to achieve the interpreted geological continuity. Use of polylines and additional control points was minimized but were incorporated into the model as needed to reflect geological contacts observed or interpreted at surface and to guide the geological interpretation in areas of sparse data density. The lithology block model resulting from the lithology wireframes was used by IMC. All models were snapped to drill hole contacts. Default resolution was set to 50 ft (15 m), although some narrow or complex intervals were set to lower resolution (e.g. 10 ft (3 m) for unmineralized xenoliths).

14.2.1.1 Input Data

The drill data used to update the MES202006 geological model were imported as CSV files from an acQuire database and reflect logged interpretation and geochemical lithological classification and assay data as of June 10, 2020.

The original assay intervals commonly contained shorter intervals of two or more lithology codes, and to ensure that assays would not be split while modeling the estimation domains, the majority code was determined for each assay interval.

14.2.1.2 Geological Model

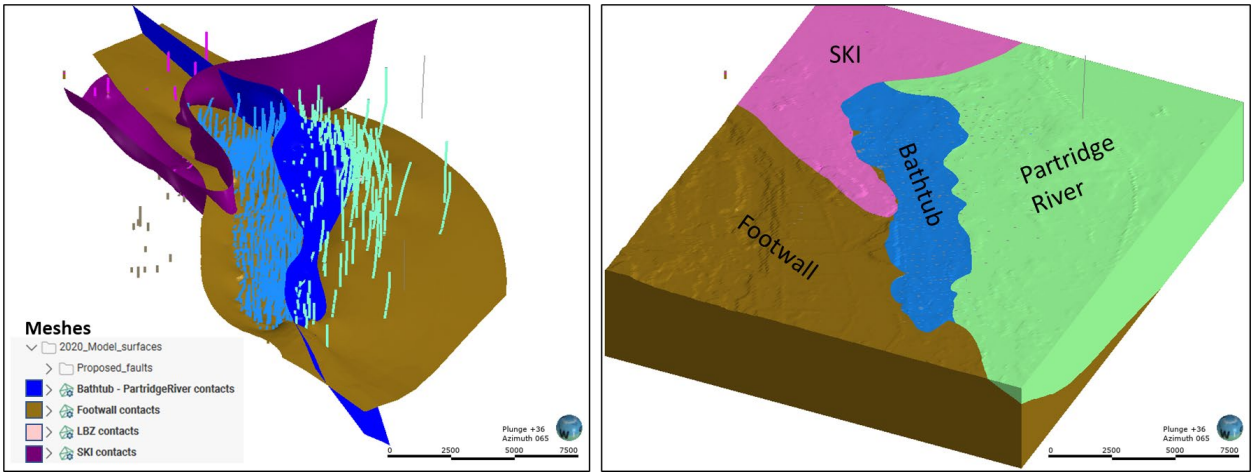
An implicit, 3D, geological model was created using interval selections which were informed by logged lithology codes combined with geochemical clusters defined by Weatherley (2020) using spectral cluster analysis and wavelet tessellation.

The deposit area was subdivided into four major 'blocks' (Figure 14-1) representing:

- Footwall sequence;
- Bathtub Intrusion;
- Partridge River Intrusion;
- South Kawishiwi Intrusion.

Sub-lithologies were modeled into each block as required (Table 14-2).

Surfaces were generated and applied in the lithology and estimation domain models as faux "faults" to separate the major areas in the master lithological model. An additional surface was created as an administrative boundary to constrain high-grade massive sulfides associated with the Local Boy mineralization (Figure 14-2), which was applied in the estimation domain model only. The geological model was evaluated internally by back-flagging the final 3D solid meshes onto the drill traces and comparing the modelled results to the interval selection codes. The statistical results of over 95% are considered to be very good.



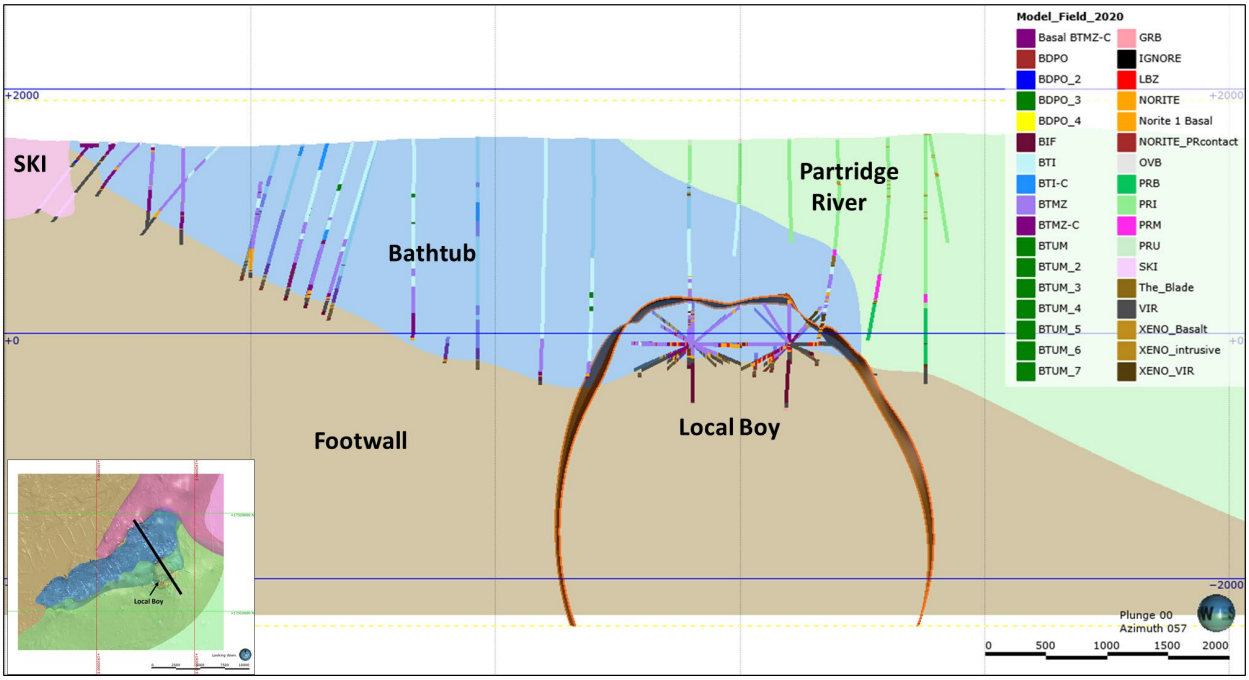
Source: Figure courtesy Teck, 2022

Figure 14-1: Modelled Lithologies

Table 14-2: Modelled Sub-lithologies

Major Block	Sub-lithology	Comment
Footwall	Giants Range Batholith (GRB) Biwabik Iron Formation (BIF) Virginia Formation (VIR)	Various logged sub-units located within the BIF and VIR were not discretely modeled. The upper contacts of the GRB and the BIF were modeled using the deposit surface tool. A pyrrhotite-rich unit within the VIR, the BDPO, has been modeled separately as it has potential geometallurgical and environmental implications. This unit was created in a separate geologic model using the vein tool and incorporated into both the lithology and mineralization models.
Bathtub intrusion	NORITE, BTMZ-C, BTMZ, BTI less continuous intervals of BTI-C and BTUM	An additional interval selection field was created to broadly define the location of basal Norite, and the boundary between the BTMZ and BTI, to provide a background lithology onto which the less continuous lithology could be modeled. The top of the basal Norite unit was created using the deposit surface tool. The contact between the background BTMZ and BTI was created using an erosion surface. BTMC-C, remaining BTMZ, BTI-C, LBZ, and remaining NORITE, were modeled using the intrusion tool. The BTUM lithology was modeled using the vein system tool.
Partridge River Intrusion	basal Norite, PRB, PRI, LBZ, PRU	Modeled as a broadly layered sequence. A background group of PRB, and background group of PRI were coded to define the contacts between these main lithologic units. Remaining PRB, NORITE, and LBZ intervals were modeled using the intrusion tool. PRU is a thin, discontinuous unit in the upper portion of the intrusion, restricted to the area above Local Boy, and was modeled using the vein tool. The PRM was modeled in a separate geologic model in Leapfrog that was not constrained by the major unit boundaries, and brought into the final lithology model, crossing a short distance locally into the Bathtub intrusion.

Major Block	Sub-lithology	Comment
	Xenoliths	Unmineralized xenoliths (XENO <0.27% Cu) were also modeled using the intrusion tool and a resolution of 10 feet to capture even fairly small rafts of Virginia formation within the intrusions and to exclude them from the estimation domains. Xenoliths were subdivided into XENO_VIR (where the associated lithology logging code indicated Virginia formation) and XENO_Basalt (where associated logging code was BSLT). These were brought into the lithology and mineralization models using the intrusion – 'create from surface' tool. A number of XENO_VIR intervals along the boundary between the Bathtub and Partridge River intrusions appear to line up as a continuous sheet or slab. This has been referred to as "the blade" and was modeled using the vein tool to capture its continuity. The final output was brought into each of the four boundary blocks using the intrusion – 'create from surface' tool.
	Overburden	Modeled as an erosion surface to ensure that the unit was not impacted by false boundary artifacts. The final output was brought into each of the four boundary blocks using the intrusion – 'create from surface' tool.



Source: Figure courtesy Teck, 2022; View looking northeast.

Figure 14-2: Local Boy Mineralization

Teck created a grade estimation model which sub-divided or overprinted the lithology model for the purposes of segregating higher and lower grade zones. IMC used this model for some of its early statistical review of the drill hole data base. The grade estimation model included the following units.

The Local Boy mineralization, located at the base of the Bathtub intrusion, is characterized by higher metal grades associated with greater accumulations of semi-massive to massive sulphides than elsewhere in the deposit. This zone was separately modelled to constrain higher grades for statistical and estimation purposes. An intrusion modeling tool was used, restricted to the area above the footwall contact and bound by the Local Boy boundary surface.

The PRM lithological unit is defined primarily on the basis of its elevated metal content, particularly in PGE elements, and formed a discrete estimation domain.

The xenolith model output was imported directly into the mineralization model as an intrusion created from surfaces to overprint the mineralization models and remove the xenolith volumes from the estimation domain.

The bedded pyrrhotite-rich unit within the footwall sequence was used as an estimation domain to constrain the sulphur estimate. Although the unit contains little copper, it is important to constrain the distribution of sulfur for characterization of waste rock material and to understand where pyrrhotite is concentrated.

The Teck_2020 block model contains codes for the basic lithology and sub-lith groups based on the geochemical interpretation. IMC has utilized the Teck_2020 lithology interpretation within this resource model. Table 14-3 summarizes the list of rock lithologies that have been coded into the block model.

In addition to the lithology coding, there are additional estimation domains that reflect mineralization or alteration overprints. The most important of those domains are the Bedded Pyrrhotite zone and an area referred to as the Local Boy Zone.

Table 14-3: Resource Model Lithology

Model Code	Abbreviation	Description
110	VIR	Virginia Formation
120	BDPO	Bedded Pyrrhotite
130	BIF	Biwabik Iron Formation
140	GRB	Giants Range Batholith
210	NOR	Norite
220	BTMZ	Bathtub Intrusion Mineralized Zone
230	BTMZC	Bathtub Intrusion Mineralized Zone - Contaminated
240	BTI	Bathtub Intrusion
250	BTIC	Bathtub Intrusion - Contaminated
260	BTUM	Bathtub Ultramafics
270	LBZ	Local Boy Ore Zone
310	PRB	Partridge River Intrusion - Basal Unit
320	PRI	Partridge River Intrusion
330	PRM	Partridge River Intrusion - Middle Mineralized Horizon
340	PRU	Partridge River Intrusion - Upper Mineralized Horizon
400	SKI	South Kawishiwi Intrusion
910	XenoC	Xenoliths of Virginia Formation
920	XenoB	Xenoliths of Basalt
999	OVB	Overburden

14.3 DATA BASE AND ASSAY CAPS

The drill hole data base was provided to IMC by Polymet. IMC completed a review of the QAQC and spot-checked assay certificates against the data as summarized in Sections 11 and 12 and deemed it acceptable for use to generate a mineral resource estimate. The Teck_2020 model that was provided to IMC was coded with the Teck estimation domains. As a starting point, IMC back assigned the block model estimation domains from the block model to the

assay data base. IMC calculated the assay count and mean grade within those domains to begin to understand the grade distribution of the deposit.

Within each Teck domain, IMC prepared cumulative frequency plots for the assays for each of the metals of interest. The cumulative frequency plots were used to establish cap levels on assays for each metal within each of the Teck domains. Table 14-4 summarizes the base statistics for each metal for each domain, and the cap value and number of assays capped prior to compositing and block grade estimation.

Within the data base there were numerous intervals, where metal assays were reported as -9, which is typically interpreted as “no assay”. A review of internal Teck reports and of the resulting work indicates that these intervals were likely intended as “trace” or below detection limit.

Copper, nickel, and sulfur were nearly completely assayed, however, many of the accessory metals, particularly Cobalt, were substantially under assayed relative to copper. Table 14-4 has removed the -9 values from the calculation of sample count and mean grade. The impact is particularly obvious in the Cobalt assays for the Local Boy Zone.

Treatment of the unassayed intervals during block grade estimation will be addressed later in this section.

Table 14-4: Assay Count, Mean, and Cap Value Based on Tech Estimation Domains

Teck	Copper %				Total Nickel %				Cobalt PPM				Platimum PPM				Paladium PPM				Gold PPM				Silver PPM				Sulfur % PPM			
Initial Domain Code	Number of Assays	Mean of Assays	Grade Cap Level	Number Assays Capped	Number of Assays	Mean of Assays	Grade Cap Level	Number Assays Capped	Number of Assays	Mean of Assays	Grade Cap Level	Number Assays Capped	Number of Assays	Mean of Assays	Grade Cap Level	Number Assays Capped	Number of Assays	Mean of Assays	Grade Cap Level	Number Assays Capped	Number of Assays	Mean of Assays	Grade Cap Level	Number Assays Capped	Number of Assays	Mean of Assays	Grade Cap Level	Number Assays Capped	Number of Assays	Mean of Assays	Grade Cap Level	Number Assays Capped
0	205	0.275	1.30	2	205	0.073	0.30	2	204	84.6	200	1	202	0.025	NA		202	0.057	0.70	2	202	0.021	NA	0	203	1.191	5.00	1	205	0.632	3.00	1
10	11,988	0.544	5.00	6	11,955	0.126	2.00	2	10,346	116.0	1,500	1	9,155	0.040	2.00	2	9,155	0.107	2.00	3	9,154	0.035	1.00	2	10,336	1.937	30.00	3	11,980	1.566	NA	
20	5,075	0.402	2.00	3	5,054	0.099	1.00	3	4,479	98.5	1,000	1	4,083	0.050	1.00	1	4,083	0.138	2.00	1	4,083	0.036	NA		4,481	1.514	40.00	3	5,071	0.794	10.00	4
30	1,640	0.343	1.30	8	1,640	0.091	0.40	1	1,488	95.7	300	1	1,424	0.056	NA		1,424	0.171	2.00	2	1,424	0.037	NA		1,488	1.285	7.00	2	1,640	0.641	10.00	1
40	621	0.252	1.30	1	621	0.072	NA		614	87.8	NA		556	0.051	NA		556	0.137	NA		556	0.033	1.00	1	614	1.005	5.00	2	621	0.510	NA	
60	2,092	0.359	1.50	5	2,092	0.094	1.00	1	1,335	82.0	500	3	1,315	0.068	0.50	2	1,316	0.246	2.00	2	1,314	0.038	1.00	1	1,334	1.345	10.00	2	2,089	0.897	10.00	5
70	252	0.196	NA		252	0.065	0.20	1	222	74.1	160	1	212	0.056	1.00	1	212	0.162	2.00	2	212	0.029	0.20	2	222	0.910	3.00	4	252	0.426	NA	
80	1,199	0.347	1.30	3	1,199	0.092	0.50	1	1,040	79.3	175	1	1,134	0.099	NA		1,134	0.324	NA		1,134	0.053	1.00	1	1,040	1.339	6.00	1	1,199	0.614	4.00	1
90	16	0.471	3.00	1	16	0.139	1.00	1	16	134.9	150	1	10	0.011	NA		10	0.033	NA	0	10	0.017	NA		16	1.076	2.00	2	16	3.366	10.00	1
95	570	0.092	2.00	1	570	0.032	0.50	1	505	42.1	400	1	443	0.006	0.10	1	443	0.013	0.20	1	443	0.010	NA		505	1.126	5.00	2	562	3.501	10.00	2
100	5,385	0.954	20.00	2	5,385	0.197	3.00	4	31	145.5	300	1	4,091	0.054	2.00	4	4,150	0.174	10.00	1	4,131	0.054	3.00	4	1,009	3.413	30.00	3	5,385	2.702	NA	
900	1,282	0.110	1.30	3	1,280	0.033	0.50	3	1,086	49.3	600	2	1,157	0.011	NA		1,157	0.026	NA		1,157	0.011	NA		1,065	0.641	10.00	2	1,276	1.005	10.00	1
901	177	0.062	NA		177	0.030	NA	0	177	61.5	150	1	161	0.017	NA		161	0.035	NA		161	0.007	NA		177	1.267	NA		176	0.168	2.00	1
1010	3,046	0.216	7.00	7	3,045	0.054	2.00	1	2,408	55.4	1,000	4	2,667	0.009	0.50	2	2,677	0.027	2.00	1	2,673	0.013	3.00	2	2,442	0.882	30.00	1	3,040	1.182	30.00	4
1011	22	0.221	NA		22	0.056	NA		11.00	22.9	50	2	11.00	0.016	NA		11.00	0.040	NA		11.00	0.014	NA		11.00	0.574	2.50	1	22	0.766	2.00	2
1012	412	0.157	3.00	2	410	0.049	0.70	3	288	54.3	600	2	302	0.010	0.20	1	302	0.018	NA		302	0.012	1.00	1	290	0.592	5.00	1	370	0.812	10.00	4
1020	33,702	0.107	19.00	3	33,706	0.044	3.00	3	31,411	71.5	1,000	4	31,230	0.017	2.00	3	31,236	0.041	NA		31,227	0.012	1.00	5	30,985	0.696	30.00	5	33,715	0.252	30.00	2
1030	8,784	0.083	3.00	3	8,782	0.038	1.00	1	7,809	59.4	700	2	8,201	0.023	1.00	1	8,205	0.061	3.00	2	8,202	0.012	0.70	1	7,788	0.984	10.00	2	8,781	0.239	10.00	5
1040	866	0.138	1.30	3	853	0.050	NA		473	63.8	200	1	549	0.009	NA		549	0.018	NA		549	0.010	NA		462	0.585	5.00	1	800	0.652	NA	

Domains 10-60 Norite and Bathtub Units 95 Banded Pyrrhotite 900-901 Xenoliths
70-80 Partridge River 100 Local Boy

14.4 COMPOSITING

IMC calculated 50 ft down hole composites. This is a traditional approach where the composite length is set equal to the bench height of the block model. The IMC composites were bounded by the lithology codes that were assigned to the assay intervals, based on the back assignment from the block model.

The IMC method adjusts the composite length slightly within each lithology, so that there are no short composites at the end of a lithology composite run. For example, if the down hole intercept of Norite was 421 ft in a specific hole, the composite length in the Norite in that drill hole would be adjusted to 52.625 ft, so that there would be 8 composites, no stub or short composites to deal with. The resulting lengths are so close to the 50ft target, that the change of support during estimation can be ignored.

Table 14-5 summarizes the average grade of the composites for each metal within the lithology codes that were summarized on Table 14-4.

Table 14-5: Composite Results by Interpreted Lithology

Model		Copper		Tot Nickel %		Cobalt ppm		Platinum ppm		Paladium ppm		Gold ppm		Silver ppm		Sulfur %	
Code	Abbrev	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean
110	VIR	651	0.255	651	0.060	441	49.85	567	0.013	571	0.034	569	0.013	471	0.99	651	1.20
120	BDPO	112	0.104	112	0.032	102	44.12	86	0.007	86	0.018	86	0.010	102	1.17	112	3.41
130	BIF	98	0.128	98	0.040	66	44.63	69	0.007	69	0.013	69	0.007	66	0.52	66	0.56
140	GRB	5	0.240	5	0.065	3	25.81	3	5.194	3	0.127	3	0.034	3	1.04	5	0.72
210	NOR	1,169	0.480	1,169	0.101	688	91.89	991	0.027	992	0.083	992	0.030	790	1.64	1,169	1.68
220	BTMZ	2,875	0.435	2,873	0.105	1,919	95.32	2,255	0.046	2,256	0.128	2,256	0.034	1,966	1.38	2,874	0.95
230	BTMZC	950	0.492	950	0.112	776	108.54	761	0.032	761	0.086	760	0.029	791	1.73	951	1.42
240	BTI	3,224	0.080	3,224	0.040	3,020	68.57	2,994	0.018	2,994	0.042	2,994	0.011	2,943	0.70	3,224	0.15
250	BTIC	599	0.076	599	0.031	598	64.48	587	1.061	587	0.024	587	0.007	597	0.75	599	0.17
260	BTUM	221	0.107	221	0.077	219	106.36	219	0.019	219	0.044	219	0.012	219	0.64	221	0.19
270	LBZ	54	2.318	54	0.536	0		51	0.059	51	0.305	51	0.052	39	4.80	54	7.87
310	PRB	629	0.269	628	0.073	371	73.57	434	0.052	435	0.175	435	0.028	377	1.12	628	0.65
320	PRI	1,054	0.058	1,054	0.036	993	59.87	1,017	0.021	1,017	0.051	1,017	0.105	993	0.97	1,052	0.15
330	PRM	184	0.354	184	0.092	154	79.54	173	0.098	173	0.328	173	0.053	154	0.13	184	0.62
340	PRU	10	0.185	10	0.062	9	71.45	9	0.111	9	0.318	9	0.057	9	1.54	10	0.30
400	SKI	172	0.134	167	0.049	89	60.45	104	0.008	104	0.016	104	0.009	87	0.55	161	0.62
910	XenoC	300	0.158	300	0.039	196	49.84	270	0.011	270	0.031	270	0.012	200	0.75	300	1.11
920	XenoB	33	0.065	33	0.031	32	60.84	29	0.016	29	0.033	29	0.007	32	1.22	33	0.17
999	OVB	87	0.152	87	0.055	84	77.74	81	0.026	81	0.062	81	0.016	84	0.91	86	0.53

14.5 ESTIMATION DOMAINS BY BOUNDARY ANALYSIS

IMC completed a thorough boundary analysis for all of the metals for each of the lith types and the two selected estimation over prints. The overprints over the lith interpretation were the Pyrrhotite zone and the Local Boy zone. Those zones over print the interpreted rock type boundaries but illustrated substantial differences in grade distribution from the host lithology type.

Boundary analysis searches for pairs of composites that are on opposite sides of interpreted boundaries. The search for those paired composites is established within a set of specific sample pair spacings. Most of the IMC boundary pairings were completed at spacings less than 50 ft, which is equal to ½ of the block size in plan.

Once the pairs are established, the means of the first lith type area compared against the mean of the neighboring boundary lith type at the maximum spacing of 50 ft. In addition to a comparison of the two population means, a set of hypothesis tests are completed to provide a numeric measure of the similarity, or difference of the two populations. The two primary hypothesis tests that are applied, are the T-Statistic on the population means, and a Pair-T statistic that compares the differences between the paired data. IMC typically accepts that the population boundary can be

treated as a soft bound during estimation, if there is a 95% confidence that the two paired data sets are similar distributions.

As noted, each rock type along with the two overprint zones were analyzed in detail for each metal. It is interesting that most of the metals share the same boundary response when there is sufficient data to be meaningful. Table 14-6 summarizes the results, which indicates the lith codes and overprint types that represent grade populations at Mesaba. The result of this work is a revised set of population domains that IMC has used in block grade estimation.

One should note that the boundary analysis and hypothesis tests indicate that Norite (code 210) could be combined with the other high grade Bathtub intrusion units (220 and 230). After review of these results with Polymet staff, the Norite was broken out into a separate domain with hard boundaries in order to reflect the higher-grade sulfur and parallel the metallurgical modeling of the deposit. The IMC work indicates that the borders of Norite versus the other high grade Bathtub units is actually a transitional boundary. However, treating it as a hard boundary during estimation did not have a major impact on the results from block grade estimation.

Table 14-6: IMC Estimation Domains with Composite Grades

IMC Est	Combined	Copper		Tot Nickel %		Cobalt ppm		Platinum ppm		Paladium ppm		Gold ppm		Silver ppm		Sulfur %	
Domain	Lith or Alt	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean	Count	Mean
110	Virginia Formation	611	0.176	611	0.046	441	49.85	529	0.009	533	0.025	531	0.011	455	0.87	611	1.03
130	Biwabik Iron Formation	98	0.128	98	0.040	66	44.63	69	0.007	69	0.013	69	0.007	66	0.52	92	0.64
140	Giants Range Batholith	5	0.240	5	0.065	3	25.81	3	0.052	3	0.127	3	0.034	3	5.00	5	0.72
200	Bathtub Intrusion, High Grade	3,168	0.401	3,166	0.097	2,688	98.98	2,510	0.042	2,511	0.112	2,511	0.031	2,688	1.46	3,168	0.89
210	Norite	891	0.326	891	0.078	686	92.01	739	0.020	740	0.055	740	0.020	690	1.37	891	1.34
250	Bathtub intrusion LG & Mafics	4,044	0.081	4,044	0.041	3,837	70.09	3,800	0.017	3,800	0.039	3,800	0.011	3,759	0.71	4,044	0.15
310	Partridge Intrusion Basal Unit	604	0.266	604	0.073	371	73.57	415	0.051	416	0.174	416	0.027	372	1.11	604	0.63
320	Partridge Intrusion	1,054	0.058	1,054	0.036	993	59.87	1,017	0.021	1,017	0.051	1,017	0.011	993	0.97	1,052	0.15
330	Partridge Intrusion - Middle	184	0.354	184	0.092	154	79.54	173	0.098	173	0.328	173	0.053	154	1.31	184	0.62
340	Partridge Intrusion - Upper	10	0.185	10	0.062	9	71.45	9	0.111	9	0.318	9	0.057	9	1.54	10	0.30
400	South Kawishiwi Intrusion	172	0.134	167	0.049	89	60.45	104	0.008	104	1.637	104	0.009	87	0.55	161	0.62
910	Xenoliths of Virginia Formation	295	0.147	295	0.038	196	49.84	268	0.011	268	0.031	268	0.012	199	0.74	295	1.10
920	Xenoliths of Basalt	33	0.065	33	0.031	32	60.84	29	0.016	29	0.033	29	0.007	32	1.22	33	0.17
100	Local Boy Overprint	1,056	0.865	1,056	0.183	7	156.30	866	0.049	866	0.162	865	0.047	228	3.46	1,056	2.49
95	Pyrrhotite Overprint	114	0.104	114	0.032	104	44.29	88	0.007	88	0.018	88	0.010	104	1.16	114	3.41

14.6 VARIOGRAPHY

IMC completed a series of variograms using both the Teck_2022 estimation domains and the IMC estimation domains. The search parameters used by Teck were generally confirmed. Figure 14-3 illustrates example IMC variogram results on the irregular 50 ft composites within the IMC estimation domain for the Bathtub high grade zone (IMC domain = 200).

The 1000 x 600 ft search is generally confirmed. One should note the first range break in the 235 bearing variogram at around 500 ft. That indicates there is additional variability occurring in the 0 to 500 ft distance which would not be explained by the global variogram. This result was kept in mind when the model classification was established and reported later in this section.

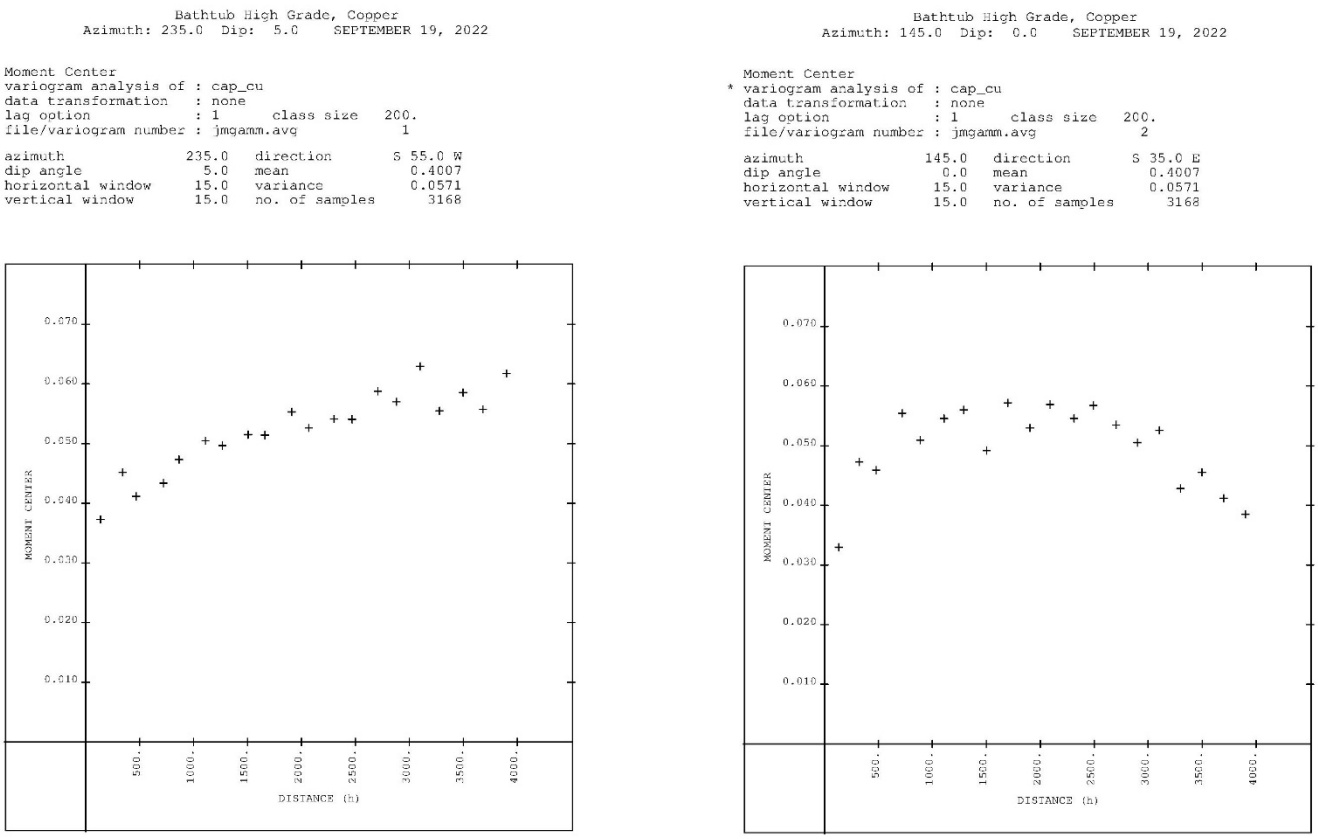


Figure 14-3: Example Copper Variograms, IMC Domain 200, Bathtub High Grade

14.7 BLOCK GRADE ESTIMATION

Block grade estimation was completed using conventional inverse distance squared methods. The method was selected to assure that the block estimates followed the local composite grade estimates within minimal over smoothing or "smearing" of the composite grades.

Each of the domains described in the previous sections was treated as an independent population with hard boundaries, meaning that composite domain codes were required to match the block domain codes during block grade estimation.

The large number of unassayed intervals in the accessory metals created a unique challenge for grade estimation. Previous work by Teck assigned a trace assay to intervals coded in the data base as -9.0. That decision by Teck indicates that the samples were not assayed because they were expected to be low, near zero grade.

IMC used an alternative approach, which did not incorporate the trace values into the average block grade estimate.

- An indicator variable was added to the composite file.
- The indicator variable was coded with a 1.0 if the composite value was greater than 0.0.
- The indicator variable was coded with a 0.0 if the composite value was less than or equal to 0.0. This included the -9 values.
- The above process was established for every metal being estimated.
- A nearest neighbor block estimate was completed for each metal using the indicator variable composites as the input parameters.

- If the nearest neighbor was block result equal to 1.0, the block was assumed to be mineralized and its grade was later estimated by inverse distance methods using the composite values where the indicator variable was set to 1.0.
- Block grade estimates were not completed using inverse distance if the nearest neighbor result was 0.0.

The above procedure assigned assayed composite grade to model blocks that were inside the inverse distance search radius and halfway to a composite that was not assayed. No grade was assigned to the unassayed areas, so they were assumed to have zero grade.

The IMC process maintains the actual composite grades for the blocks that surround the valued composites. The number of estimated blocks is reduced compared to the Teck procedure, but the grade of the IMC blocks is not diluted by assigned trace values from the unassayed areas.

Table 14-7 summarizes the estimation method applied to all metals except magnesium. Estimates for magnesium (Mg) were different than those applied to the other metals. The primary difference was that the lithology domains outlined earlier were used as grade estimation boundaries, rather than the IMC estimation domains. The inverse distance method was applied, limited by the nearest neighbor procedure summarized above.

Table 14-7: Block Grade Estimation Parameters

IMC Est Domain	Combined Lith or Alt	Use Composites	Nearest Neighbor Bound	Grade Esimate	Search Orientation			Composites Count		
					Primary Bearing/Plunge	Secondary Bearing/Plunge	Perp Bearing/Plunge	Max	Min	Max/Hole
110	Virginia Formation	110	Yes	1/D2	235/5	145/0	55/85	10	1	3
130	Biwabik Iron Formation	130	Yes	1/D2	235/5	145/0	55/85	10	1	3
140	Giants Range Batholith	140	Yes	1/D2	235/5	145/0	55/85	10	1	3
200	Bathtub Intrusion, High Grade	200	Yes	1/D2	235/5	145/0	55/85	10	1	3
210	Norite	210	Yes	1/D2	235/5	145/0	55/85	10	1	3
250	Bathtub intrusion LG & Mafics	250	Yes	1/D2	235/5	145/0	55/85	10	1	3
310	Partridge Intrusion Basal Unit	310	Yes	1/D2	235/5	145/0	55/85	10	1	3
320	Partridge Intrusion	320	Yes	1/D2	235/5	145/0	55/85	10	1	3
330	Partridge Intrusion - Middle	330	Yes	1/D2	235/5	145/0	55/85	10	1	3
340	Partridge Intrusion - Upper	340	Yes	1/D2	235/5	145/0	55/85	10	1	3
400	South Kawishiwi Intrusion	400	Yes	1/D2	235/5	145/0	55/85	10	1	3
910	Xenoliths of Virginia Formation	910	Yes	1/D2	235/5	145/0	55/85	10	1	3
920	Xenoliths of Basalt	920	Yes	1/D2	235/5	145/0	55/85	10	1	3
100	Local Boy Overprint	100	Yes	1/D2	235/5	145/0	55/85	10	1	3
95	Pyrrhotite Overprint	95	Yes	1/D2	235/5	145/0	55/85	10	1	3

14.7.1 Density Assignment

The Teck_2022 block bulk density estimate was utilized by IMC without modification. Teck reports that there were 53,789 density samples evaluated by the Archimedes method. Those were used to assign block density using an inverse distance method within each rock type. Blocks that were not estimated were assigned default average values.

14.8 CLASSIFICATION

Block grades were classified into measured, indicated, and inferred categories based on the number of composites used to estimate the block, and the distance to the closest composite during the block grade estimate. The estimation counts and distances for copper were used for this process.

The procedure was as follows:

> If any of the metals assigned by inverse distance are estimated, then
> imc_class = 3 Inferred
>
> If imc_cu_num > = 7.0 (3 holes) and imc_cu_cdist < 500 ft then
> imc_class = 2 Indicated
>
> If imc_cu_num = 10 (4 holes) and imc_cu_cdist < 90 ft then
> imc_class = 1 Measured

Where:

> imc_cu_num = number of composites used in the estimate and
> imc_cu_cdist = the distance to the closest composite.

The process above overprints indicated over inferred and measured over both indicated and inferred where appropriate during the class assignment process.

14.9 MODEL VALIDATION

14.9.1 Smear Check

IMC completed bias checks where the mean grade of composites was compared against the mean grade of the estimated blocks within the same domain. In addition, IMC expands that check into a process referred to internally as the “smear check.”

The procedure is as follows:

- A range of cutoff grades are selected for the check process. Typically, they bracket the potential planning cutoff grades.
- For each cutoff grade being tested, the blocks above cutoff are identified.
- All composites contained within those blocks are identified.
- The average grade of the composites and blocks are tabulated.
- The percentage of the contained composites less than cutoff are calculated.

Table 14-8 summarizes the results for copper within the major grade bearing domains. The test results are positive. In all cases, the model grade is properly less than the grade of the contained composites, because the model block grade estimation utilizes composite data that is located outside of the shape being tested. If the model grades were higher than the grade of the contained composites, there would be indication of high bias within the model.

The percentage of composites less than the tested cutoff is generally small in the range of applicable cutoff grades. Percentages in the range of 15% are typical for well-zoned deposits. The values less than 10% indicate that the model has done a reasonable job of following the local data. The higher percentage levels in the high-grade ranges are typical of the smoothing process that result in any grade estimator.

The low percentage of contained low grade composites within the Bathtub high grade domain (200), indicates that the inverse distance method is respecting the local composites, and should provide a better mine planning tool than methods with a higher degree of smoothing.

Table 14-8: IMC Smear Check for Bias and Grade Smoothing (block variance)

Domain 200, Bathtub High Grade

Cutoff Grade	% of Comps Less Than Cutoff	Total Comps in Shape	Mean Composite Grade %	Number of Blocks in Shape	Mean Block Grade %
0.100	4.42	3,779	0.407	58,070	0.392
0.200	5.97	3,200	0.457	51,251	0.423
0.400	5.64	1,667	0.611	24,633	0.552
0.500	4.89	1,083	0.697	14,305	0.629
0.600	4.13	629	0.790	7,203	0.710
0.800	4.35	184	0.989	1,089	0.906
1.000	2.50	40	1.235	165	1.135

Domain 250, Bathtub Low Grade

Cutoff Grade	% of Comps Less Than Cutoff	Total Comps in Shape	Mean Composite Grade %	Number of Blocks in Shape	Mean Block Grade %
0.100	4.61	1,042	0.196	17,990	0.152
0.200	1.78	337	0.303	2,465	0.258
0.400	0.00	33	0.542	116	0.491

Domain 95, Pyrrhotite Zone

Cutoff Grade	% of Comps Less Than Cutoff	Total Comps in Shape	Mean Composite Grade %	Number of Blocks in Shape	Mean Block Grade %
0.100	5.26	19	0.301	237	0.200
0.200	0.00	10	0.415	82	0.308
0.400	0.00	5	0.567	18	0.499
0.500	0.00	3	0.606	8	0.565

Domain 100, Local Boy Zone

Cutoff Grade	% of Comps Less Than Cutoff	Total Comps in Shape	Mean Composite Grade %	Number of Blocks in Shape	Mean Block Grade %
0.100	2.09	1,053	0.863	2,017	0.716
0.200	6.09	1,051	0.865	2,014	0.716
0.400	15.98	976	0.906	1,915	0.735
0.500	18.25	871	0.967	1,603	0.789
0.600	20.88	728	1.052	1,184	0.874
0.800	29.78	403	1.325	498	1.122
1.000	34.91	232	1.659	201	1.494

Domain 110, Virginia Formation

Cutoff Grade	% of Comps Less Than Cutoff	Total Comps in Shape	Mean Composite Grade %	Number of Blocks in Shape	Mean Block Grade %
0.100	18.85	244	0.377	3,738	0.250
0.200	20.48	166	0.496	1,673	0.383
0.400	22.37	76	0.760	513	0.607
0.500	22.92	48	0.924	308	0.712
0.600	24.39	41	0.970	207	0.795
0.800	21.74	23	1.191	86	0.949
1.000	12.50	8	1.429	20	1.176

Domains 310,320,330,340 Combined Partridge River

Cutoff Grade	% of Comps Less Than Cutoff	Total Comps in Shape	Mean Composite Grade %	Number of Blocks in Shape	Mean Block Grade %
0.100	2.15	883	0.290	54,710	0.262
0.200	2.23	539	0.380	31,057	0.353
0.400	2.14	187	0.557	9,153	0.515
0.500	0.00	105	0.640	4,047	0.605
0.600	2.13	47	0.744	1,674	0.690

14.9.2 Swath Plots

Horizontal swath plots have been completed for the major grade bearing domains. Figure 14-4 and Figure 14-5 illustrate the average grades of copper and nickel composites, versus model blocks within the Bathtub high-grade domain (200). There has been no effort to de-cluster the composites on the plots. The horizontal swaths are 150 ft high.

The plots indicate that the model block grades are somewhat low biased in the elevation range of 700 ft down to sea level. The number of blocks estimated becomes somewhat smaller in that elevation range and de-clustering of the composite data would likely bring the two lines closer together.

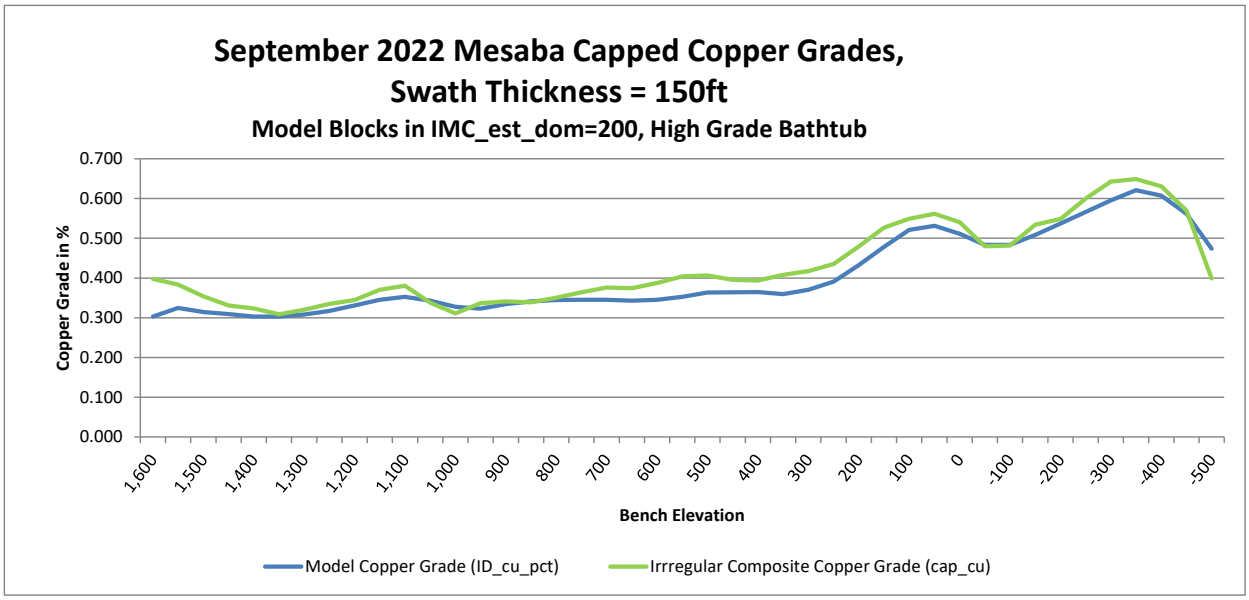


Figure 14-4: Horizontal Swath Plot for Copper in Domain 200

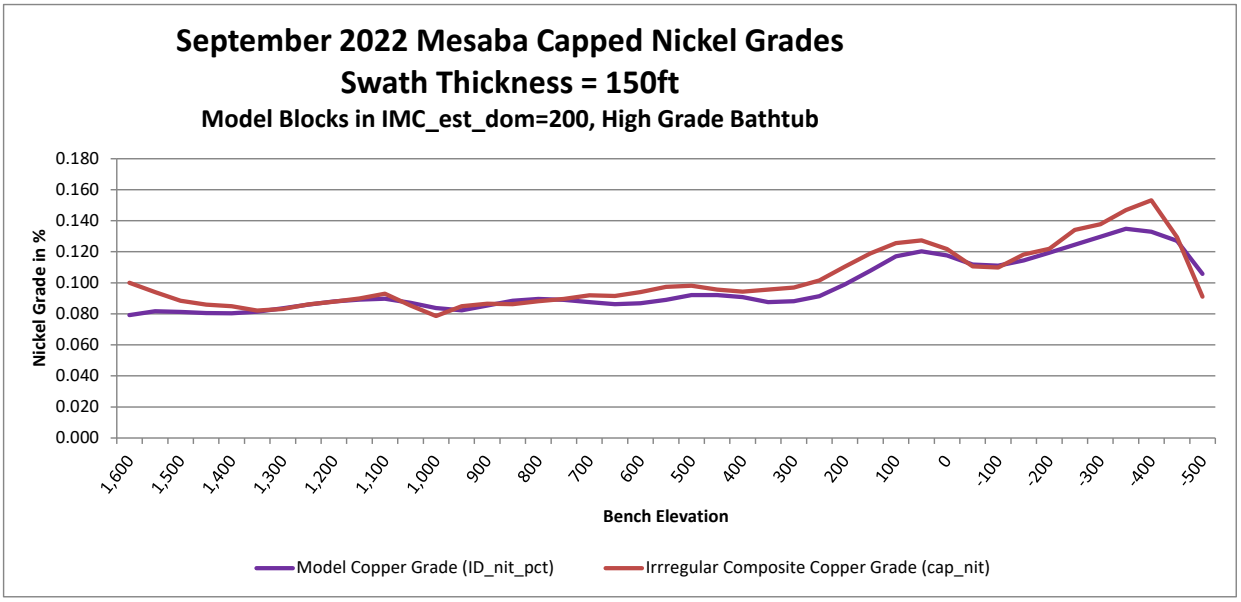


Figure 14-5: Horizontal Swath Plot for Nickel in Domain 200

14.10 MINERAL RESOURCE ESTIMATE

The Mesaba mineral resource is tabulated within an open pit shell based on a processing approach which will generate two concentrates: a copper concentrate for sale and a bulk nickel-copper concentrate which will be further processed using Teck's CSEL process to produce metal for sale. IMC used the five geometallurgy domains assigned to the Teck regularized block model for the application of metallurgical recovery to the two concentrates as discussed in Section 13.3. Table 14-9 summarizes the mineral resource using a $12.00 NSR cutoff grade. Table 14-10 summarizes the contained metal within the mineral resource.

Table 14-9: Mineral Resource Statement

	NSR Cutoff = 12.00/t								
Class	**Ktons**	**NSR, $/t**	**CU, %**	**NIT, %**	**CO, ppm**	**PT, ppm**	**PD, ppm**	**AU, ppm**	**AG, ppm**
Measured	339,827	32.52	0.496	0.115	73.91	0.036	0.101	0.028	1.23
Indicated	1,866,959	27.57	0.415	0.100	76.95	0.034	0.096	0.024	1.18
Total M&I	2,206,786	28.33	0.427	0.102	76.48	0.034	0.097	0.025	1.19
Inferred	1,422,703	24.89	0.368	0.094	67.86	0.043	0.143	0.026	0.98

1. Mineral Resources are reported assuming open pit mining methods, above a cut-off grade of 12.00 NSR. Estimates were confined within a conceptual open pit shell using pit definition software.
2. Mineral Resources are reported on an undiluted basis.
3. Inputs to the shell included long-term consensus metal prices of US$3.66/lb for Cu, US$6.79/lb for Ni, US$28.75/lb for Co, US$1,668/oz for Au, US$23.00/oz for Ag, US$1,323/oz for Pd, US$1,265/oz for Pt; direct mining costs of US$1.40/t moved; process costs of US$7.17/t milled; G&A costs of US$1.00/t milled, and inter-ramp pit slope angles of 37º, and 45º for overburden, hard rock respectively.
4. Pit shell total tons: 14,472,079 ktons.
5. Tonnages are reported in imperial units (tons). Grades are reported either as percentages (%) or parts per million (ppm).
6. Rounding as required by reporting guidelines may result in apparent summation differences between tons, grade and contained metal content.

The Mesaba Mineral Resources meet the current CIM definitions for classified resources. It should be noted that, due to the uncertainty that may be attached to Inferred Mineral Resources, it cannot be assumed that all or any part of an Inferred Mineral Resource will be upgraded to an Indicated or Measured Mineral Resource as a result of continued exploration. Confidence in the Inferred portion of the estimate is insufficient to allow the meaningful application of technical and economic parameters or to enable an evaluation of economic viability worthy of public disclosure. Inferred Mineral Resources must be excluded from estimates forming the basis of feasibility or other economic studies.

The qualified person for the mineral resource is Herbert E. Welhener of IMC.

Table 14-10: Contained Metal Within the Mineral Resource

	Copper	**Nickel**	**Cobalt**	**Platinum**	**Palladium**	**Gold**	**Silver**
	Lbs x 1000	**Lbs x 1000**	**Lbs x 1000**	**Ozs x 1000**	**Ozs x 1000**	**Ozs x 1000**	**Ozs x 1000**
Measured	3,377,900	781,607	55,370	357	1,002	277	12,201
Indicated	15,495,751	3,733,916	316,735	1,851	5,255	1,312	64,472
Total M&I	18,873,651	4,515,523	372,105	2,208	6,257	1,589	76,673
Inferred	10,471,094	2,674,682	212,855	1,768	5,917	1,071	40,748

Note: Lbs x 1000 = Pounds times 1,000; Ozs x 1000 = Troy Ounces times 1,000

14.10.1 Contained metal within mineral resource pit shell

Table 14-11 lists the metal prices used which are the same as currently being used by PolyMet for input to resource tabulations at its NorthMet property and are current as of March 2022. Table 14-12 shows either the recovery or the equation for the recovery to the two concentrates by the geometallurgy domain (GMU). The recoveries for cobalt, palladium, platinum, gold and silver are based on the average of the 2019 locked-cycle tests. Table 14-13 shows the

various costs, deducts or other inputs to the pit shell determination. Table 14-14 shows the sensitivity of the mineralization within the resource pit shell by NSR cutoff grade (note this is for sensitivity to cutoff grade only, the mineral resource is tabulated at a NSR cutoff of $12.00/t).

Table 14-11: Mineral Resource Metal Prices

March 2022 Metal Prices						
CU/lb	**NI/lb**	**CO/lb**	**PT/oz**	**PD/oz**	**AU/oz**	**AG/oz**
$3.66	$6.79	$28.75	$1265.	$1323.	$1668.	$23.

Table 14-12: Metal Recovery Inputs

Metal	Combined Recoveries	Copper Concentrate	Bulk Nickel Concentrate
Copper	94.3 x (1-exp(-14.4*Cu))-3.2	60%	Combined – Cu concentrate
Nickel	Sulfide model (see Section 13)	4.3%	Combined – Cu concentrate
Cobalt		_	41.70%
Palladium		18.20%	49.50%
Platinum		11.18%	53.50%
Gold		50.06%	25.10%
Silver		38.18%	30.70%

Table 14-13: Resource Pit Shell Economic Inputs

Mining Cost	$1.40/total ton					
Process	$7.17/mill ton					
G&A Cost	$1.00/mill ton					
TCRC Deducts & Payable						
	Copper Concentrate			**Bulk Nickel Concentrate - CESL**		
Per concentrate ton	**Freight= $125 Smelting=$90**			**Process=$239 Freight=$130**		
	Deduct	**% Payable**	**Refining Charges**	**Recovery 1**	**Recovery 2**	**Deducts**
Copper	-	96.5	$0.09/lb	-	95.0	
Nickel	-	-		95.0	80.0	
Cobalt	-	-		95.0	60.0	
Palladium	1 gm	90.0	$8.40/oz	82.0	80.0	2 grams
Platinum	1 gm	90.0	$15.00/oz	82.0	75.0	2 grams
Gold	1 gm	97.0	$5.00/oz	82.0	80.0	
Silver	1 oz	90.0	$0.40/oz	75.0	80.0	

Table 14-14: Sensitivity to NSR Cutoff Grade

	Short Ktons	NSR $/t	Copper $3.66/lb CU %	Nickel $6.79/lb NIT %	Cobalt $28.75/lb CO ppm	Platinum $1265/oz PT ppm	Palladium $1323/oz PD ppm	Gold $1668/oz AU ppm	Silver $23/oz AG ppm	Sulfur S %
	NSR366 Cutoff = 20.00									
Measured	263,227	37.28	0.566	0.128	75.53	0.0392	0.1111	0.0308	1.37	1.33
Indicated	1,335,136	32.07	0.477	0.112	81.45	0.0376	0.1065	0.0270	1.34	1.05
Total M&I	1,598,363	32.93	0.492	0.115	80.48	0.0379	0.1073	0.0276	1.34	1.10
Inferred	872,154	30.60	0.431	0.108	72.96	0.0528	0.1795	0.0319	1.12	1.00
	NSR366 Cutoff = 16.00									
Measured	304,813	33.65	0.528	0.121	74.70	0.0375	0.1056	0.0292	1.30	1.24
Indicated	1,628,301	29.54	0.441	0.105	79.25	0.0357	0.1013	0.0254	1.25	0.98
Total M&I	1,933,114	30.19	0.455	0.108	78.54	0.0360	0.1020	0.0260	1.26	1.02
Inferred	1,129,190	27.73	0.400	0.101	70.53	0.0475	0.1604	0.0287	1.05	0.94
	NSR366 Cutoff = 14.00									
Measured	322,335	33.58	0.512	0.118	74.39	0.0368	0.1035	0.0286	1.26	1.21
Indicated	1,757,296	28.48	0.427	0.102	78.04	0.0348	0.0989	0.0247	1.22	0.96
Total M&I	2,079,631	29.27	0.440	0.104	77.47	0.0351	0.0996	0.0253	1.22	1.00
Inferred	1,272,639	26.29	0.384	0.097	68.66	0.0449	0.1512	0.0271	1.01	0.92
	NSR366 Cutoff = 12.00									
Measured	**339,829**	**32.52**	**0.497**	**0.115**	**73.91**	**0.0360**	**0.1011**	**0.0279**	**1.23**	**1.18**
Indicated	**1,866,958**	**27.57**	**0.415**	**0.100**	**76.95**	**0.0340**	**0.0965**	**0.0241**	**1.18**	**0.94**
Total M&I	**2,206,787**	**28.33**	**0.428**	**0.102**	**76.48**	**0.0343**	**0.0972**	**0.0247**	**1.19**	**0.98**
Inferred	**1,422,703**	**24.89**	**0.368**	**0.094**	**67.86**	**0.0426**	**0.1426**	**0.0258**	**0.98**	**0.90**
Total Mineralization	**3,629,490**	**26.98**	**0.404**	**0.099**	**73.10**	**0.0376**	**0.1150**	**0.0251**	**1.11**	**0.95**
	NSR366 Cutoff = 10.00									
Measured	359,698	31.33	0.480	0.112	73.28	0.0353	0.0990	0.0273	1.20	1.15
Indicated	1,959,716	26.79	0.404	0.098	76.18	0.0333	0.0945	0.0236	1.16	0.92
Total M&I	2,319,414	27.49	0.416	0.100	75.73	0.0336	0.0952	0.0242	1.16	0.96
Inferred	1,580,571	23.51	0.351	0.091	66.73	0.0406	0.1350	0.0246	0.95	0.87
	NSR366 Cutoff = 8.00									
Measured	379,700	30.15	0.464	0.109	72.88	0.0349	0.0977	0.0268	1.17	1.11
Indicated	2,056,471	25.95	0.393	0.096	75.63	0.0330	0.0936	0.0233	1.14	0.90
Total M&I	2,436,171	26.60	0.404	0.098	75.20	0.0333	0.0942	0.0238	1.14	0.93
Inferred	1,746,990	22.12	0.334	0.087	65.45	0.0396	0.1304	0.0238	0.92	0.84

14.11 FACTORS THAT MAY AFFECT THE MINERAL RESOURCE ESTIMATE

Areas of uncertainty that may materially impact the Mineral Resource estimates include:

- changes to long-term metal price assumptions;
- changes in geological interpretations including the size, shape and distribution of interpreted lithologies;
- changes in local interpretations of mineralization geometry, fault geometry and continuity of mineralized zones;
- changes to the net smelter return used for the estimates;
- changes to metallurgical recovery assumptions;
- changes to the expected product types resulting from the assumed metallurgical processing routes;
- changes to the input assumptions used to derive the conceptual open pit outlines used to constrain the estimate;
- variations in geotechnical, hydrogeological and mining assumptions;
- changes to the surface ownership or mineral lease terms; and
- changes to environmental, permitting and social license assumptions.

14.12 COMMENTS ON SECTION 14

The QP is of the opinion that Mineral Resources were estimated using industry-accepted practices and conform to the 2019 CIM Definition Standards. Mineral Resources are based on open pit mining assumptions.

There are no other environmental, legal, title, taxation, socioeconomic, marketing, political or other relevant factors known to the QP that would materially affect the estimation of Mineral Resources that are not discussed in this Report.

15 MINERAL RESERVE ESTIMATES

This section is not relevant to this Report.

16 MINING METHODS

This section is not relevant to this Report.

17 RECOVERY METHODS

This section is not relevant to this Report.

18 PROJECT INFRASTRUCTURE

This section is not relevant to this Report.

19 MARKET STUDIES AND CONTRACTS

This section is not relevant to this Report.

20 ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

Teck has been collecting baseline environmental data for over ten years to characterize the natural resources in the Mesaba Project area and in preparation for the environmental review process if the Project proceeds to the mine development stage There are regional ecosystems and environmental sensitive areas in the vicinity of the Mesaba deposit that are subject to regulation under various federal and state laws, including surface waters, wetlands, threatened and endangered species, groundwaters, and cultural and historic resources. Teck continues to collect data associated with these areas to analyze potential impacts to these natural resources if mine development proceeds and to establish measures to avoid or mitigate such impacts in accordance with applicable laws.

Baseline studies that have been underway in some form include:

- Surface water quality, quantity, and geomorphologic surveys
- Wetland extents
- Groundwater quality and water level evaluations
- Wild rice surveys
- Meteorological data collection
- Biological assessments
- Cultural resources studies and surveys
- Air assessments
- Waste rock and tailings characterization
- Environmental Site Assessments of purchased properties
- Vegetation surveys
- Aquatic biota surveys
- Wildlife surveys

As part of its ongoing activities relating to mineral exploration and environmental data collection, Teck received permits and other regulatory approvals, including those necessary to construct an access road to the Mesaba Project area, which includes a bridge over a public water, and those necessary for past exploratory drilling programs and past gravel and timber removal. New permits and approvals may be required for any additional future drilling or other exploration or data collection activities.

Teck will be required to secure various approvals from governmental authorities as part of applicable environmental review and permitting processes if a mine and/or related infrastructure is constructed in connection with the Mesaba Project. Apart from the data collection described above, those environmental review and permitting processes have not yet commenced. Although the Combination Agreement among PolyMet and Teck, and their respective U.S. subsidiaries, will bring the Mesaba and NorthMet Projects under single management as discussed in Section 1, assuming the transaction closes, it is anticipated that the separate projects, which are at significantly different stages of evaluation and potential development, will continue to involve separate proceedings with respect to required permitting.

Teck has an office in Babbitt, Minnesota and maintains its facilities as part of the Babbitt community. There is a small local staff that operates out of the Babbitt office, with a larger support network from Teck in its U.S. and Canadian operations. Assuming evaluation of the Mesaba Project continues, it is anticipated that the size of Teck's internal staff in Minnesota will increase to support the local operation.

21 CAPITAL AND OPERATING COSTS

This section is not relevant to this Report.

22 ECONOMIC ANALYSIS

This section is not relevant to this Report.

23 ADJACENT PROPERTIES

There are several other deposits in the Duluth Complex, including the Mesaba project owned by Teck, the NorthMet Project owned by PolyMet, Serpentine owned by Encampment Resources, and the Maturi project owned by Twin Metals Minnesota, a wholly owned subsidiary of Antofagasta plc.

Pursuant to the Combination Agreement among PolyMet, its subsidiary Poly Met Mining, Inc., Teck and its subsidiary Teck American Inc., the parties agreed to the Transaction that will place the separate Mesaba Project and PolyMet's NorthMet Project under single management. PolyMet and Teck will become equal owners in Poly Met Mining, Inc., which will be renamed NewRange Copper Nickel LLC upon closing of the Transaction. As of the date of this Report, the closing of the Transaction remains pending. The separate Mesaba and NorthMet projects account for approximately one-half of the known resources of copper, nickel, PGM in Minnesota's Duluth Complex. The joint venture remains subject to satisfaction of customary closing conditions and receipt of certain regulatory approvals.

Figure 23-1 identifies the location of projects in the Duluth Complex.

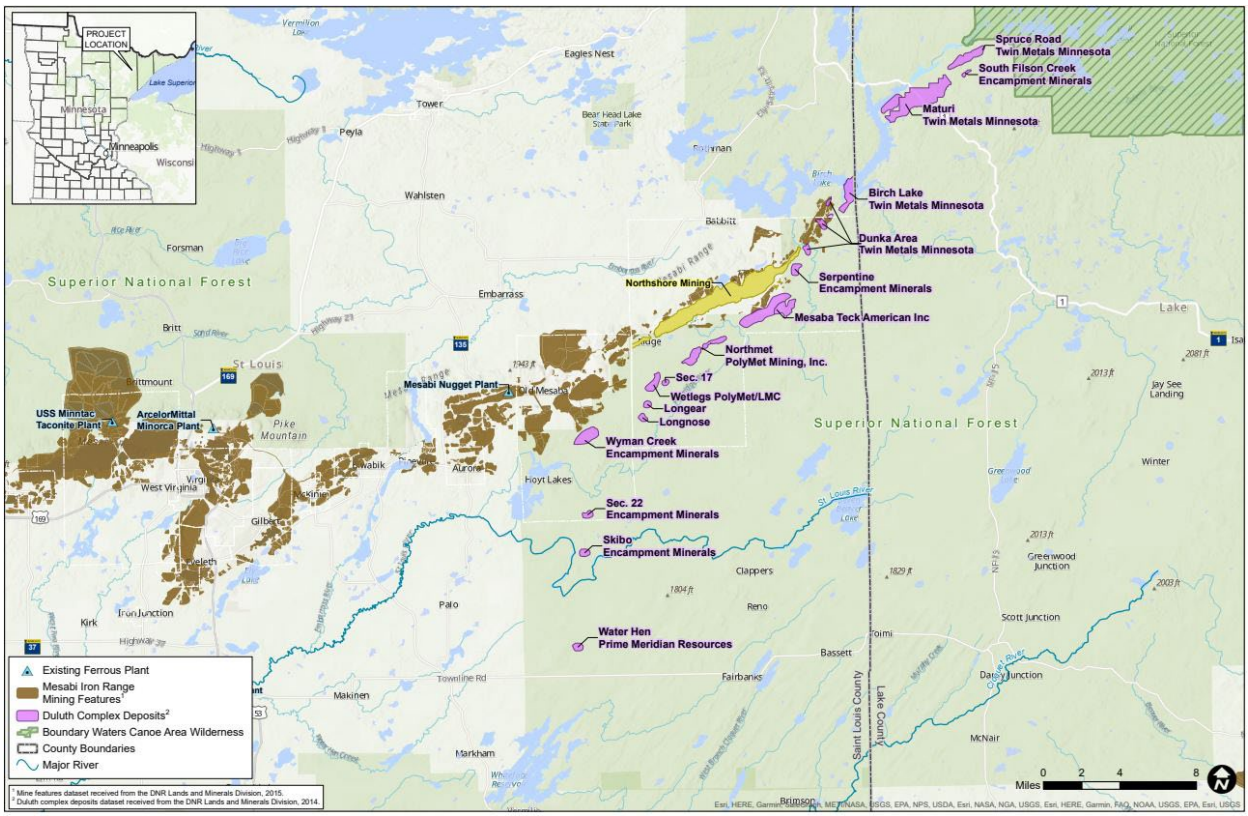


Figure 23-1: Adjacent Properties

24 OTHER RELEVANT DATA AND INFORMATION

There is no additional relevant data to be included in this Report.

25 INTERPRETATION AND CONCLUSIONS

25.1 INTRODUCTION

The QP notes the following interpretations and conclusions, based on the review of data available for this Report.

25.2 MINERAL TENURE, SURFACE RIGHTS, WATER RIGHTS, ROYALTIES AND AGREEMENTS

- Information provided by legal and tenure experts on the mineral tenure held by Teck in the Project area supports that Teck has valid mineral rights to the Mesaba deposit area that is sufficient to support declaration of Mineral Resources;
- The mineral lease position for the Mesaba Project comprises portions of Sections 15, 20, 22, 24 –35, T60N, R12W and Section 36, T60N, R13W, 4th Principal Meridian, St. Louis County, Minnesota;
- The mineral leases are held under four mineral leases with three entities:
    - A lease with Longyear Mesaba Company;
    - A negotiated State Metallic Minerals lease (MM-9831N) with the State of Minnesota;
    - A standard State Metallic Minerals lease (MM-9857) with the State of Minnesota;
    - A lease with the DuNord Land Company LLC;
- The State has the right to cancel the negotiated State leases under certain conditions and at certain lease milestones, but the State leases remain in good standing if Teck complies with the lease terms and conditions;
- As long as the annual advance royalty payments are made and Teck complies with lease terms, the Longyear Mesaba and DuNord leases remain in good standing;
- The production royalty for three of Teck's four mining leases is based on the State of Minnesota's Base Royalty Rate Table for net return value (minimum 3.95%) plus a premium of 0.55%. This royalty rate is applicable to the two State of Minnesota mining leases and the DuNord mining lease held by Teck. The Longyear Mesaba lease is subject to a 4% royalty with no premium. The Longyear Mesaba lease also includes a "most favored nation" term as described in Section 4.6;
- Although Teck owns some surface rights, it may need to acquire additional surface rights in support of any future mine development and operation;
    - Teck may need to secure additional surface rights for a process plant, a tailings facility, stockpiles, or other surface infrastructure because it owns or has limited surface holdings with respect to the Mesaba Project;
    - Project development may also require securing additional surface rights over the Mesaba deposit area to facilitate mining, particularly with respect to the surface rights held by Northshore Mining Company on some of the lands to which Teck holds mineral lease rights within the Project boundary.
- The existing local infrastructure, availability of staff, and methods whereby goods could be transported to the Project area are well-established and well understood by Teck, and can support the declaration of Mineral Resources;
    - Corridors for transportation and infrastructure will likely need to be established through commercial permits or agreements for reaching the mineral lease area using the existing road network, either as easements or licenses;
    - Power line rights-of-way must be verified and/or obtained;
    - Negotiations will be required with Cleveland Cliffs and the State to move the Cleveland Cliffs railroad that crosses the Project area before any construction relating to the Mesaba Project can begin;
- A plan of operations ("PoO") detailing drilling plans on State of Minnesota mineral lease lands is required to be submitted to the MDNR prior to each drill program;
- A notice and PoO detailing drilling plans on private or State minerals underlying federal surface within the Project area is required to be provided to USFS to obtain a concurrence determination before drilling;
- Installation of environmental wells on State surface have been included in the PoOs submitted to date to the MDNR. Teck has an income contract with the MDNR for stream flow measurements;

- Certain permits and other governmental authorizations issued previously for exploration and environmental activities in support of Project evaluation may need to be renewed for additional exploration and environmental work;
- No major environmental baseline studies have been completed at the effective date of this Report but such studies are currently in progress;
- The umbrella Minnesota Chippewa Tribe, which is comprised of six Bands and is a federally recognized tribal government, comprise key communities of interest for the Mesaba Project;
- To the extent known, there are no other significant factors and risks known to the QP that may affect access, title, or the right or ability to perform work on the Project that are not discussed in this Report.

25.3 GEOLOGY AND MINERALIZATION

- The Mesaba Project deposits are classified as contact-type magmatic nickel–copper–PGE deposits;
- The geological understanding of the settings, lithologies, and structural and alteration controls on mineralization is sufficient to support estimation of Mineral Resources;
- Exploration potential that remains in the Project area includes:
    - Potential for high-grade massive sulfide zones such as the Local Boy zone to be present in the poorly-drilled areas to the south;
    - Potential for high-grade massive sulfide zones within structures such as the Grano and South Minnamax faults which may be feeder zones to the larger disseminated mineralization;
    - Potential for thick zones of high tenor copper and PGE-enriched disseminated sulfides higher in the stratigraphic sequence of the Partridge River Intrusion as observed in the sparse drilling south–southeast of Local Boy;
- The deposit remains open at depth to the south, and potential remains to increase the known disseminated mineralization extent.

25.4 EXPLORATION, DRILLING AND ANALYTICAL DATA COLLECTION IN SUPPORT OF MINERAL RESOURCE ESTIMATION

- The exploration programs completed to date are appropriate for the deposit style;
- Prior to Teck's involvement in 1998, a total of 624 surface and underground holes (613,524 ft) were drilled. Of the drill sample intervals used for resource estimation, 58.5% are from drill holes completed prior to Teck's Project involvement. Teck has completed 221 drill holes (196,373 ft [59,854 m]);
- Sampling methods are acceptable for Mineral Resource estimation;
- Sample preparation, analysis and security met industry standards at the time the sampling was conducted;
- The quantity and quality of the lithological, geotechnical, collar and down hole survey data collected during the exploration and delineation drilling programs are generally sufficient to support Mineral Resource estimation. The collected sample data adequately reflect deposit dimensions, true widths of mineralization, and the style of the deposit. Sampling is representative of the grades in the deposit, reflecting areas of higher and lower grades;
- The Teck QA/QC and re-assay programs adequately address issues of precision, accuracy and contamination. Drilling programs typically included blanks, duplicates and standard samples. QA/QC submission rates meet industry-accepted standards. The QA/QC programs did not detect any material sample biases;
- The data verification programs concluded that the data collected from the Project adequately support the geological interpretations and constitute a database of sufficient quality to support the use of the data in Mineral Resource estimation.

25.5 METALLURGICAL TEST WORK

- Metallurgical test work has been undertaken since the 1950s and includes historical data and data generated from Teck's investigations;
- Test work completed by Teck and third party laboratories includes: optical mineralogical evaluation; bulk modal mineralogy mineral liberation analysis (MLA) examinations on selected drill core samples; JK drop weight tests; SMC Tests; Bond ball mill work index and bulk density testing;
- Bench-scale flotation tests produced a marketable copper concentrate (>24% Cu, <0.5% Ni) and a copper–nickel concentrate that could be further refined in a CESL refinery. The test work was completed on composites and variability drill core intervals;
- A model was developed in 2020 to define a sulfide model, recovery equations for copper and nickel, and geometallurgical domains. This deportment study demonstrated that nickel deportment to non-recoverable minerals is a strong function of lithology;
- The predicted copper recovery varies ranging from 86% for material grading in the 0.2% Cu cut-off grade range and plateaus at 91.1%. The recovery range observed in the locked-cycle tests was 89–92%;
- The predicted nickel recovery to the bulk concentrate for blocks above the 0.2% Cu cut-off varied from 47–64% (25th to 75th percentile) which corresponded well with the range observed in the locked-cycle tests (43–68%)
- The recovery assumptions used for cobalt and precious metals are based on the average of the 2019 locked-cycle tests:
    - Co: 41.7%;
    - Ag: 30.7%;
    - Au: 25.1%;
    - Pd: 49.5%;
    - Pt: 53.5%;
- Samples selected for metallurgical testing were representative of the various styles of mineralization and were obtained from two bulk sample sites. Sufficient samples were taken, and tests were performed using sufficient sample mass for the respective tests undertaken;
- Copper recovery will be subject to variability due to varying mineralization responses, and nickel recovery will be subject to variability due to presence of nickel in pyrrhotite and silicate nickel;
- No elements reach penalty limits in the nickel concentrate that was produced during the test work programs;
- A penalty would be payable on the copper concentrate should the nickel content exceed 0.5% Ni. Depending on market conditions, Teck would have the option of reducing copper recoveries to the copper concentrate to reduce the nickel reporting to that concentrate, or could elect to maximize copper recovery and pay the penalty.

25.6 MINERAL RESOURCE ESTIMATES

- The Mineral Resource estimation for the Project conforms to industry best practices and is reported using the 2019 CIM Definition Standards;
- There is upside potential for the estimates if mineralization that is currently classified as Inferred can be upgraded to higher-confidence Mineral Resource categories or additional drilling may add to the currently defined mineral resource;
- Factors that could affect the estimates include: changes to long-term metal price assumptions; changes in geological interpretations including the size, shape and distribution of interpreted lithologies; changes in local interpretations of mineralization geometry, fault geometry and continuity of mineralized zones; changes to the net smelter return used to constrain the estimates; changes to metallurgical recovery assumptions; changes to the input assumptions used to derive the conceptual open pit outlines used to constrain the estimate; variations in geotechnical, hydrogeological and mining assumptions; changes to environmental, permitting and social license assumptions.

25.7 RISKS AND OPPORTUNITIES

25.7.1 Risks and Uncertainties

Magmatic deposits are often emplaced by complex processes. The geometry of mineralized domains used for resource estimation may be more isolated than connected in some parts of the deposit, particularly in upper lenses where mineralized zones are more often thin or lower grade. Boundaries within the upper mineralized lenses, with respect to grade, could be less sharp than have been interpreted. There is a degree of uncertainty and subjectivity that comes with connecting zones of alternating mineralized intervals between drill holes that may cause over projection of mineralization zones. The opposite can also be true, such that a mineralization zone appears more disconnected than it is due to a break in mineralization caused by a subtle late cross-cutting intrusion or xenolith.

The geometry and connectivity of geological domains have some uncertainty. Therefore, the associated sulfide model and recovery estimates could be higher, or lower, for a given resource block.

The lithochemical approach to creating geological domains relies on four-acid digest data that are missing in some drill holes, particularly in the Local Boy area and the area directly north of Local Boy. Geological domains in these areas are modelled based on proxy geochemical data, which could lead to minor errors in interpretation that could result inconsistent geological modelling in the area and the associated recovery implications.

Graphite, which can negatively affect recovery, may be less predictable across the current geological domains, as the presence of graphite within units was not explicitly modelled. Outside of the Virginia Formation footwall, graphite can be expected to be found in the xenoliths of Virginia Formation and the norite domains of the new model, but it can also occur in other igneous domains typically closer to the footwall.

Due to the uncertainty related to the degree of faulting that has taken place in the deposit, separate fault blocks are not currently included in the geological model. Mineralization in the north of the deposit may be more horizontally oriented rather than steeply-ramping if any significant displacement caused by faulting occurred. The current interpretation is that the orientation of the footwall is controlled by pre/syn intrusion folding, due to the corresponding steeply-dipping sedimentary bedding and lack of fault evidence in drill core.

Historical mining dangers could occur in the Local Boy area in the form of open cavities resulting from previous mining efforts.

Mine optimization should focus on minimizing mining disturbance and exposure of the pyrrhotite bearing footwall Virginia Formation.

Sulphide-bearing waste rock management will be required that could be achieved by a range of engineering and design solutions including co-disposal of sulphide-bearing waste rock with non-sulphide bearing waste rock, geolining, or lined waste rock facilities. Each of these approaches will effectively contain or capture precipitation exposed to sulphide-bearing waste rock. These designs and facilities are successfully used in other sulphide mining operations. Water contamination under both acid and non-acid leaching conditions is possible. Continued monitoring and testing of existing long term HCT's to support waste pad design, wastewater management requirements and water quality forecasting is required.

The Duluth Complex along with other mafic and ultramafic rocks can contain acicular mineral alteration products. Identification and isolation of such zones in mine planning is needed to allow for planning and appropriate management of this material if present.

Mineral interests, including in some instances mining leases, are held by third parties at the Mesaba deposit periphery. Teck should finalize acquisition of the parcels ensuring the ultimate pit shape is not constrained. Additional surface rights acquisitions should also continue to be evaluated on an as needed basis.

25.7.2 Opportunities

The deposit remains open at depth to the south, and potential remains to increase the known disseminated mineralization extent.

Exploration potential that remains in the Project area includes:

- Potential for high-grade massive sulfide zones such as the Local Boy zone to be present in the poorly-drilled areas to the south;
- Potential for high-grade massive sulfide zones within structures such as the Grano and South Minnamax faults which may be feeder zones to the larger disseminated mineralization.
- Additional high tenor copper mineralization in low total sulfur zones. This style of mineralization is documented and further drilling should be undertaken to assess possible upside in mill tons. The mineralization typically occurs higher in the intrusive stratigraphy and could represent an increase of the mineral resource tons in GMU 50.

25.8 CONCLUSIONS

Based on the available data, and under the assumptions presented in this Report, Mineral Resources show reasonable prospects of eventual economic extraction.

26 RECOMMENDATIONS

26.1 INTRODUCTION

Teck has provided a list of tasks to be undertaken to advance the Mesaba Project which the QPs' have divided into a Phase 1 and Phase 2 approach along with the addition of some tasks in Phase 2 or beyond.

26.2 PHASE 1

- Prioritize getting all re-assay programs into the model, particularly those associated with actual data gaps versus precision concerns or questions in secondary payable elements. For example, the gaps north of the Local Boy zone may change the pit outline in that area. Presently these sample intervals have been populated with half detection limit values to avoid over-estimation.
- Complete the 3 shorter-spaced (approximately 200 ft) geostatistical crosses. Locations may need to be adjusted to ensure they are representative and/or updated pit location. The tighter spaced drilling will enable assumptions regarding resource classification to be validated. The geostatistical crosses would also enable validation regarding the short-range variability of the categorical lithology and estimation domain models. These in turn also impact geometallurgy and grade estimation.
- Continue with the planned 2022-2023 drill program to confirm and potentially expand the mineralization identified in wide spaced drill areas and areas within GMU 50;
- The current test work has demonstrated that copper recoveries of 92.3% and nickel recoveries of 43% to 68% can be achieved using flotation technologies. The goal of further testwork would be to achieve copper recoveries of greater than 93% to fall in line with the recoveries used in the current resource report. JDS recommends that metallurgical samples be developed from splits of the drill core from the in-fill and extension drilling, and possibly separate metallurgical holes, to conduct further composite testing. It is also recommended that new flotation technologies which allow for primary recovery at coarser grind sizes (i.e.. Eriez Hydrofloat) or a reduction in the necessary residence time which will allow for a smaller footprint.

Once the Phase 1 tasks are completed (or at stages through Phase 1) update the mineral resource block model to evaluate the impacts from the results of the Phase 1 tasks.

26.3 PHASE 2

- The Bedded Pyrrhotite (BDPO) unit within the deposit in the Project area will require further evaluation in the mine design to address potential permitting implications.
- Phase 2 metallurgical testwork should focus on variability testwork to prove the recommended flowsheet throughout the ore body. JDS recommends that a few drillholes be specifically drilled for metallurgical testwork, which will guarantee fresh sample for comminution and flotation testwork. The variability program should include 60 to 100 individual samples from around the deposit.

As in Phase 1, as milestones are reached in the Phase 2 work, evaluate the impacts on the mineral resource estimate.

Ongoing work through out Phases 1 and 2 and beyond would be to:

- Complete environmental base line studies for permit applications.
- Continue negotiations with surface owners within the Project boundary and near the periphery of the Project.
- Advance the project to a PEA.

No budget has been released for the above-mentioned work.

27 REFERENCES

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APPENDIX A – CONTRIBUTORS AND PROFESSIONAL QUALIFICATIONS

CERTIFICATE OF QUALIFIED PERSON
HERBERT E. WELHENER, SME-RM

I, Herbert E. Welhener, SME-RM, of Tucson, Arizona, do hereby certify that as the author of the Technical Report entitled "Mesaba Project Form NI 43-101F1 Technical Report – Mineral Resource Statement" ("Technical Report") dated November 28, 2022; I hereby make the following statements:

1. I am currently employed by and carried out this assignment for Independent Mining Consultants, Inc. ("IMC") located at 3560 E. Gas Road, Tucson, Arizona, USA, phone number (520) 294-9861.
2. This certificate applies to the Technical Report entitled "Mesaba Project Form NI 43-101F1 Technical Report – Mineral Resource Statement" dated November 28, 2022 (the "Technical Report").
3. I graduated with the following degree from the University of Arizona: Bachelor of Science – Geology, 1973.
4. I am a Registered Member of the Society of Mining, Metallurgy, and Exploration, Inc. (# 3434330RM), a professional association as defined by National Instrument 43-101 – Standards of Disclosure for Mineral Projects ("NI 43-101"). I am a Qualified Professional Member (Mining and Ore Reserves) of the Mining and Metallurgical Society of America (#01307QP).
5. I have worked as a mining engineer or geologist for 49 years since my graduation from the University of Arizona.
6. I am familiar with NI 43-101 and by reason of my education, experience and affiliation with a professional association (as defined in NI 43-101) and I am a Qualified Person (as defined in NI 43-101). I am a Vice President of Independent Mining Consultants, Inc. since 1983.
7. I am responsible for Sections 1-12, 14-27 of the Technical Report. I last visited the property on September 7, 2022.
8. I have had prior involvement with the property that is the subject of this Technical Report as part of a study team in 2018 and 2019.
9. I am independent of PolyMet Mining Corp. and related companies, applying all of the tests set out in Section 1.5 of NI 43-101.
10. I have read NI 43-101 and I certify that the Technical Report has been prepared in compliance with NI 43-101 and Form 43-101F1.
11. As of the effective date of this Technical Report, to the best of my knowledge, information and belief, this Technical Report contains all the scientific and technical information that is required to be disclosed to make this Technical Report not misleading.
12. I consent to the filing of the Technical Report with any stock exchange and other regulatory authority and any publication by them, including electronic publication in the public company files on their websites assessable by the public.

Effective Date: November 28, 2022
Signed and dated: 28th day of November 2022 at Tucson, Arizona

Signed "*Herbert E. Welhener*"
Herbert E. Welhener, SME-RM

CERTIFICATE OF QUALIFIED PERSON
SHANE TAD CROWIE, P.ENG.

I, Shane Tad Crowie, P.Eng., of Vancouver, British Columbia, do hereby certify that as the author of the Technical Report entitled "Mesaba Project Form NI 43-101F1 Technical Report – Mineral Resource Statement" ("Technical Report") dated November 28, 2022; I hereby make the following statements:

1. I am currently employed as Senior Metallurgist with JDS Energy & Mining Inc. ("JDS") with an office at Suite 900 – 999 West Hastings Street, Vancouver, British Columbia, V6C 2W2.
2. I am a graduate of the University of British Columbia with a B.A.Sc. in Mining and Mineral Process Engineering, 2001. I have practiced my profession continuously since 2001.
3. I have worked in technical, operations and management positions at mines in Canada. I have been responsible for recovery optimization projects, capital improvement projects, budgeting, planning, and pilot plant operations. I have been an independent consultant for 4 years and have performed mill design, mill cost estimation, operations management, technical due diligence reviews and technical report writing for mines worldwide.
4. I am a Registered Professional Mining Engineer in British Columbia (#34052).
5. I have read the definition of "qualified person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101. I am independent of the issuer, vendor, property and related companies applying all of the tests in Section 1.5 of NI 43-101.
6. I have not visited the Mesaba Project Site.
7. I am responsible for Sections 13, 25.5, and 26 of this Technical Report.
8. I am independent of PolyMet Mining Corp. and related companies, applying all of the tests in Section 1.5 of the NI 43-101.
9. I have had no prior involvement with the property that is the subject of this Technical Report;
10. As of the effective date of this Technical Report, to the best of my knowledge, information and belief, this Technical Report contains all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.
11. I have read NI 43-101, and I certify that the Technical Report has been prepared in accordance with NI 43-101 and Form 43-101F1.
12. I consent to the filing of the Technical Report with any stock exchange and other regulatory authority and any publication by them, including electronic publication in the public company files on their websites assessable by the public.

Effective Date: November 28, 2022
Signed and dated: 28th day of November 2022

(Original signed and sealed) "*Shane Tad Crowie, P.Eng.*"
Shane Tad Crowie, P.ENG.