NI 43-101 TECHNICAL REPORT

(Amended)
Preliminary Economic Assessment of the **Re-scoped Shymanivske Iron Ore Deposit**

DNEPROPETROVSK REGION, UKRAINE

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LIST OF ABBREVIATIONS

A

Abrasion index .... Ai
Above Sea Level .... ASL
Azimuth-Dip-Azimuth .... ADA

B

Banded Iron Formation .... BIF
Bankable Feasibility Study .... BFS
Basic Oxygen Furnace .... BOF
Bench Face Angle .... BFA
Black Iron Inc. .... Black Iron, BKI
Bond Work Index .... BWi
Breton, Banville and Associates Inc. .... BBA

C

Capital Expenditure .... CAPEX
Central mining and beneficiation plant .... CGOK
Cleaning Magnetic Separation .... CMS
Comma Separated Value .... CSV
Cost and Freight .... CFR
Council of the Canadian Institute of Mining Metallurgy and Petroleum .... CIM
Crusher work index .... CWi
Cut-Off Grade .... COG

D

Database .... DB
Davis Tube .... DT, DTT
Diameter .... dia
Diamond Drillhole .... DDH
Digital Elevation Model .... DEM
Down the hole .... DTH
Drawing Exchange Format .... DXF
Drop-Weight Test .... DWT

E

Electric Arc Furnace .... EAF
Environmental expert assessment .... EEA

Engineering, Procurement, and Construction Management ..... EPCM
Environmental Assessment ..... EA
Environmental Impact Assessment ..... EIA
Environmental Impact Statement ..... EIS
Environmental Preview Report ..... EPR
Environment, Social and Health Impact Assessment ..... ESHIA
European Bank for Reconstruction and Development ..... EBRD
Evapotranspiration ..... ET

F

Financial Analysis ..... FA
Finisher Magnetic Separator ..... FMS
Federation of Trade Unions of Ukraine ..... FPU
Free on Board ..... FOB

G

General and Administration ..... G&A
General Arrangement ..... GA
Geo Inter Consulting Limited ..... GIC
Geographic Information System ..... GIS
Global Positioning System ..... GPS
Government Service Centre ..... GSC
Gravity Gradient Instruments ..... GGI
Ground control points ..... GCP

H

Heavy Liquid Separation ..... HLS
Hematite ..... Fe_2O_3
High Pressure Grinding Roll ..... HPGR

I

Internal Rate of Return ..... IRR
International Absolute Gravity Base Station Network ..... IAGBN
International Comparative Legal Guide ..... ICLG
International Council on Mining and Minerals ..... ICMM
International Finance Corporation ..... IFC
Interpajp ..... NPIG
Inter-ramp Angles ..... IRA

Inverse Distance .... ID
Inverse Squared Distance .... ID^2
Iron Formation .... IF

K

KrivBassProekt .... KBP

L

Length L
Lerchs-Grossman 3D .... LG 3-D
Life of Mine .... LOM
Letter of intent .... LOI
Loss on ignition .... LOI
Low Intensity Magnetic Separation .... LIMS

M

Magnetite Iron .... Fe_{mag}
Magnetite .... Fe_3O_4
Major Resource Project .... MRP
MehanobrCherMet .... MCM
Memorandum of understanding .... MOU
MineSight economical planner .... MSEP
Motor Control Centre .... MCC

N

Net present value .... NPV
North Atlantic Treaty Organization .... NATO

O

Operating expenditure .... OPEX
Ore dressing and processing plant .... GOK
Organization for Security and Co-operation in Europe .... OSCE
Overburden .... OB
Otsinka Vplyvu na Navkolyshne Seredovysce .... OVNS
Oxide iron formation .... OIF

P

P&E Mining Consultants Inc. .... P&E
Pellet feed .... PF
Power factor .... Cosϕ
Project control file .... PCF

Process control system .... PCS
Process flow diagram .... PFD
Process flowsheet .... PFS

Q

Qualified person .... QP
Quality assurance .... QA
Quality control .... QC
Quantitative evaluation of minerals by scanning electron microscopy .... QEMSCAN™
Quarter .... Q

R

Reclamation material stockpile .... RMS
Relative to sea level .... RSL
Revenue factor .... RF
Rod work index .... RWi
Rougher magnetic separation .... RMS
Run-of-mine .... ROM

S

Safety, health, environment and community .... SHEC
SAG Mill Comminution .... SMC
SAG Power Index .... SPI
Sales, general, and administrative expenses .... SG&A
Satmagan .... Sat
Semi autogenous grinding .... SAG
SGS Lakefield Research .... SGS Lakefield
Silicate Iron Formation .... SIF
Silicate-Carbonate Iron Formation .... SCIF
Single Line Diagram .... SLD
Specific Gravity .... SG
Stakeholder Engagement Plan .... SEP
State Environment Review .... SER
Stripping Ratio .... S/R

T

Tailings Storage Facility .... TSF
Three-Dimensional 3D
Toronto Stock Exchange .... TSX

Total Iron Content .... Fe_{tot}
Total Pinion Energy .... Wtot
Topographic, Geodetic and Navigation Technologies .... TNT TPI, TNT TPI LLC
Two-Dimensional 2D

U

Ukrainian Design Institute .... UDI
Ukrainian National Railway .... UNR
Unexploded ordnance .... UXO
United Nations Development Programme .... UNDP
United Nations Environment Programme .... UNEP
United States Dollars .... USD

W

Work Breakdown Structure .... WBS
Waste Management Plan .... WMP
Waste Storage Facility .... WSF
Watts, Griffis and McOuat Limited .... WGM
Weight Recovery .... wt. rec.
Weight .... wt
Wilfley Table .... WT
Work Index .... WI
Work Index of Coarse Particle .... Mia
Work Index of the Fine Particle .... Mib

Y

YuzhGiproRuda .... YGR
Yuzhny GOK .... YuGOK

UNITS OF MEASURE

Above Sea Level	ASL
Foot	', ft
Inches	″, in
Degree	°, deg
United States Dollar	USD or $
Dollar per tonne	$/t
Micron (Micro Metre)	µm
Centimeter	cm
Canadian Dollars	CAD
Feet per minute	fpm
Gram	g
Gram per cubic centimeter	g/cc, g/cm^3
Gallons per minute	GPM
Giga watt hour	GWh
Hour	h
Hectare	ha
Horsepower	hp
Kilogram	kg
Kilometer	km
Square kilometer	km^2
Kilotonne	kt
Kilovolt	kV
Kilovolt-Ampere	kVA
Kilo Pascal	kPa
Kilowatt	kW
Kilowatt-hours per tonne	kWh/t
Litres	L

Pounds per hour .... lb/h
Metre .... m
Million .... M
miliGal .... mGal
Million tonnes per annum .... Mtpa
Cubic metre per hour .... m^3/h
Mile .... mi
Millimeter .... mm
Million tonnes .... Mt
Mega Volt Amps .... MVA
Mega Watt .... MW
Standard cubic feet per minute .... scfm
Tonnes per hour .... tph
Tonnes per cubic metre .... t/m^3
Tonnes per annum .... tpa
Metric tonnes .... tonnes or t
Short tons .... tons
Weight .... w
Year .... y

1. SUMMARY

1.1 Introduction

This amended Technical Report for the "Preliminary Economic Assessment of the Re-scoped Shymanivske Iron Ore Deposit" effective November 21, 2017 has been prepared following detailed due diligence from a potential offtake investor which identified an error in the calculation of in pit mineral resources. The table showing the pit optimization results has been updated, however, the pit shell selected from the pit optimization remains the same and the open pit design has not changed. An additional 25 m lift has been added to the waste rock facility to account for the additional waste rock. The mine plan for the PEA has been updated resulting in 17-year mine life. The mine equipment fleet requirements and manpower have been updated for this amended report as well as the mining cost model and the overall project economics. All other sections of the report remain as originally published.

This Technical Report (the "Report" or the "Study") presents the results of the re-scoped Preliminary Economic Assessment (PEA) that was undertaken for the development of the Shymanivske Iron Ore Property, which is part of the KrivBass iron ore basin, located in the Dnepropetrovsk region of Ukraine. The Shymanivske subsurface usage permit for the extraction of iron ore, registered as Special Permit No. 4537, is owned by a Ukraine registered company called Shymanivske Steel LLC who, in turn, is owned by Black Iron Cyprus Ltd. and ultimately Black Iron Inc. ("BKI" or the "Corporation"), registered in Ontario, Canada. The Property covers 256 hectares and is located approximately 330 km south-east of Kiev and 150 km north of the Black Sea in Ukraine.

Since 2011, BKI has advanced the development of the Shymanivske Project (the "Project") by performing exploration activities as well as a number of technical studies. The 2014 feasibility study ("2014 FS") sought to maximize economic returns through optimal equipment use and concentrate production. This, however, resulted in a Project having an initial capital cost in excess of $1 billion US. In early 2014, iron ore prices (62% Fe Platts benchmark price) were well over $100/t but began a steep slide to just under $40/t in early 2016. With the fall in price coupled with political instability in Ukraine, there was too much uncertainty to advance the Project to construction.

Since late 2016, there are strong indications that the iron ore market is again morphing and favouring higher iron grade products (i.e. >62% Fe), such as BKI's ultra-high grade of 68% Fe product, at the detriment of lower grades. This is mainly driven by Chinese steel mills seeking to become more efficient and reduce their environmental footprint. There is a prevailing sentiment that this trend will not subside and higher grade iron ore will continue to attract greater premiums. Investments in Ukraine still carry some risks due to the ongoing political tensions however, since 2014, the Ukrainian Hryvnia (UAH) has devalued by more than 300% versus the USD, thus having a significant impact on overall Project economics.

Given these factors, BKI has taken the initiative of seeking to advance the Project by building it in phases with initial reduced scale, hence lower initial capital requirements to construct the Project.

This is economically viable in BKI's case given the close proximity of major infrastructure including rail, power, water and ports coupled with the use of local highly skilled low cost labour to construct and operate the Project. As such, it has asked BBA to undertake a PEA level study to estimate capital and operating costs for the re-scoped Project and assess its economic performance prior to undertaking a feasibility level study. The re-scoped Project considers a mining and mineral processing operation having an initial nominal capacity of 4.0 Mtpa of dry 68% Fe blast furnace pellet feed concentrate. The flowsheet and process equipment for the initial 4.0 Mtpa of concentrate will be replicated in order to double the production capacity with construction starting in Year 3 to allow for production of 8.0 Mtpa starting in Year 5 of production.

This present re-scoped PEA replaces the previous 2014 Feasibility Study NI 43-101 Report as the current Report for the Shymanivske Project. The capital cost estimate in this PEA has been prepared with an accuracy of +/- 35% as per industry standards. The results of the 2014 FS, including the mineral reserve estimate and economic analysis, are no longer relevant and should not be relied upon.

1.2 Geology and Mineralization

The Property is situated in the Kryvyi Rih Basin ("KrivBass"), a Paleoproterozoic synclinorium structure in the Archean Ukrainian Shield. The KrivBass lies along the western edge of the Middle Dnieper Block of the Shield, adjacent to the Inhul-Inhulets, or Kirovograd Block. KrivBass is one of several Ukrainian iron formation-hosting basins on micro-plate boundaries.

The iron formation on the Property is of the Lake Superior-type. This type of iron formation consists of banded sedimentary rocks composed principally of bands of iron oxides, magnetite and hematite within quartz or chert-rich rock, and contains variable amounts of silicate, carbonate and sulphide lithofacies. Such iron formations have been the principal sources of iron throughout the world.

Mineralization of economic interest on the Property is the oxide facies iron formation (OIF) or oxide facies banded-iron formation, which is magnetite-rich taconite that contains minor hematite throughout. The Soviet literature commonly refers to this mineralization as "un-oxidized ferriferous quartzite" or "low-grade iron mineralization." Supergene iron mineralization is also present on the Property. It is commonly associated with the faults and fault zones that may be coincident with an unconformity occurring along the western margin of the Property adjacent to the Archean basement. A layer of oxidized iron mineralization, usually no more than a few metres thick, also commonly lies along the upper surface of the taconite immediately under the Cenozoic cover rocks. The supergene mineralization comprises concentrations of martite and goethite/limonite mineralization. In the Soviet literature, this type of mineralization is called "rich iron ore" or "oxidized quartzite mineralization".

The taconite mineralization in the Saksagan sequence extends along the entire NE-SW extent of the Property for 2.2 km and beyond, and occurs over a width of 800 m to 1 km in a NW-SE direction. The taconite is folded and its true thickness varies throughout because of tectonic thickening, erosion and possibly the original basin topology. The true thickness of the iron formation package, including the intervening inter-oxide iron formation "slate" members, is on the order of 200 m to 250 m. Because of the folding there is no consistent relationship between drill hole orientation and the true width of mineralization.

1.3 Exploration and Drilling

Black Iron initiated exploration of the Property in 2011 and conducted Phase I and Phase II diamond drilling programs. Black Iron's programs also included ground magnetic and gravity surveys, and satellite imaging designed to construct a digital topographic model for the Property and environs. Part of this phase also involved the location and surveying of previous casings for validation of historic information. The Twin Drilling Program (Phase I) comprised 22 holes, aggregating 6,042 m of drilling. Immediately following Phase I, the Phase II Drilling Program was initiated. It consisted of 48 holes aggregating 11,435 m of drilling and included seven holes (totaling 695 m) that were drilled to acquire larger diameter core for comminution testwork. Black Iron's drilling was done largely along the same cross-sections used in the Soviet programs. Total Black Iron drilling aggregated 70 holes in 17,477 m of drilling. The primary purpose of the Phase I Program was to collect material for metallurgical testwork by drilling a selection of drill holes as close as possible to historic locations and at a similar attitude. The secondary goal of the drilling program was to validate historic drilling completed on the Property. The purpose of the Phase II program was to provide additional information in order to advance deposit interpretation and support an updated and upgraded categorized Mineral Resource estimate.

1.4 Sample Preparation and Data Verification

Black Iron's 2011 Phase I and Phase II drilling programs were managed by the local drilling contractor "GEORESOURCE". The company's drill rig geologists logged the drill holes in the field adjacent to the drills. The intervals for sampling were determined and marked on the core. Nominal sample length was 3 m, with variations being based on geology and no narrow gaps being left between samples. Shoulder samples were collected on the margins of all mineralized intervals. The samples were sawn in half with diamond core saws. The primary laboratory for Black Iron's 2011 drilling programs was MehanobrCherMet (MCM), based in Kryvyi Rih. Sample preparation for assaying included first-stage jaw crushing, second-stage roll crushing and finally, puck and ring pulverization. The samples were to provide representative pulps for assaying. Assaying at MCM included determination of Fe_{tot}, Fe_{mag}, FeO_T, SiO_2, S_T and P on all samples, including routine and field-inserted QA/QC samples and laboratory-inserted QA/QC materials. Determinations at MCM were generally by wet-chemical methods; Fe_{mag} was determined with a magnetization saturation analyzer. Specific gravity and bulk density were determined on selected samples.

The 2011 QA/QC program for sampling and for sample analysis included components conducted by GEORESOURCE that were initiated during core sampling in the field, in addition to the components that MCM operated as part of the in-laboratory QA/QC program. In-field, standards, blanks and duplicate samples were inserted into the sample stream going to MCM. Supplementary to the GEORESOURCE in-field QA/QC program, the MCM in-laboratory QA/QC program involved the preparation of duplicates (replicates), analytical duplicates, blanks and Certified Reference Standards. These QA/QC materials were analyzed along with the samples received from GEORESOURCE. In addition to the in-field insertion of blanks, duplicates and standards, some follow-up check-assaying was completed with a view to understanding and resolving particular issues. Some of this check-assaying was managed by Black Iron; some, by WGM. Black Iron's checks included the re-assaying of samples at MCM as well as at SGS-Lakefield at Lakefield, Ontario, Canada; and at ALS in Perth, Australia.

WGM made site visits to the Property in 2011 to assist with the implementation of sampling and assaying protocols, to verify drilling, and to complete independent sampling. WGM checked collar locations for drill holes and also for historic casings that had been located. WGM "quick" logged a number of Black Iron Phase I and II drill holes. During this process, WGM confirmed that GEORESOURCE logging was reasonably accurate with its lithostratigraphic coding as it generally agreed with WGM's observations. During this process, WGM also checked the locations of sample intervals and sample identifiers for agreement with locations recorded in the database, and found no errors.

WGM completed independent sampling of Black Iron's half-split drill core and assay pulps prepared by MCM during its second, third and fourth site visits to the Property. In total, WGM collected 23 samples of half-split core and 93 pulps. WGM submitted these samples and some quality-control samples for assaying at SGS-Lakefield. WGM's independent sampling and assaying largely verified MCM's assays. WGM also completed the analysis of QA/QC data from the drilling program, including Black Iron's analytical results for samples analyzed at MCM, ALS and at SGS-Lakefield. WGM also researched and checked Soviet historic documents, including checking a selection of assay and geological records, drill hole locations, azimuths and inclinations, with a view to validating the historic data used for the Mineral Resource estimate.

1.5 Mineral Resource Estimates

Following the completion of additional drilling in December 2011, Black Iron prepared an updated Mineral Resource estimate for the Shymanivske deposit. WGM was retained by Black Iron to audit this in-house estimate. The resources are reported above a -440 m ASL (about 500 m from surface), which is the same pit shell depth used in the previous BFS.

A summary of the NI 43-101-compliant Mineral Resources is provided in Table 1-1 below.

Table 1-1: Categorized Mineral Resource Estimate for the Shymanivske Iron Ore Deposit (Cut-off Grade of 10% Fe_{mag})

Category	Tonnes (Million)*	Fe_{tot} %	Fe_{mag} %
Measured	355.1	32.0	19.5
Indicated	290.7	31.1	17.9
Total M&I	645.8	31.6	18.8
Inferred	188.3	30.1	18.4

* Tonnage and grade numbers rounded to the first decimal

Mineral Resources that are not Mineral Reserves do not have a demonstrated economic viability. Given the uncertainty that may be attached to Inferred Mineral Resources, it cannot be assumed that continued exploration will lead to the upgrading of all or any part of an Inferred Mineral Resource to an Indicated or Measured Mineral Resource.

The Mineral Resource estimate for the Shymanivske deposit was completed using block sizes of 10 m x 20 m x 15 m and is based on 215 historical diamond drill holes, drilling from Black Iron's twin hole program (22 holes), and its definition-drilling program (41 holes). The drill holes are dispersed along the Banded Iron Formation horizons for approximately 2,150 m of strike length and 900 m of width of the Shymanivske deposit. The drilling was done on sections perpendicular to the strike of the formations, with spacing varying from 30 m to 130 m along sections, and from 80 m to 300 m along the strike with vertical depths of 250 m to 550 m.

Three major mineralized domains (SX1F, SX2F and SX4F) and one Oxide Domain (SX5F) were defined using a cut-off grade of 10% Fe_{mag} for the block model resource estimate. Alteration products in the form of martite, hematite, limonite and goethite are dominant features in the Oxide Domain. This domain was treated as waste in the Mineral Resource estimate because the iron contained in this zone cannot be recovered using the process designed to maximize iron recovery from the non-oxidized zones in which the bulk of the resource is contained. The inverse squared distance (ID^2) grade interpolation used 5 m equal-length composites generated from the raw assays and statistical analysis completed for the domains. The interpolation showed good normal distributions for both the composites and the raw assays, and it was determined that capping was not required for the Shymanivske deposit.

WGM conducted specific gravity (SG) measurements using bulk density and pycnometer data at both the MCM laboratory in Ukraine and, for validation purposes, at SGS-Lakefield in Canada. The results from both labs showed that the SG, when measured by pycnometer correlates strongly with %Fe_{mag} on the selected samples, except in the Oxide Zone where alteration has occurred. Using the variable density model, a 20% Fe_{mag} gives a SG of approximately 3.49.

A four-step approach based on search ellipse size and number of samples was used to generate the Fe_{tot} and Fe_{mag} grade models; however, the classification of the Mineral Resources was also based on drill hole density (or drilling pattern); geological knowledge/interpretation of the geology;

and some other constraints, such as the presence of alteration (Oxide Zone). A Distance Model was generated and the estimated Mineral Resources were reported by distances that represented the category or classification: Measured blocks were less than 100 m distance (average approx. 60 m), Indicated blocks were 60 m to 150 m (average approx. 100 m) and Inferred blocks were greater than 150 m (average approx. 200 m). The drilling density was lower in the deeper parts of the deposits, hence the drill hole spacing was taken into consideration when classifying the Mineral Resources and these areas were given a lower confidence category.

1.6 Mining Methods

Using the 2011 mineral resource estimate and geological block model, a pit optimization analysis was conducted to determine the cut-off grade and to what extent the deposit can be mined profitably. This was done using the 3D Lerchs-Grossman algorithm in MineSight with inputs such as mining and processing costs, revenue per block and operational parameters such as the Fe recovery, pit slopes and other imposed constraints. The subset of Mineral Resources within the open pit designed for the Shymanivske deposit, inclusive of mining dilution and mining recovery are presented in Table 1-2.

Table 1-2: Subset of Mineral Resources within the Open Pit Design (Above 13% Fe_{mag} Cut-off)

Material	Tonnage (Mt)	Fe_{tot} (%)	Fe_{mag} (%)
Measured	283	31.4	19.4
Indicated	106	31.2	19.0
Total Measured & Indicated	**389**	**31.4**	**19.3**
Inferred	22	31.2	19.6
Overburden	108	-	-
Waste Rock	286	-	-
Total Stripping	**394**	-	-
Strip Ratio	**1.0**	-	-

A mine plan based on continuous processing operations over 365 days per year, seven days per week and 24 hours per day was developed to support mining operations for the Project. The mine life was estimated at about 16.5 years. Annual ore requirements were determined based on processing plant production capacity and are in the order of 14.3 Mtpa in Phase 1 of the Project and 28.7 Mtpa in Phase 2 of the Project.

Mining phases, not to be confused with Project phases, including initial overburden and waste pre-stripping requirements and an annual mining schedule were developed. The mining method selected for the Project is based on conventional drill, blast, load and haul. Annual mining equipment fleet requirements were developed based on equipment performance parameters and average hauling distances based on pit design and configuration and location on the site plan for the crusher and waste piles. Capital and operating costs were estimated based on the mine plan.

1.7 Mineral Processing and Metallurgical Testwork

A significant amount of testwork was completed over a number of years, including that done by WorleyParsons during the 2012 BFS and additional tests by Lycopodium for the 2014 BFS. The main conclusion that came from the 2012 BFS testwork was that the iron mineralization from the Shymanivske deposit can be processed and upgraded to the targeted specifications with crushing, stage grinding, low intensity magnetic separation and sulphide flotation. The additional testwork completed during the 2014 BFS allowed the flowsheet to be refined and supported the results derived from the 2012 campaign. Testwork indicated that a final grinding size of 80% passing 32 µm was required to achieve a concentrate grading 68% iron and 4.5% silica with a sulphur content of 0.05%.

1.8 Recovery Methods and Beneficiation Plant Design

Metallurgical laboratory and pilot testwork achieved the desired quality of concentrate and demonstrated that by using the designed process and flowsheet it is possible to recover a saleable magnetite from Shymanivske ore.

In order to produce concentrate with the desired specification, the ore will be processed through stage crushing, stage grinding, low-intensity magnetic separation and sulphide flotation. Table 1-3 shows the process design basis for the Project. Annual and hourly nominal and design production rates as well as the operating and metallurgical performance parameters used to determine these rates.

Table 1-3: Process Design Basis for Phase 1 of the Shymanivske Concentrator

	Nominal Operating Parameters (Dry basis)		
	Average	**Nominal Hourly Throughput**	**Design Value**
Throughput (fresh feed)	14.3 Mtpa	1,818 tph	2,091 tph
Average Concentrate production	4.1 Mtpa	515 tph	592 tph
Tailings generated	10.3 Mtpa	1,303 tph	1,498 tph
Concentrate Wt Rec %	28.3%*	-	-
Concentrate Fe Rec % - Fe_{mag} Rec %	61.9% - 93.0%	-	-
Crushing circuit utilization %	70%	-	-
HPGR and concentrator utilization %	90%	-	-

	Nominal Operating Parameters (Dry basis)		
	Average	Nominal Hourly Throughput	Design Value
LOM Head grade %Fe - % Fe_{mag}	31.4% - 19.3%	-	-
Concentrate Specifications (%)	Fe = 68.0 SiO_2 = 4.5 S = 0.05 max Al_2O_3 = 0.43% P = 0.02 Moisture = 9.0 P_{80} = 32 µm		

* Weight recoveries were determined using the following weight recovery formula "Wt Rec = Fe_{mag}*1.464. This recovery equation was established from testwork during the 2014 FS.

The process flowsheet and resulting plant design consists of the major processing areas as described below:

- ROM mineral from the open pit is hauled to the gyratory crusher;
- ROM is stage-crushed prior to being conveyed by overland conveyor to the stockpile;
- The reclaim conveyor feeds the HPGR circuit where the mineral is reduced to a P_{80} of 2.1 mm;
- The HPGR circuit was conceptualized to allow for a single unit to handle the duty required to produce 4.0 Mtpa of concentrate;
- Crushed material from the HPGR circuit is subjected to a stage of cobber magnetic separation wherein the magnetic fraction is recovered;
- The cobber magnetics are sent to a ball mill in closed circuit with screens and magnetic separators;
- The ball mill circuit product is further treated in closed circuit grinding with tower mills, hydrocyclones and magnetic separation and is reduced to the final grind size of 32 µm;
- The tower mill circuit product undergoes a final (finisher) stage of magnetic separation;
- The finisher magnetic separator magnetic fraction is subjected to sulphide flotation in order to ensure the final concentrate meets the requirement of a max Sulphur level of 0.05%;
- The de-sulphurized concentrate is dewatered via thickening and press filters prior to being sent to the loadout where it is loaded onto trains manually in Phase 1 of the Project and via an automated system in Phase 2;
- Tailings from the various process stages are dewatered and pumped to the Tailings Management Facility (TMF).

1.9 Project Infrastructure

The major features and designated locations for site infrastructure developed during the 2014 FS were maintained for the re-scoped Shymanivske Project. For this PEA, the site plot plan has been adjusted to reflect the conceptual changes arising from the re-scoped Project. Major site infrastructure consists of the following:

- Shymanivske open pit mine constrained within the mining allotment boundary;
- Overburden and waste-rock dumps;
- Surface water management features (ditches and settling basins) and water treatment facilities;
- Roads, bridges and accesses for mine vehicles and light traffic;
- Mine support infrastructure including mine equipment maintenance shop, truck wash station, fuel loading and vehicle fueling system, explosives magazine;
- Dry process areas and buildings including primary crusher, secondary crushing area, crushed ore stockpile, HPGR area and conveyors;
- Wet process areas including primary and secondary grinding areas, LIMS areas, thickener area and filtering area;
- Concentrate handling including conveyors, covered stockpile, load-out system and rail spurs;
- Designated footprint for capacity expansion (addition of second mineral processing line);
- Tailings storage facility (TSF) and tailings pumping system;
- Main electrical substation and electrical distribution system;
- Diesel fuel receiving and storage area.

The Project area is serviced by existing powerlines, rail and ports. Rail transportation, port terminal and ship loading services will be provided by a common service provider. As such, BKI will not need to build its own infrastructure for these areas. Several port options were reviewed in the previous feasibility studies. For this PEA Study, it is assumed that rail and port facilities will have sufficient capacity and availability to service the Project as was previously confirmed by BKI through the signing of letters of intent with each major infrastructure provider.

Black Iron's Project will require the movement of 4 Mtpa of dry concentrate (4.4 Mtpa wet) in Phase 1 of the Project and 8 Mtpa of dry concentrate (8.8 Mtpa wet) in its ultimate Phase 2, from the Kryvyi Rih area Moiseevka rail station to the Black Sea port Yuzhny berth owned by TransInvestServic (TIS).

According to the local power utility consultant, UkrEnergoSetProekt (UESP), electrical power for Black Iron's Shymanivske Project will be drawn from the existing 150 kV Gornaya Substation owned by the local power utility Dneprovskaya ElectroEnergetisheskaya Systema, NEK Ukrenergo. The Gornaya substation is located 30 km south-east of the Shymanivske site.

1.10 Market Studies and Contracts

As part of this PEA Study, it is required that a commodity selling price be assumed in order to perform the Project Economic Analysis. BKI has not undertaken a market study and must therefore resort to other means to reasonably assume the selling price of iron ore concentrate.

The IODEX and MBIOI 62% Fe, CFR China Port indices are commonly used as the benchmarks for basing off-take agreements. Indices based on 65% Fe iron ore products have also become an important benchmark to differentiate higher quality iron ore products.

Adjustments in the form of a premium or penalty are made to account for higher (or lower) Fe content. The spread between the 62% Fe index and the 65% Fe index provides a good measure of the premium attributed to higher grade products. Quality premiums/penalties are also tracked for other elements such as SiO_2, Al_2O_3 and P, which have an important impact on downstream operations such as sintering, pelletizing, ironmaking and steelmaking.

The PEA assumes a product selling price of $108.73/t of concentrate, CFR China. This price was calculated using the 36-month trailing average price of $61.88/t for the Platts IODEX 62% Fe, CFR North China, adding the three-month trailing average iron grade premium of $7.21/t per 1% Fe above 62% Fe, which equates to $43.28/t for Black Iron's 68% Fe product, and applying a trace element premium (for silica, phosphorus and alumina), net of penalties, of $3.57/t of concentrate. The realized selling price for a ship loaded at Port Yuzhny (FOB) assumed in the financial analysis is $97.19/t. The final price is determined after applying the current actual shipping cost of $11.54/t to deliver product to North China.

1.11 Environment

Prior to May 2017, the Ukrainian EIA, or the Otsinka Vplyvu na Navkolyshne Seredovysce (OVNS), was required by law to be approved by a State Environment Review (SER) prior to commencement of Project development activities. Legally, the OVNS can be prepared and submitted only by a suitably authorized Ukrainian design institute.

The OVNS process has some similarities to an Environment, Social and Health Impact Assessment (ESHIA), as undertaken in other countries. However, the OVNS process is generally viewed as a compliance procedure, whereby the determination of the calculated emission and pollutant level that falls beyond a statutory sanitary (or buffer) zone, must be reduced to compliance limits. This determination is the basis for the regulatory approval decision.

As of December 18, 2017, organizations planning any activity that has the potential to significantly impact the environment are required to perform an EIA subject to the requirements imposed by Law No. 2059-VIII regarding Environment Impact Assessment adopted on May 23, 2017. Considering that an OVNS was not completed on the Shymanivske Project before December 18, 2017, the Project will be subject to the new law. Mandatory regulatory requirements and standards for the Project include the following:

- Ukrainian laws and regulations;
- International environmental treaties and conventions that Ukraine is signatory to; and
- International agreements.

Voluntary codes and practices referred to in this Chapter include:

- Guidelines and standards from the World Bank / International Finance Corporation (IFC); and
- Industry association standards (cf. industry best practice).

Since 2010, Black Iron has been reviewing the environmental and social baseline and context of the Project and establishing appropriate data-collection programs, impact-assessment studies, consultation programs and design criteria, so that the Project can meet the required environmental and social standards. BBA (2011) outlined the general environmental and social compliance requirements for the Project, including an overview of the regulatory process.

In April 2012, following a technical and commercial tendering process, Black Iron Inc. commissioned TPA to undertake the ESIA baseline surveys and to define the boundaries of the Sanitary Zone. Baseline data collection commenced in June 2012, in line with a program of surveys that had been designed collaboratively between TPA and WorleyParsons. WorleyParsons conducted a number of surveys in tandem with the ESIA baseline surveys, in order to enhance the design and engineering work and develop a more comprehensive understanding of Project risks and approaches to managing the risk assessment. TPA conducted the first round of ESIA baseline surveys during the months of June and July 2012.

The Shymanivske iron ore deposit is part of a well-established iron ore mining area with several active iron ore mining operations surrounding it. The special permit under which the Project operates covers an area of 256 ha and is located 330 km south-east of Kiev, in central Ukraine. As such, environmental studies to be undertaken by BKI as part of its permitting process will be greatly influenced by historical and existing activities. Furthermore, future activities related to advancing the Project permitting process need to be aligned with the new law that has recently been adopted.

1.12 Capital and Operating Cost Estimates

The Shymanivske Project scope covered in this PEA Study is based on the construction of a facility having a nominal annual production capacity of 4.0 Mt of concentrate followed by a second construction phase to introduce a duplicate parallel processing line to increase the annual production to 8.0 Mt in Year 5.

Table 1-4 presents a summary of total estimated capital cost for Phase 1 of the Shymanivske Project.

Table 1-4: Estimated Phase 1 Capital Costs

Estimated Capital Costs	(M$)
0000 - Construction Indirects	5.1
1000 - Mine Area	22.2
2000 - Beneficiation Plant	192.0
3000 - Tailings and Waste	11.1
5000 - Project Infrastructure	44.1
Total Direct Costs	**274.5**
Owner's Costs	38.2
Project Indirect Costs	41.2
Contingency	53.7
Total Project Capital Cost	**407.6**
Mine Pre-Stripping (Capitalized from OPEX)	13.9
Mining Equipment Leasing Cost (Capitalized)	30.0
Total Pre-production Capital Cost	**451.5**

The total Phase 1 capital cost is estimated to be $407.6M and the total pre-production capital costs are estimated at $451.5M. This capital cost estimate is expressed in constant Q4-2017 US Dollars using the following exchange rates:

- 28.00 UHA = 1.00 USD
- 6.55 CNY = 1.00 USD

Table 1-5 presents a summary of total estimated capital cost for Phase 2 of the Shymanivske Project.

Table 1-5: Estimated Phase 2 Capital Costs

Estimated Capital Costs	(M$)
0000 - Construction Indirects	-
1000 - Mine Area	3.3
2000 - Beneficiation Plant	196.4
3000 - Tailings and Waste	3.2
5000 - Project Infrastructure	24.0
Total Direct Costs	**226.9**
Owner's Costs	11.2
Project Indirect Costs	33.6
Contingency	43.7
Total Project Capital Cost	**315.3**

Mining Equipment	49.0
Total Phase 2 Capital Cost	**364.3**

The total Phase 2 capital cost is estimated to be $364.3M.

Direct costs include costs related to transporting purchased equipment to the Project site. The pre-production capital costs include the initial mine pre-stripping costs in the amount of $13.9M. Also included in the costs is the initial mining equipment fleet required for pre-stripping and Year 1 of mining operations, having an estimated value of $94.3M, as well as concentrate loaders required for Phase 1 with an estimated value of $15.5M, which both will be leased. As such, annual lease payments over the life of the leases are included in the operating costs. Lease payments made prior to production start-up amount to $30.0M.

The preceding Phase 1 and Phase 2 estimate tables do not include the following items:

- Sustaining capital costs are estimated at $231.6M and consist of:
  - Mine equipment fleet additions and replacements totalling $119.5M
  - Facilities additions and improvements, and costs related to phasing of the TSF dam construction over the LOM, as described in Chapter 18, totalling $112.1M;
- Costs related to closure and rehabilitation of the mine site, totaling $27.9M, assumed to be disbursed in the final year of operations. These costs consist of costs associated with the closure of the TMF, as estimated by Knight Piesold, as well as costs associated with the restoration of other site infrastructure that were estimated by BBA using factors from similar projects.

1.13 Operating Costs

Table 1-6 presents a summary of total estimated average, life of mine (LOM) operating costs in $/t of dry concentrate produced.

Table 1-6: Total Estimated Average LOM Operating Cost ($/t Dry Concentrate)

Estimated Average	$/t
Mining	11.47
Mineral Processing	10.17
Site Infrastructure	0.68
General Administration	0.64
Environmental and Tailings Management	0.37
Rail Transportation and Port Services	9.30
Total	**32.63**

The total estimated operating costs are $32.63/t of dry concentrate produced. Operating costs include the estimated costs of leased equipment (equipment cost plus interest) over the life of the leases as well as the salvage value estimated for the concentrate loaders, which will no longer be required in Year 5 of operation and beyond.

Royalties and working capital are not included in the operating cost estimate presented but are treated separately in the Economic Analysis.

1.14 Economic Analysis

The Economic Analysis for the Shymanivske Project was performed on a pre-tax and post-tax basis using a discounted cash flow model based. The results are presented in Table 1-7 and Table 1-8. The results of the economic analysis project a pre-tax but post royalty internal rate of return (IRR) of 40.5% and a $1.9 billion net present value (NPV) at a 10% discount rate.

Table 1-7: Pre-Tax (Unlevered) Economic Analysis Results

IRR = 40.5% **Payback = 2.9 years**	**NPV (M$)**
Discounting Rate	
0%	5,725
8%	2,295
10%	1,852
12%	1,501

The Project is subject to two levels of taxation that are material to the financial performance of the Project:

- Corporate tax applied at a rate of 18% on taxable income;
- Value Added Tax (VAT) applied at a 20% rate on all taxable purchases of goods and services. In practice, the VAT is not expected to be refunded until the Project is operational. After operations commence, the VAT is expected to be refunded with a one-year delay after being incurred.

The results of the economic analysis project a post-tax IRR of 34.4% and a $1.4 billion NPV at a 10% discount rate.

Table 1-8: Post Tax (Unlevered) Economic Analysis Results

IRR = 34.4% Payback = 3.3 years Discounting Rate	NPV (M$)
0%	4,642
8%	1,807
10%	1,442
12%	1,152

1.15 Project Schedule

A high level Project Execution Plan and a Project Execution Schedule were developed as part of this Study. Following this PEA Study, Black Iron will likely proceed with a new Feasibility Study for the re-scoped Project, which is expected to last approximately nine months. In parallel, the permitting process will also be undertaken. The Project Schedule presented in Table 1-9 is based on duration and key milestones relative to the date whereby all required permits are obtained.

Table 1-9: Key Project Milestones

Major Milestones	Month
Complete Exploration Drilling and Update Mineral Resource Estimate	M -21
Start New FS on Re-Scoped, Phased Project	M -21
Complete New FS on Re-Scoped, Phased Project	M -12
Assemble Owner's Team	M -12
Award EPCM Contract and Start EP	M -9
Permit to Start Construction Available	**M 0**
Start Construction (Site Preparation)	M 0
Construction Completed	M 24
Cold Commissioning Completed	M 25
Hot Commissioning and Handover to Operations	M 28

1.16 Conclusions and Recommendations

The re-scoped Shymanivske Project demonstrates a significant benefit in executing the Project in two phases, namely by providing a significant reduction of initial capital required. The concentrate produced by the Project is of high Fe grade (68%) and is low in deleterious elements such as alumina and phosphorus. This attracts significant price premiums when compared to the benchmark 62% Fe fines. This is driven primarily by Chinese steelmakers trying to increase efficiency, reduce overall costs and most importantly reduce their greenhouse gas emissions. Furthermore, the Shymanivske concentrate is of fine particle size making it readily usable for any pelletizing operation as pellet feed.

The Project has been subject to two previous Feasibility Studies. The ongoing political instability in the Ukraine remains an important risk to the development of the Project. Some legal issues related to the relocation of a small village as well as to the new environmental permitting law should also be noted. Technical risks are mainly related to tailings dam design and extreme waterfall events. These risks can be mitigated firstly through proper design and secondly through proper operations. Processing risks are mainly associated to adequate equipment sizing, especially in the flotation circuit, based on the mineral characterization performed during the extensive metallurgical testwork that was done during the past studies.

Based on the information available and the degree of development of the Project as of the effective date of this Report, BBA is of the opinion that the Project is technically and financially sufficiently robust to warrant proceeding to a Feasibility Study for the re-scoped Project.

2. INTRODUCTION

This amended Technical Report for the "Preliminary Economic Assessment of the Re-scoped Shymanivske Iron Ore Deposit" effective November 21, 2017 has been prepared following detailed due diligence from a potential offtake investor which identified an error in the calculation of in pit mineral resources. The table showing the pit optimization results has been updated, however, the pit shell selected from the pit optimization remains the same and the open pit design has not changed. An additional 25 m lift has been added to the waste rock facility to account for the additional waste rock. The mine plan for the PEA has been updated resulting in 17-year mine life. The mine equipment fleet requirements and manpower have been updated for this amended report as well as the mining cost model and the overall project economics. All other sections of the report remain as originally published.

2.1 Scope of Study

This Technical Report (the "Report" or the "Study") presents the results of the re-scoped Preliminary Economic Assessment (PEA) that was undertaken for the development of the Shymanivske Iron Ore Property, which is part of the KrivBass iron ore basin, located in the Dnepropetrovsk region of Ukraine. The Shymanivske subsurface usage permit for the extraction of iron ore, registered as Special Permit No. 4537, is owned by a Ukraine registered company called Shymanivske Steel LLC who, in turn, is owned by Black Iron Cyprus Ltd. and ultimately Black Iron Inc. (BKI or the Corporation), registered in Ontario, Canada. The Property covers 256 hectares and is located approximately 330 km south-east of Kiev and 150 km north of the Black Sea in Ukraine.

In August 2017, BKI commissioned the engineering consulting group BBA Inc. (BBA) to perform this PEA. This Report was prepared at the request of Mr. Matt Simpson, CEO of BKI. The Corporation is a Canadian iron ore exploration and development company listed on the Toronto Stock Exchange (TSX) under the symbol BKI, with its head office situated at:

65 Queen St. West
Suite 800
Toronto, Ontario
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This Technical Report titled "Preliminary Economic Assessment of the Re-scoped Shymanivske Iron Ore Deposit" was prepared by Qualified Persons (QPs) following the guidelines of the "Canadian Securities Administrators" National Instrument 43-101 (NI 43-101), and in conformity with the guidelines of the Canadian Mining, Metallurgy and Petroleum (CIM) Standard on Mineral Resources and Reserves.

This Report is considered effective as of November 21, 2017.

2.2 Background and Project History

Since 2011, BKI has advanced the development of the Shymanivske Project by performing exploration activities and studies. The Property has been the subject of a number of technical studies, as outlined by the following historic technical reports, as filed on SEDAR:

- January 27, 2011: Resource Estimate - Shymanivske Deposit in Ukraine. This Report presented BKI's Mineral Resource estimate based on historical data;
- December 14, 2011: Preliminary Economic Assessment Report of the Shymanivske Iron Ore Deposit. This study was based on the development of mining and mineral processing operations having a production capacity of 7.3 Mtpa of iron ore concentrate grading 67% Fe and included an option to add a pellet plant having a capacity to produce 7.6 Mtpa of acid blast furnace pellets at the mine site. For this PEA, a twin hole drilling program was undertaken to confirm the Mineral Resource estimate which was previously based on historical data;
- December 17, 2012: Feasibility Study Report of the Shymanivske Iron Ore Deposit. This study was based on the development of mining and mineral processing operations having a production capacity of 9.2 Mtpa of iron ore concentrate grading 68% Fe. In this study, the mineral processing flowsheet was optimized in order to maximize throughput and reduce operating costs;
- January 24, 2014: Feasibility Study Report of the Shymanivske Iron Ore Deposit. This study updated the previous 2012 FS to include results from pilot plant metallurgical test work and use of wet cobbing instead of dry. These changes lead to a more compact processing plant with higher production capacity of 9.9 Mtpa of iron ore concentrate grading 68% Fe.

The 2014 FS sought to maximize economic returns through optimal equipment use and concentrate production. This however resulted in a project having an initial capital cost in excess of $1 billion US. In early 2014, iron ore prices (62% Fe Platts benchmark price) were well over $100/t but began a steep slide to well under $50/t in early 2016. With the fall in price coupled with political instability in Ukraine, it became difficult for BKI to advance the Project to construction.

Since late 2016, there are strong indications that the iron ore market is again morphing and favouring higher iron grade products (i.e. >62% Fe) at the detriment of lower grades. This is mainly driven by Chinese steel mills seeking to become more efficient and reduce their environmental footprint. There is a prevailing sentiment that this trend will not subside and higher grade iron ore will continue to attract greater premiums. Investments in Ukraine still carry some risks due to the ongoing political tensions however, since 2014, the Ukrainian Hryvnia (UAH) has devalued by more than 300% versus the USD, thus having a significant impact on overall Project economics.

Given these factors, BKI has taken the initiative of seeking to advance the Project by reducing the initial scale, hence the initial capital requirements of the Project and phasing its development. As such, it has asked BBA to undertake a PEA level study to estimate capital and operating costs for the re-scoped Project and assess its economic performance prior to undertaking a feasibility level study. The re-scoped Project considers a mining and mineral processing operation having a nominal capacity of 4.0 Mtpa of dry 68% Fe blast furnace pellet feed concentrate. The flowsheet and process equipment for the initial 4.0 Mtpa of concentrate line will be replicated in order to double the production capacity to 8.0 Mtpa in Year 5 of production.

This present re-scoped PEA replaces the previous 2014 Feasibility Study NI 43-101 Report as the current Report for the Shymanivske Project. The results of the 2014 FS, including the mineral reserve estimate and economic analysis, are no longer relevant and should not be relied upon.

2.3 Sources of Information

BBA based this current PEA Study primarily on the previous 2012 and 2014 Feasibility Studies and their underlying information, including the Mineral Resource block model, the metallurgical testwork, process flowsheets, site and plant layouts and capital and operating costs. This information has been used and updated for the re-scoped Project as required.

2.4 Terms of Reference

Unless otherwise stated:

- All units of measurement in the Report are in the metric system;
- All costs, revenues and values are expressed in terms of US Dollar (USD or $); and
- A foreign exchange rate of $1 USD = 28.0 UAH.

A list of abbreviations is included in this Report and can be found after the Table of Contents.

This Report is intended to be used by Black Iron, subject to the terms and conditions of its agreement with BBA. The contract allows Black Iron to file this Report as a Technical Report with Canadian Securities Regulatory Authorities, pursuant to provincial securities legislation. Except for the purposes legislated under provincial securities laws, any other use of this Report by any third party is solely at that party’s risk.

2.5 Site Visit

Mr. Angelo Grandillo, P. Eng. has not visited the Property.

Mr. Jeffrey Cassoff, P. Eng. has not visited the Property.

Watt, Griffis and McOuat Limited (WGM) Senior Associate Geologist, Mr. Richard Risto, P.Geo, QP, visited the Property four times in 2011. WGM's first site visit was from April 11 to April 18; site visit two was from May 22 to May 29; site visit three was from June 27 to July 3; and the fourth site visit was from December 12 to 17. WGM then reviewed Black Iron's program results with Black Iron's Geologist, Mr. Farshid Ghazanfari, P.Geo., and the GEORESOURCE personnel conducting the program. Mr. Risto collected independent drill core samples during the second, third and fourth site visits for independent assay.

Mr. Michael Kociumbas, P.Geo., Senior Geologist and Vice-President of WGM, has not visited the Property.

3. RELIANCE ON OTHER EXPERTS

Neither BBA nor WGM have verified the legal titles to the Property nor any underlying agreement(s) that may exist concerning the licences or other agreement(s) between third parties, but has relied on BKI to have conducted the proper legal due diligence. BKI has provided sections of Chapter 4 of this Report, which describe the ownership structure of the Project.

WGM has not carried out any independent geological surveys of the Property, but, did complete a number of site visits. It has relied on geological descriptions and program results, historic reports, field notes and communications with BKI.

For this PEA, BBA has performed the Economic Analysis for the Project on a pre-tax basis and has relied on BKI and its tax consultants to provide an estimate of annual taxes due to perform the post-tax Economic Analysis, as outlined in Chapter 22 of this Report.

Any statements and opinions expressed in this document are given in good faith and in the belief that such statements and opinions are not false or misleading at the effective date of this Report.

This Report was prepared using the resource materials, reports and documents noted in the text and listed in Chapter 27 – References. Although the authors have made every effort to convey the content of the reports accurately, they cannot guarantee either the accuracy or the validity of the work described in them.

BBA had the responsibility for assuring that this Technical Report meets the guidelines and standards stipulated. Table 3-1 outlines responsibility for the various sections of the Report.

The following QPs have contributed to the writing of this PEA and have provided QP certificates, included in this Report, indicating the chapters and/or sections of the Report that they have authored.

- Angelo Grandillo BBA
- Richard Risto WGM
- Michael Kociumbas WGM
- Jeffrey Cassoff BBA

Mr. Pavlo Bodak, not a QP as per NI 43-101 standards, has contributed to the Study by providing BBA with local Project unit costs and labour rates used for estimating capital and operating costs.

Table 3-1: Technical Report Chapter List of Responsibility

Chapter Number	Chapter Title	Responsibility	Comments and Exceptions
1	Summary	BBA	Contribution by WGM
2	Introduction	BBA	
3	Reliance on Other Experts	BBA	
4	Property Description and Location	BBA	BKI provided information on Property description and ownership.
5	Accessibility, Climate, Local Resources, Infrastructure and Physiography	BBA	
6	History	WGM	
7	Geological Setting and Mineralization	WGM	
8	Deposit Types	WGM	
9	Exploration	WGM	
10	Drilling	WGM	Contribution by BKI
11	Sample Preparation, Analyses, and Security	WGM	
12	Data Verification	WGM	
13	Mineral Processing and Metallurgical Testing	BBA	
14	Mineral Resource Estimate	WGM	Contribution by BKI
15	Mineral Reserve Estimate	BBA	
16	Mining Methods	BBA	
17	Recovery Methods	BBA	
18	Project Infrastructure	BBA	
19	Market Studies and Contracts	BBA	Information on contracts and agreements provided by BKI.
20	Environmental Studies, Permitting and Social or Community Impact	BBA	Contribution by BKI

Chapter Number	Chapter Title	Responsibility	Comments and Exceptions
21	Capital and Operating Costs	BBA	
22	Economic Analysis	BBA	
23	Adjacent Properties	BBA	Contribution by BKI
24	Other Relevant Data and Information	BBA	
25	Interpretation and Conclusions	BBA	Contribution by WGM
26	Recommendations	BBA	Contribution by WGM
27	References	BBA	Contribution by WGM

4. PROPERTY DESCRIPTION AND LOCATION

4.1 Property Location

Ukraine is strategically situated between Europe, Russia, Asia and the Middle East. The Shymanivske iron ore deposit is located approximately 330 km south-east of the capital city of Kiev and 243 km north-east from Ukraine's largest Black Sea port of Odessa. The Property encompasses an area of approximately 300 ha and is situated in the well-known iron ore mining district of KrivBass in the Dnepropetrovsk Region. KrivBass is the heart of mining and metallurgy in the country, containing a significant portion of the country's ore reserves. The mine site is 8 km southwest from the city of Kryvyi Rih; Figure 4-1 presents a map of Ukraine and the Project site location. The pit is centered at approximately 47°50'N latitude and 33°16'E longitude. ArcelorMittal's Kryvyi Rih open pit mine is located immediately north of the Property and shares a Property boundary.

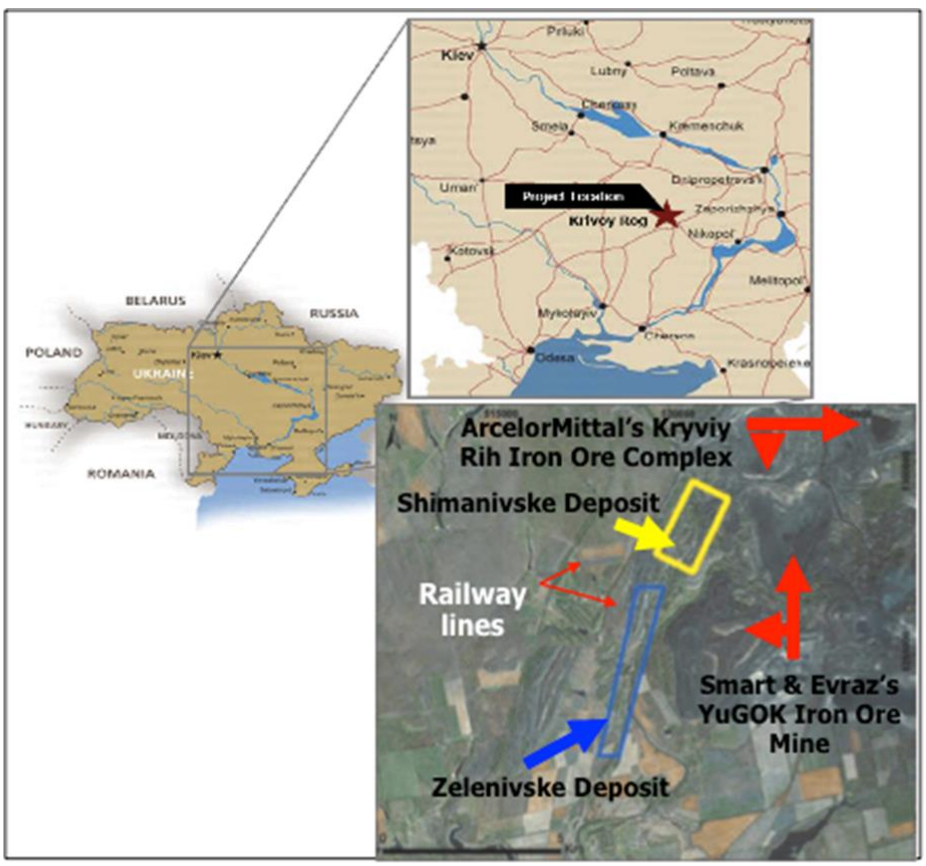


Figure 4-1: Map of Ukraine with Project Location

4.2 Property Description and Ownership

The existing Special Permit No. 4537, issued on December 13, 2007, covers 2.56 km² (256 ha) of land and is valid until November 1, 2024 with the option to renew it in 20-year increments. The permit authorizes the extraction of the subsurface ferriferous quartzite minerals from the Shymanivske deposit.

Table 4-1 provides the vertices of the Property as listed on the licence documentation issued by the government of Ukraine.

Table 4-1: Shymanivske Property in Ukraine

ID	Latitude (deg, min, sec)	Longitude (deg, min, sec)
T1	47 49 57 N	33 15 32 E
T2	47 51 02 N	33 16 21 E
T3	47 50 46 N	33 17 10 E
T4	47 49 40 N	33 16 22 E

In order to maintain the active mining licence, compliance with the following work program is required. Table 4-2 presents the type of work and time schedule.

Table 4-2: Program of Work Under Special Permit No. 4537

Type of work	Beginning	End
Making amendments to the Special Permit for subsurface use №. 4537, dated December 13, 2007 and to Program of Work	Q1-2016	Q2-2016
Drawing and approval of the mining allotment design	Q3-2016	Q1-2017
Drawing and approval of the land allotment design	Q2-2017	Q1-2018
Drawing of own processing plant design	Q3-2016	Q4-2017
Beginning of opening of the ferruginous quartzite deposit and mining of iron ore	Q2-2018	
Operating at designed capacity	Q4-2024	

The proposed pit shell covers the majority of the Shymanivske licence area; yet, additional land for the plant, tailings and waste-rock dumps is needed for the development of the Project. The east and south sides of the licence area face space limitations due to close proximity of active mine operations and infrastructure. However, on the west side of the Shymanivske licensed territory, there are more than 3,000 ha of state-owned land currently being used by the Ministry of Defence, 1,460 ha of which are being sought to support Project development and further expansions. To access this land on the west, a small portion of land will need to be leased or acquired from the State Forestry agency, which is supportive of a land swap based on fairly advanced land rezoning work, as of the time of writing of this Report. On the north, there is a small portion of land owned by the City of Kryvyi Rih that is not being used.

The area to the south is occupied by the village of Rudnichnoe. This village falls into the sanitary zone of the future open pit and will have to be relocated. In addition, there is an old mine service garage, reclaimed waste dumps and small portion of a railway line owned by the neighbouring mines YuGOK and ArcelorMittal KR, which are located on the Shymanivske Property and that will have to be moved by BKI, the costs of which are included in the capital cost estimate contained within the Report. The Company has started discussions with YuGOK, ArcelorMittal KR, and the local authorities with respect to the garage, railway line and partial waste dump removals.

4.3 Property Agreements

A land consultant was hired by BKI to perform a detailed “land audit” of the required Project properties. The audit confirmed that the land east of the ArcelorMittal railway needed for pit development (~650 ha) belongs to the Kryvyi Rih City Council. The land west of the ArcelorMittal railway necessary for accommodating the Project general infrastructure, tailings storage facility, waste dumps and beneficiation plant is owned by the Ukrainian state. BKI is currently in discussion with the City Council and the State authorities regarding obtaining the surface rights for all lands required by the Project.

BKI is not aware of any environmental liabilities or any royalties attached to the Property, other than levies that are payable to the Ukrainian State. These are calculated as the higher of the following:

1. 8% of the net selling price (defined as gross selling price less shipping, rail, port and any customs fees); or
2. Cost (defined as mining and beneficiation costs) corrected with a profitability factor (which is defined by the government) multiplied by 8%, thus the current formula is:
   - (Cost + (Cost x .22)) x 8%.

In BKI’s case, it is expected that the first formula based on selling price will be the higher of the two.

The majority of the surface rights upon which the Shymanivske Property resides are owned by the City of Kryvyi Rih. However, a portion in the northern end of the Shymanivske Property, where most of the inferred resources are located, has been leased to ArcelorMittal by the Kryvyi Rih City Council. Acquisition of these surface rights is required to maximize the Project's economics given this area of the ore body contains relatively high grade and low strip ratio ore. BKI has initiated a legal proceeding to challenge the legitimacy of the processes of the Kryvyi Rih City Council, as land owner, in granting these leases. At the request of the Kryvyi Rih City Mayor, a working group has been created to address the land issues and find an out of court resolution as was successfully done with the parcel of land formerly leased to another neighbouring mine called YuGOK that has since been turned back to the City of Kryvyi Rih.

On March 29, 2017 the Kryvyi Rih City Council approved the Project's DPT which allows Shymanivske Steel to start the land allotment procedure. This entails conducting design work in preparation for allocating a major part of KR City land (except the village of Rudnichnoe) for the Project's development purposes. A Ukrainian Company called Yuristek Grup LLC (Surveyors and Consulting Company) was selected to execute the above work and started on September 22, 2017.

4.4 Permitting

BKI does not yet have all the necessary surface rights to conduct mining activities on the Project. However, surface rights are not required to conduct the on-going exploration and engineering activities. The next major permitting step for BKI is to obtain a Land Allotment, which entails hosting a public hearing on the Project followed by completion of a detailed report describing the proposed major infrastructure and utility tie-ins required for the Project. BKI's management, supported by local city council, successfully completed the public hearings in January 2017 and received approval from Kryvyi Rih's City Council to complete the Land Allotment plan in March, 2017. Work on the Land Allotment plan is currently ongoing as of the time of publishing this PEA. Figure 4-2 shows an overview of the major steps in the mine permitting process, according to the current Ukrainian regulations.

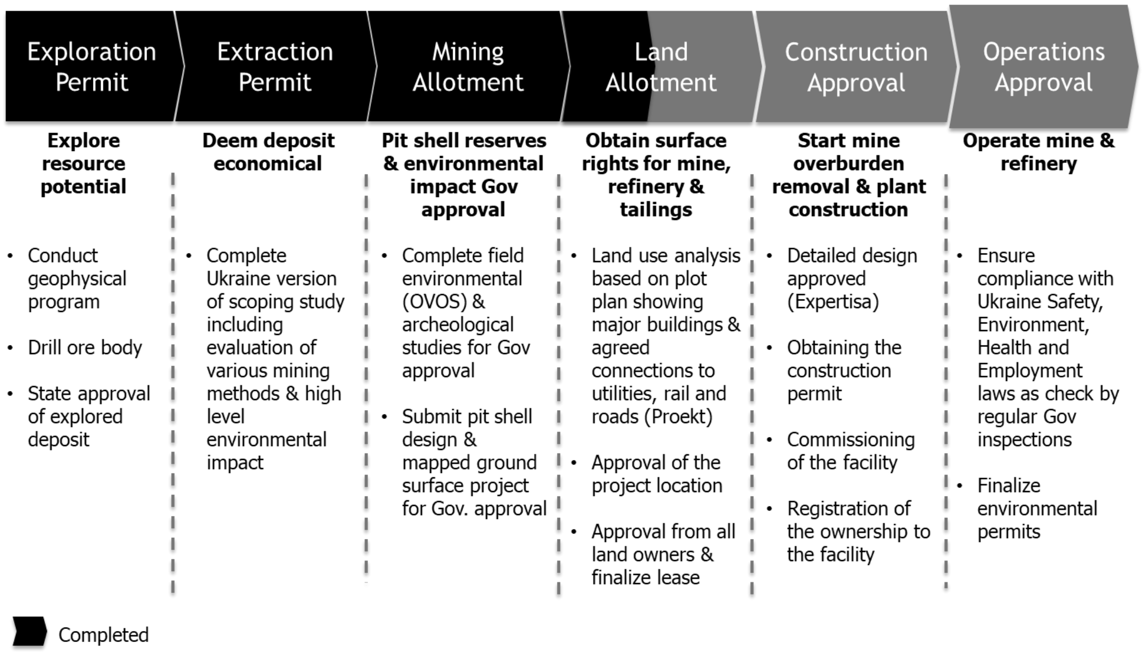


Figure 4-2: Ukrainian Permitting Process Overview

The process consists of six major steps. The first step is to obtain an exploration permit that allows the company to conduct necessary ground geophysical surveys and exploration drilling to determine the resources available for extraction. The second step is to obtain an extraction permit, which entails proving the economic viability of mining the resources found using the optimal mining method. The third step is to obtain a Mining Allotment, which entails proving to the authorities that the deposit has sufficient reserves to justify industrial scale mining; that the design of the pit follows all local technical, safety and environmental requirements; and that the current land owners do not object to mining activities on their land. The Company had also completed a preliminary ecological impact study to determine both the current baseline and the likely impact of this Project on parameters such as wildlife, fauna, air and water quality in the region. Additionally, an archeological study has been conducted to make sure that no historical or cultural landmarks are negatively impacted by the mining activities. Both studies will have to be reviewed and approved by the State committees responsible for each area, along with a review and approval of the pit shell design by the Government's State Mining Technical Examination Board (Gosudarstvenoy Gornoy Technicheskiy Nadzor). With the mining allotment now in hand, BKI is currently developing a land allotment plan for the pit and production facilities that includes the following: (i) analysis of the types of land that are going to be engaged in the mining activities; (ii) losses to the State budget related to the change of the land usage; (iii) the way the new development impacts local development plans and; (iv) tie-ins to the existing infrastructure, such as electricity, gas, water, railroad, etc. Once this work is completed and approved by local authorities, BKI will obtain approval from all land owners and sign long-term leases.

After securing the land the company will start step five, which is the basic design of the complete production facility for approval by the State Architectural and Construction Commission known as GASK. As construction starts, BKI will sign contracts with local utilities and infrastructure providers, such as the National Railway, to connect services to their existing networks.

Once the tie-ins are completed for the pit, the beneficiation plant, and major infrastructure, a number of State agencies responsible for safety and environmental protection will have to inspect the facility and sign off their approval before starting operations as the final, sixth, step in the permitting process. Regular checks will continue throughout the life of the asset to ensure that the standards and rules are being followed.

5. ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

5.1 Access

The Property is immediately adjacent to the city of Kryvyi Rih and is encompassed by road systems serving the city and local mines. These roads are mostly paved. During the 2011, 2012 exploration program, the Property was accessed from the south via an old cobblestone road to the town of Shirokoe. Although there is an airport in Kryvyi Rih, suitable for large commercial aircraft, international access is typically achieved using the Dnepropetrovsk International airport which is serviced by multiple daily flights and is a 2.5 hr drive to site.

The government owned Ukrainian National Rail System is located within 1 km of the Shymanivske proposed Plant facility and a memorandum of understanding (MOU) has been put in place to secure up to 20 million tonnes per annum.

There are five sea ports, ranging from 140 km to 520 km away from the site and including Odessa, Kerch, Yuzhny, Izmail and Nikolaev. A MOU has been signed with a company owning several berths at Port Yuzhny to secure 9.5 million tonnes per annum of capacity.

5.2 Climate

The climate of the Kryvyi Rih region is temperate-continental, semiarid (Bsk) according to the Köppen climate classification system. This climate tends to generate warm summers and cold winters, with low precipitation and an average annual air temperature 8.3°C. The average temperature in January is -4.9°C. The maximum temperature in July is 38°C. The average depth of snow cover is 10 to 14 cm and the maximum depth of frost penetration is 0.8 to 1 m.

Relative humidity of the air during the winter period is about 80-85% and about 55-60% during summer. The average annual quantity of precipitation generally ranges from 400 to 600 mm.

5.3 Physiography

The Property is rather flat-lying, with some gullies. It slopes generally to the south-east. Its central part is divided by the Tymashova Valley and its southeast side drops towards the Inhulets River. The highest altitudes of the Property are in its western and eastern parts, at 122 m above sea level (ASL), while the central part is lower, ranging from 65 m ASL down to 45 m ASL.

There are three old and very small pits on the Property, the vestiges of the mining of high grade mineralization and the extraction of limestone, clay, sand and gravel for building materials. Thin soil overlies flat-lying Cenozoic limestones and green and red clays, which vary in thickness from 9.7 to 21.2 m with an average of 16 m. Mine waste covers a significant portion of the Property, particularly its west and east margins, leaving its centre corridor mostly free. On the basis of comparison of the present topography with data presented on historical drill cross-sections for the Property, it is determined that waste rock, in places, is up to 30 m thick.

The vegetation consists mainly of grassy pastures and shrubby areas. The village of Shimanovka previously occupied part of the Property but was removed several years ago to provide additional space for mine waste from YuGOK and NKGOK, predecessor of ArcelorMittal.

5.4 Local Resources and Infrastructure

Considerable infrastructure around the plant already exists. The mining operations local resources and infrastructure consist of:

- The Property is adjacent to the City of Kryvyi Rih, a major city with a population of 647,700 (as of 2015). Kryvyi Rih was built around the open pit and underground iron ore mines that are located within the city and to the northwest and southeast of it. Agriculture is also an important industry, and there are agricultural lands adjacent to the Property. City institutions include universities and trade schools, which in large part exist to supply direct and indirect labour to the local iron ore mines;
- With the seven operating mines in the area, there is a well-educated and large resource pool of workers that have experience in iron ore mining operations;
- Electrical power for the Project will be drawn from the existing 150 kV Gornaya Substation, owned by the local power utility, Dneprovskaya ElectroEnergetisheskaya Systema – NEK Ukrenergo and located 30 km south east of the Project site. UESP confirmed that the local power grid has sufficient spare capacity (2400 MW by 2017) to deliver the required power to the Project. Currently the Gornaya Substation is loaded only at 30% of its full capacity;
- Process water for the plant will be provided by a 9-km pipeline from Yuzhnaya aeration station plant. Water from the Yuzhnaya Aeration Plant is biologically treated prior to its use as make-up water;
- Natural gas from the public distribution system is obtained from ZelenaBalka through a 9-km 100 mm line with pressure of 410 KPa;
- The source of potable water is the Karachunovskoe Reservoir, north of the plant via a 7-km water pipeline;
- The Shymanivske area is serviced by existing rail and ports. Several options were reviewed for the export of concentrate, which were subsequently narrowed down to two port options. The port of Nikolaev is the closest and therefore the most economical port of export; however, there is a limited excess of only 2 Mtpa. Hence, the plan is to send production to the deep sea port of Yuzhny where it will be loaded onto Cape sized ocean going vessels at the privately-owned TIS terminal;
- To date, BKI has signed the letters of intent with most service providers including power, rail, port, water and natural gas.

6. HISTORY

6.1 General

A summary of the historical work compiled from available documents is presented below. Details, however, are scant as documentation is incomplete. Most of the information, described herein for the pre-1989 periods, is derived from the 1989 Soviet report on the Property, titled: “Detailed Elaboration of Ferriferous Quartzites, Shymanivske Deposit of Krivorozhsky Iron-Ore Basin of the Dneprovsky Region” by Pashkova E.P., Postolyuk R.I. and others. GEORESOURCE Chief Geologist Leonid Galchansky, supervisor of Black Iron’s 2011 drill program, was a co-author of this 1989 report and has provided additional insight. In addition to what is summarized herein, the report also includes some description of geophysical surveys conducted throughout the Soviet era, but these surveys are not described in this Report because they are not relevant to the current situation.

WGM believes the historical descriptions presented are generally accurate, but the company has not independently verified the data and there is no way for WGM to know if they are complete. This is particularly true for any work completed in the post-Soviet period. WGM’s understanding from Black Iron is that all of the information contained in the government archives has been provided, that government archives contain no additional information and that the lack of more complete files is said to be attributable to civil and political turmoil in the post-Soviet period.

The account below includes historic "mineral resource" and "reserve" estimates. These historic estimates were prepared prior to the implementation of NI 43-101, under different guidelines and specifications. WGM has neither audited these estimates nor made any attempt to classify them according to NI 43-101 standards and definitions. They are presented because Black Iron and WGM consider them to be relevant and of historic significance. Therefore, these estimates should not be relied upon. The 1989 report describes historic work in terms of four phases or periods:

- Period 1: Up to 1965;
- Period 2: 1966 to 1978;
- Period 3: 1982 to 1984; and
- Period 4: 1985 to 1989.

In 2005, Oberon Coal LLC (Oberon) obtained rights to the Property and carried out a pre-feasibility study. This study included work performed by Geo Inter Consulting Limited (GIC) to compile and create a database of drilling information, model the deposit and audit the 1989 Soviet “mineral resource” estimate.

Period 1: Up to 1965

In the period up to 1965, work was directed at achieving two goals:

- Drill testing the rich-iron (supergene) “oxidized quartzite” mineralization associated with the lithological contact between Gdantsev and Saksagan (or Saxagan depending on translation and spelling) sequence rocks (west margin of the Property); and
- Completing a series of short vertical exploratory drill holes to test taconite-style mineralization for a proposed Shymanivkse open pit mine.

The only record of pre-1965 work that WGM has seen is contained in the 1989 Soviet report that states 32 holes for the purpose of testing the rich iron mineralization on the contact were drilled, aggregating 6,818 m. WGM understands that these drill holes were not extended to test the taconite, but the drill holes were mostly terminated just after achieving the contact.

The 1989 report states that 48 short vertical holes, 22 m to 45 m long, aggregating 1,624 m were drilled on the site of the Shymanivske open pit. The report also states that magnetic iron was not determined in the samples from this drilling.

Because documentation for these programs is incomplete with respect to drill hole identifiers during these Soviet drilling programs, drilling dates for most of the historic drill holes are not available and drill hole identifiers are not entirely in sequence because of the existence of additional drill holes drilled in the same drill hole numbering sequence on adjacent properties. Consequently, there is a degree of uncertainty about which holes in the drill hole database, and which drill holes shown on historic Soviet cross-sections and maps, actually correspond to the drilling described.

Period 2: 1966 to 1978

During this period, work on the Property was carried out by two different entities. The Inguletsky GRP of Krivbassgeologiya Trust (“Inguletsky GRP”) conducted work mainly to the south of the Property but partially coincident with the Shymanivske deposit area, while the Central GDS of Krivbassgeologiya Trust (“Central GDS“) carried out work elsewhere on the Property. The work by the Inguletsky GRP was aimed at achieving an estimate of mineralization (presumably mainly the rich-iron ores of the supergene type – “oxidized quartzite”) and included metallurgical testwork. The program of Central GDS was aimed at evaluating the magnetic taconite – “un-oxidized quartzite” – mineralization. The 1989 report states that a total of nine holes aggregating 2,580 m were drilled. It is not clear to WGM whether this total includes all holes drilled by both Inguletsky GRP and Central GDS. It also is unclear which holes in the drill hole database this drilling represents.

Period 3: 1982 to 1985

During this period, a program was carried out and described as “preliminary prospecting of ferriferous quartzites [taconites] of I, II, IV and V ferriferous horizons on the site of the Shymanivske open pit.” The report for this program is available, but has not been translated into English. This program was conducted to increase the mineral resource base of NKODPE (the previous owner of the adjacent iron mines now owned by Arcelor Mittal Kryvyi Rih). A total of 32 holes aggregating 9,902.6 m were drilled along Cross-sections 1 to 7. This cross-section nomenclature is still maintained by Black Iron. From this work, “mineral resources” were estimated. The 1985 report includes the logs for the 30 drill holes and a series of cross-sections containing the holes drilled during the 1982 to 1985 period, and earlier. Downhole geophysical surveys included measuring electrical, electromagnetic, magnetic and radioactivity components, as well as hydrological surveys.

On the basis of exploration, drilling and testwork performed to 1985 at the Shymanivske deposit, in-pit and global “mineral resources” for the un-oxidized ferriferous quartzite’s (taconite) were estimated. In addition, “mineral resources” for the “oxidized quartzite” (supergene) mineralization were estimated. These 1985 “mineral resources” are summarized in Table 6-1, from the Soviet 1989 report. No iron grades or cut-off grade information is specified.

Table 6-1: 1985 “Mineral Resource” Estimate for the Shymanivske Deposit (Adapted after the Soviet 1989 Report)

	Category	Tonnes (Millions)
Un-oxidized Quartzite (taconite)		
In-pit	C1	228,117
	C2	126,874
Global to depth of 300 m	C1	390,790
	C2	145,653
Global to depth of 500 m	C1	432,578
	C2	179,412
Oxidized Quartzite		
In-pit	C2	42,716
Global to depth of 500 m	C2	56,466

Period 4: 1986 to 1989

During the 1985 to 1986 period, exploration, drilling and testwork continued. The program of detailed exploration of quartzites of I, II, IV and V of ferriferous horizons of the Shymanivske deposit was conducted by the Krivorozhsky Prospecting Expedition. In all, 96 holes aggregating 18,113 m were drilled along Cross-sections 1a, 1b, 1, 2, 2a, 3, 3a 4, 4a, 5, 6, and 7. These cross-sections are part of the same system mentioned previously, supplemented by infill sections. The drilling program and results leading to a new "mineral resource" estimate are summarized in the eight-volume 1989 Soviet report.

The 1989 "mineral resource" estimate included estimates for the in-pit and global taconite (un-oxidized ferriferous quartzites) and supergene enriched iron mineralization (oxidized quartzites – martite mineralization). For the taconite mineralization, the estimates were completed at cut-off grades of 16%, 12%, and 10% Fe_{mag} and for the supergene mineralization, at cut-off grades of 30% Fe_{tot}, 28% Fe_{tot}, and 26% Fe_{tot}. The estimate was completed using the cross-sectional method. Geological interpretation was completed and volumes calculated and iron grades assigned on the basis of area of influence of drill hole intersections. Rock density was applied to volumes on the basis of unit identification (horizons), and averages were calculated from determinations made on composites from each horizon.

Table 6-2 summarizes the in-pit "mineral resources" to a depth of 300 m for the taconite-type (un-oxidized ferriferous quartzites) mineralization, estimated at a cut-off of 10% Fe_{mag}, after Genivar, 2011. Table 6-3 presents the resources for the taconite mineralization extending below the pit (from 300 m to 500 m depth).

Table 6-2: Summary of 1989 In-pit "Mineral Resource" Estimate – Oxidized Ferriferous Quartzites, Cut-off of 30% Fe_{tot} (Adapted after Genivar, 2011)

Resource Classification	Horizon	Tonnes (millions)	% Fe_{tot}	% Fe_{mag}
B	SX1F	6,002	31.5	17.45
	SX2F	80,811	32.5	20.34
	Total	**86,813**	**32.4**	**20.14**
C1	SX1F	24,150	30.8	17.51
	SX2F	137,403	31.6	19.84
	SX4F	74,409	32.7	20.41
	Total	**235,962**	**31.9**	**19.78**

Resource Classification	Horizon	Tonnes (millions)	% Fe_{tot}	% Fe_{mag}
B + C1	SX1F	30,152	31.0	17.50
	SX2F	218,214	31.9	20.02
	SX4F	74,409	32.7	20.41
	Total	**322,775**	**32.0**	**19.87**
C2	SX1F	1,170	33.1	18.34
	SX4F	8,005	32.3	20.52
	Total	**9,175**	**32.4**	**20.24**

Notes: The horizons are the interpreted lithological stratigraphic units to which the mineral resource blocks are assigned: SX = Saksagan Group; number = member number; f = ferriferous horizon. See Chapter 7 of this report for more on lithostratigraphic nomenclature.

Table 6-3: Summary of 1989 Below Pit "Mineral Resource" Estimate – Un-Oxidized Ferriferous Quartzites, Cut-off of 10% Fe_{mag} (Adapted after Genivar, 2011)

Resource Classification	Horizon	Tonnes (millions)	% Fe_{tot}	% Fe_{mag}
C1	SX1F	23,402	30.6	17.93
	SX2F	2,241	29.8	15.84
	Total	**25,643**	**30.6**	**17.75**
C2	SX1F	90,640	31.0	17.08
	SX2F	92,427	31.8	18.47
	SX4F	301,907	30.6	18.88
	Total	**484,974**	**30.9**	**18.46**

In addition, mineral resources for oxidized iron mineralization were estimated. These are summarized in Table 6-4.

Table 6-4: Summary of 1989 "Mineral Resource" Estimate Oxidized Ferriferous Quartzites, Cut-off of 28% Fe_{tot} (Adapted after Genivar, 2011)

Resource Classification	Tonnes (millions)	% Fe_{tot}	% Fe_{mag}
In-pit (to 300 m depth)			
C1	3,672	33.5	-
C2	19,286	34.4	-
Below Pit 300 m to 500 m			
C2	93,223	31.9	4.05

2005 Pre-feasibility Study

Oberon-Coal LLC., acquired rights to the Property on November 4, 2004 through the granting of Licence 775189 by the State Committee of Ukraine on Building and Architecture. Its work consisted of a pre-feasibility study on the taconite mineralization of the Shymanivske deposit. Pre-project development studies considered two scenarios: underground and open-pit mining. An English translation of a section of the report completed by Oberon is available.

As part of this work, in January 2005, GIC was mandated the task of compiling a digital drill hole database from the historical work available for the Shymanivske deposit. Then, employing digital modeling, the company used this database to validate the 1989 "resources and reserves" for the deposit. According to Genivar, 2011, the 2005 GIC results confirmed the 1989 results. Apparently, no additional field work was completed as part of the 2005 study and no additional exploration was performed from 1989 onwards, until Black Iron started its programs.

Other

It is known that several underground mines once existed near the Property and likely several on the Property. For the most part, these are thought to have been small operations. These mines, presumably exploited by shafts, extracted high-grade martite-goethite-limonite supergene mineralization associated with the contact between the Gdantsev and Saksagan sequences. The "Novaya", a prominent example, was an underground, multi-level iron ore mine located immediately south of the Property. It operated from the mid-1960s to 1989, when it flooded and was shut down. These mines are now obscured by the piles of mine waste from the adjacent open-pit mines.

The Property was previously the site of the village of Shymanivske, which was removed several years ago to accommodate a mine development.

There is an existing quarry, partially filled with water, located just SW of the Property's centre, approximately 212 m long (NNW-SSE) and 100 m wide (WNW-ESE) at surface. The quarry was allegedly excavated to provide limestone to test and evaluate its potential (a flat-lying unit of limestone overlies the older, folded rock sequence that includes the iron formation). The topographic survey by Abitibi Geophysics (Abitibi) shows that it is over 20 m deep, from water surface in pit to natural topographic level adjacent to pit. Observation by WGM suggests it penetrates into the iron formation and is very close to where an accumulation of martite mineralization would be expected to occur, however no record of any mining or testwork of the iron mineralization is known to the author. No other information concerning this quarry, besides its surface dimensions in plan and its location, is available.

7. GEOLOGICAL SETTING AND MINERALIZATION

For geological descriptions and program results, WGM has relied solely on historic reports, notes and communications with Black Iron personnel. Additional results and descriptions have been summarized in previous NI 43-101 Technical Reports.

7.1 Regional Geology

The Property is situated in the Kryvyi Rih Basin ("KrivBass"), a Paleoproterozoic synclinorium structure in the Archean Ukrainian Shield. The KrivBass lies along the western edge of the Middle Dnieper block of the Shield adjacent to the Inhul-Inhulets, or Kirovograd Block (Shchipansky and Bogdanova, 1996). The basin extends approximately 85 km north to south and is 2 to 10 km wide. KrivBass is one of several Ukrainian iron formation-hosting Paleozoic basins on micro-plate boundaries. Most of the iron ore production in Ukraine comes from the KrivBass and Ukraine ranks as the sixth largest iron ore producer in the world, behind Russia and ahead of the United States and Canada.

Kulik and Chernovsky (1996) describe the rocks in the basin or synclinorium as deformed by superimposed folds of several orders with amplitudes ranging from millimetres to kilometres. Several of the second order fold components have been named. After Belevtsev and Belevtsev, 1981, and from west to east, these major component folds are the Tarapako-Likhmanovakaya anticline, the Main Syncline and the Seksaganskaya anticline and syncline. The component fold structures tend to range from upright to slightly overturned. The larger folds have symmetrical hinges and asymmetric limbs. All folds are described as plunging gently northeast at 15 to 20 degrees. The western margin of the synclinorium is cut by a steep regional thrust fault or fault zone. This fault largely separates the Archean basement from the KrivBass Paleoproterozoic sequence and provides egress of meteoric fluids to weather the iron formation.

The Regional Geology is shown in Figure 7-1. The Archean basement comprises biotite and biotite-hornblende tonalite and microcline-plagioclase granite with relics of mafic volcanics and ultramafic rocks.

The KrivBass is filled with a folded sequence of Paleoproterozoic sedimentary rocks, including iron formation, clastic metasediments and remobilized basement as intrusions. The metasediment series is named the Kryvyi Rih Supergroup or Series, depending on source information.

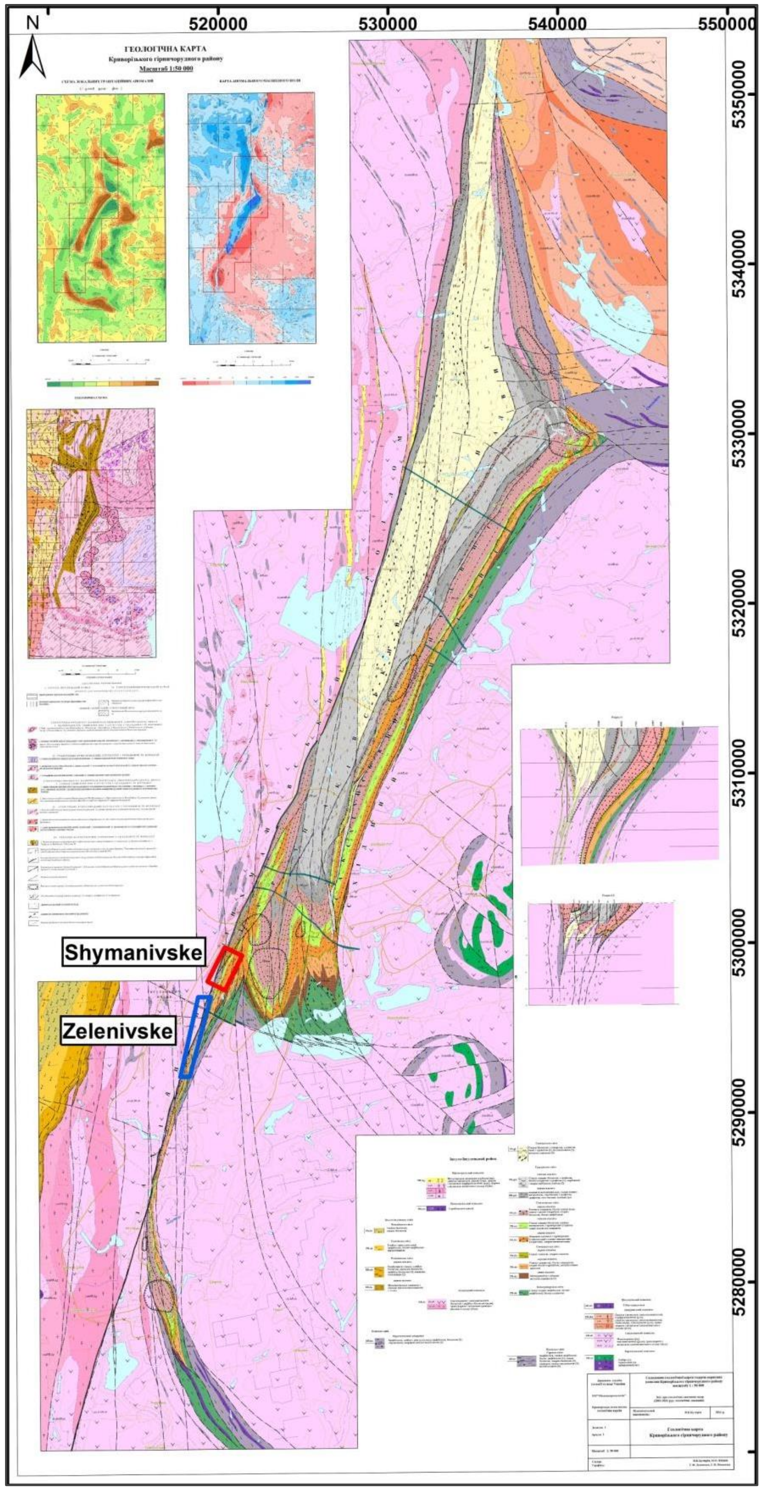


Figure 7-1: Regional Geology

From bottom to top, this sequence consists of the Novokrivoirog (New Kryvyi Rih), Skelevat, Saksagan, Gdantsev and Gleevat Formations or Groups. Diabase dikes cut all older lithologies. The KrivBass regional stratigraphy, after Belevtsev and Belevtsev (1981) and others is summarized in Table 7-1.

Table 7-1: Regional Stratigraphic Column

Cenozoic Limestone	
-----------unconformity-----------	
Microcline granites	
Diabase dikes	
Lower Proterozoic	
Gleevatskaya Formation (gl) OR Gleevat Group or Formation	Quartz-biotite schist and meta-sandstone
	Dolomite and dolomitized limestone
	Quartz-graphite schists, quartz-biotite-chlorite schist, meta-conglomerate and meta-sandstone
Gdantsevskaya Formation (gd) Gdantsev Group	Quartz-mica, quartz-chlorite, graphite schist
	Meta-sandstone, sandy shale, conglomerate, quartzite, magnetite-chlorite iron formation breccias
-----------unconformity-----------	
Saksaganskaya Formation (SX) OR Saksagan Group or Formation OR Saxagan Group	Up to seven ferruginous chert horizons or members 1f to 7f comprising amphibolite-magnetite-chlorite schists and in places martite (banded iron formation -japilites) separated by six members of amphibole-chlorite-biotite ±graphite-pyritic slate or schist designated 1s to 6s.
Skelevataya Formation (sk) OR Skelevat Group or Formation	Chlorite-talc schist, carbonate-talc, serpentine-talc, sandstone conglomerate.
	Sericite-muscovite, mica staurolite phyllite
	Quartz-arkose meta-sandstone, conglomerate and quartzite
-----------unconformity relicts of metamorphic residual soil-----------	

Archean	
Novokrivoroshskaya Formation (nk) OR New Kryvyi Rih Group	Biotite, hornblende, hornblende, epidote, amphibolite, biotite schist, meta-sandstone
	Meta-basite, and meta-ultrabasite, plagioclase granite and migmatite
Note: Belevtsev and Belevtsev, 1981 place an unconformity between the Saksagan and Skelevat but from other accounts (Kulik and Korzhnev, 1997) the relationship is conformable.	

The Saksagan sequence is the main iron formation host, although minor iron formation is also said to occur in the overlying Gdantsev sequence. The Saksagan lies conformably or unconformably on the underlying Skelevat sequence that contains talc schist (from WGM's observations on the Shymanivske Property, the relationship is conformable). The Saksagan or Saxagan sequence (depending on spelling and translation) contains up to seven horizons or members of ferruginous cherts (iron formation), named 1F to 7F, separated by schist or slate horizons 1s to 5s (including the Formation or Group prefix: "SX" from Saxagan, the nomenclature is, for example: SX1F or SX2S). The inter iron formation schists or slates range in composition from biotite to sericite-chlorite, sericite-amphibole-chlorite, graphite-sericite and carbonate. Contacts between members of the Saksagan are gradational. Not all members can be recognized through the extent of the KrivBass and all of the members are perhaps not strictly stratigraphic by usage. The total thickness of the Saksagan is said to be in the range of 1,200 m to 1,500 m. This entire stratigraphic thickness obviously does not prevail on the Property.

Multi-stages of metamorphism are described (Dagelaysky 1993). The basement rocks are metamorphosed from epidote-amphibolite to granulite grade, while the Paleoproterozoic rocks are largely greenschist facies, but metamorphic grade increases northwards in the KrivBass, reaching amphibolite and granulite facies and leading to the remobilization and intrusion of granite bodies within the Paleoproterozoic sequence. A metamorphosed weathering crust has also been identified on the unconformity or regional-scale-fault zone between the Gdantsev and older Saksagan, adjacent to the contact with the Archean basement (Dagelaysky 1993). This unconformity or fault zone is the site for the supergene iron-rich iron ore types produced from the taconites by alteration.

7.2 Property Geology

The Property geology appears analogous to the regional geology of the KrivBass in terms of both rock units and structure. However, several different structural interpretations are available for the Property, depending on the source of the interpretation and the drilling results available at the time the interpretation was made. The sources of historic interpretations for the Property are the 1985 and 1989 Soviet reports and the geological drill cross-sections and plans made during the course of these programs. No outcrop is exposed on the Property, so all interpretation must be made from correlating the drilling and geophysical results. Superimposed scales of folding make interpretation from drill hole information difficult.

Most drilling has been close to vertical, with a minimal range of analyses, i.e. little major element analyses, and lithostratigraphic members are apparently compositionally indistinct. WGM has made its own geological interpretation, which differs markedly from the 1989 Soviet interpretation but is more similar to older Soviet interpretations and the regional interpretation. Figure 7-2 is a plan showing the current geological interpretation of the Property used for Black Iron's Mineral Resource estimate (Chapter 14 of this Report) showing all drill holes known. Figure 7-3 and Figure 7-4 are, respectively, Abitibi Geophysics (Abitibi) magnetic and gravity surveys of the Property, as described under "Exploration," Section 9.2.

The general structural alignment of rocks is NE-SW, parallel to the KrivBass, according to the interpretation of drilling results and surface geophysical surveys, notably the ground magnetic and gravity survey completed as part of Black Iron's 2011 exploration program. Similar to the regional context, the KrivBass Paleoproterozoic rocks, Skelevat to Gdantsev sequences, are deformed into a series of gently north-plunging sub-parallel first-order NE-SW folds, and have superimposed minor folding of multiple orders. The main fold components describe a tight to asymmetric anticline which, on the Property, includes the western part of the Paleoproterozoic sequence and a parallel trending open syncline that underlies the central and eastern parts of the Property. This large-scale structure is generally quite consistent from drill cross-section to cross-section, from SW to NE. The closure of the main open syncline is just SW of Cross-section Line 1, as shown by drilling results and magnetics. To the NE, and perhaps not on the Property, but NE of the Property boundary, the Saksagan sequence rocks likely plunge below surface and are covered by Gdantsev metasediments. Drilling information northeast of Cross-section 7 would be required to resolve this.

The oldest rocks on the Property are the Archean-age basement rocks intersected by historic drill holes on the northwestern part of the Property. None of Black Iron's drilling intersects these basement rocks, but they were drilled as part of historic programs. These rocks include granites with intercalated amphibolites that are part of the Novokrivoroshskaya or "New Kryvyi Rih" Group (nk). These rocks are cut by a series of NE-SW oriented, steeply dipping to NW, dipping faults. Eastwardly, the basement is succeeded by rocks of the younger Gdantsev Group. The Gdantsev rocks in fault, and/or unconformable contact with the older rocks, include quartz-biotite metasediments and perhaps minor iron formation. In some of the historic Soviet drill holes, intersections of "talc schist" are coded. In some interpretations they are correlative with rocks in the Skelevat sequence, but these may be chlorite schist, belonging to the Gdantsev or the New Kryvyi Rih sequences, unrelated to the Skelevat.

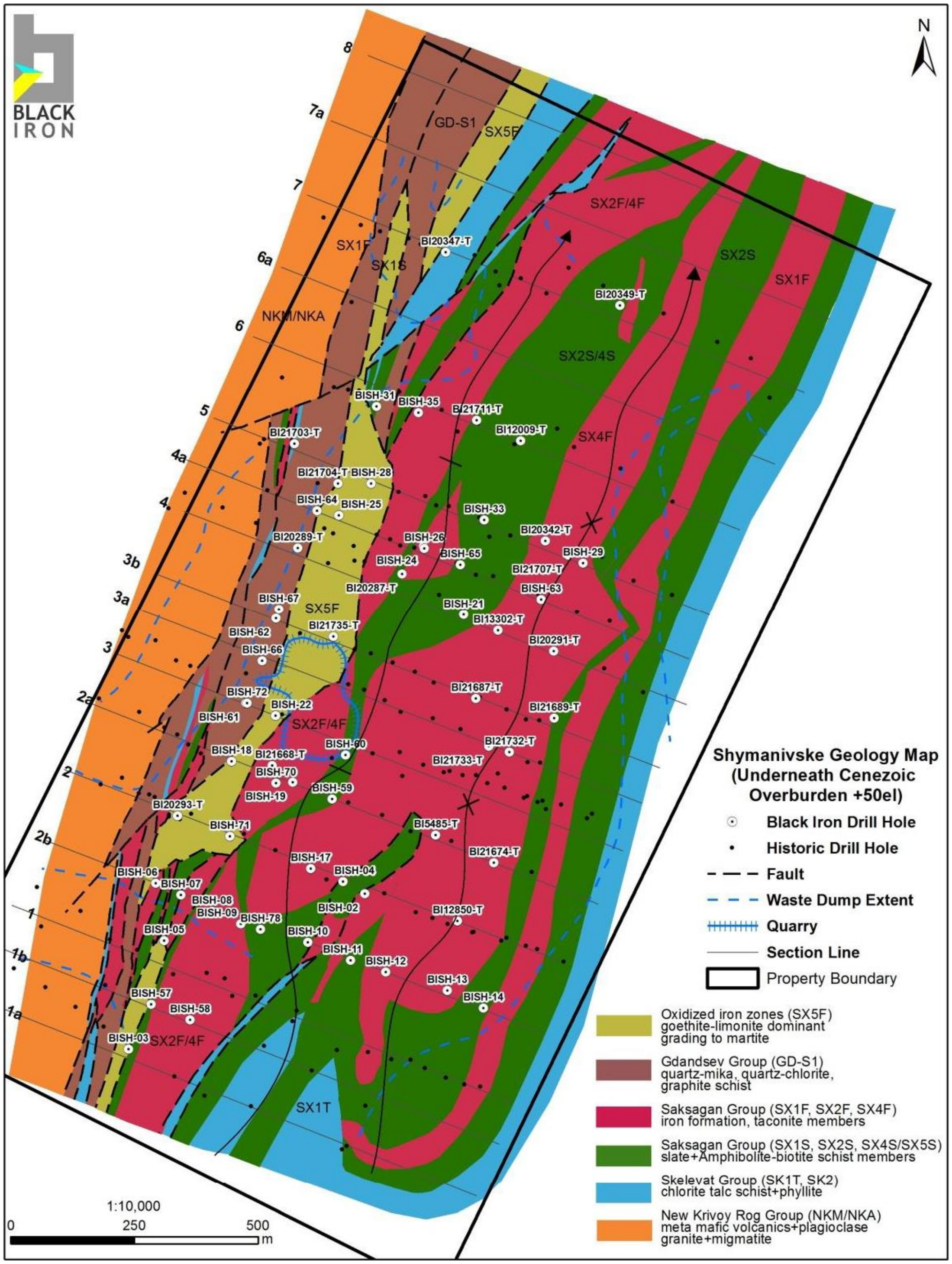


Figure 7-2: Property Geology with Drill Holes

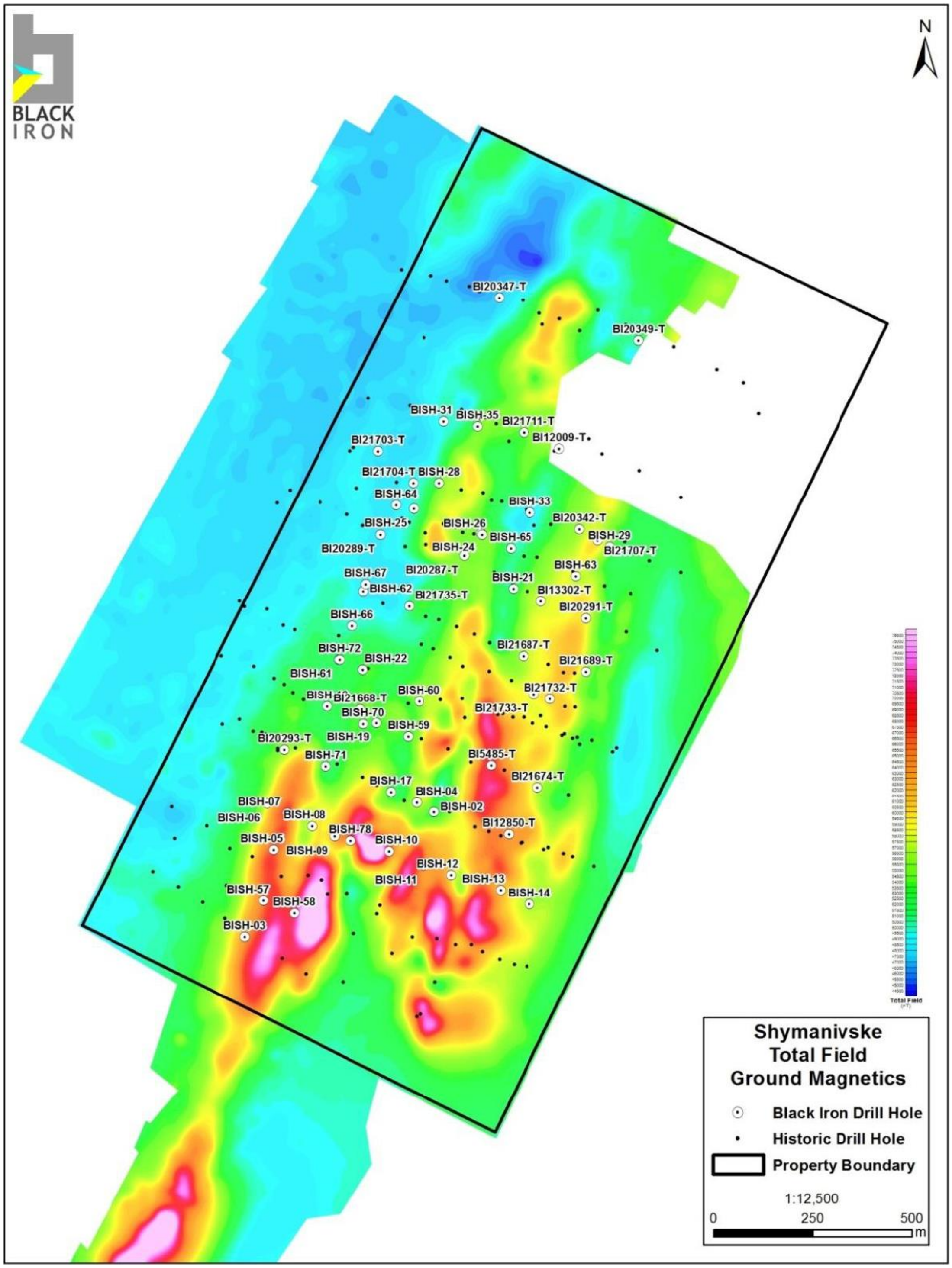


Figure 7-3: Total Magnetic Intensity Map after Abitibi Geophysics with Drill Holes

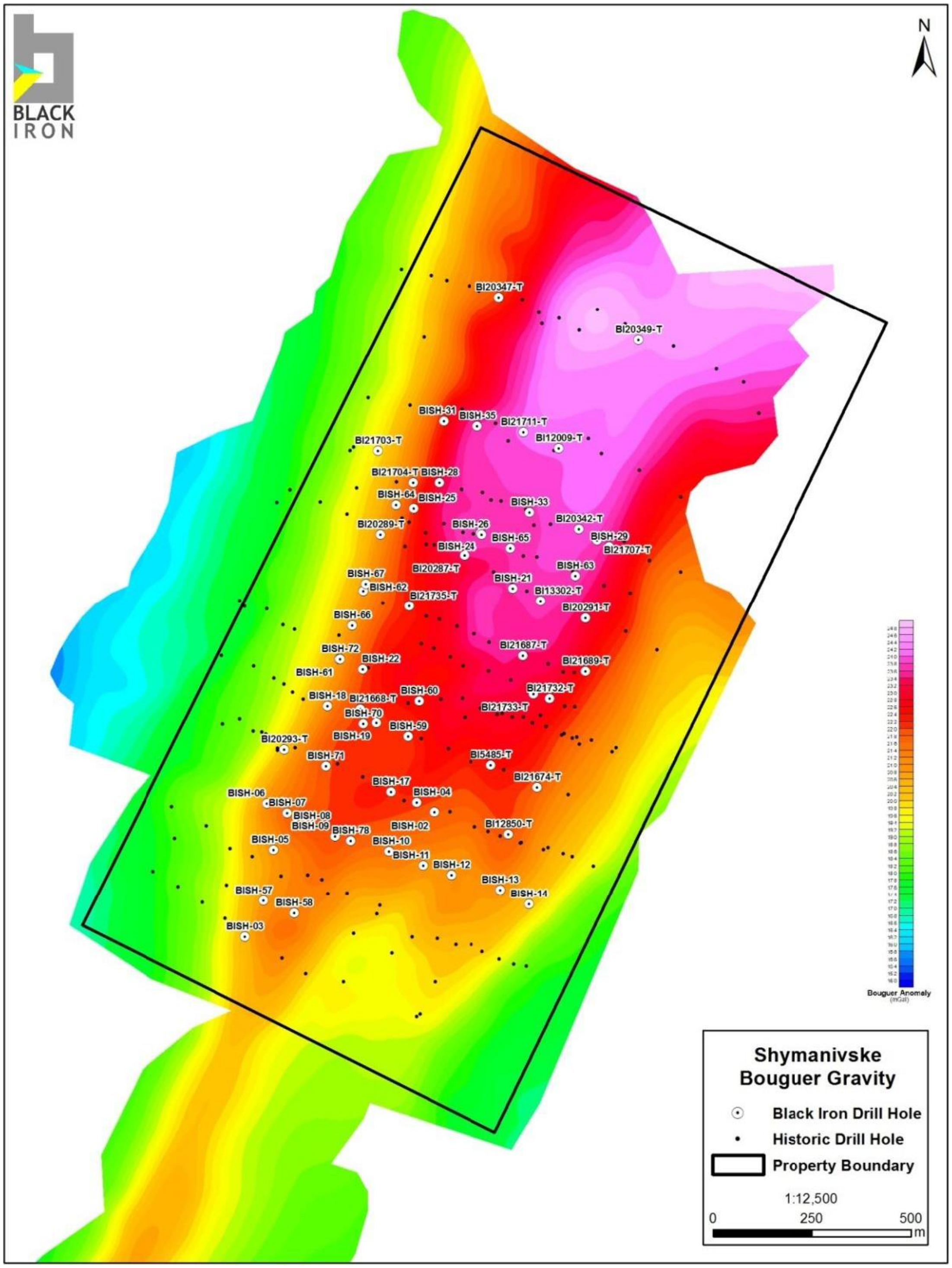


Figure 7-4: Residual Bouguer Gravity Survey Map after Abitibi Geophysics with Drill Holes

The faulting and alteration along the unconformity between the Archean basement and the Paleoproterozoic Kribass sequence has resulted in a complex *mélange*. The faults dip NW and are sub-concordant to the succeeding limbs of the older Saksagan sequence that contain the main taconite iron formation in a tight anticline and, to the SE, a more open syncline. In the central to eastern part of the Property, Saksagan members 1f and 2f, separated by the inter-slate member 2s, are clearly identifiable. In certain places these same members can be identified with some confidence in the anticlinal limb of the structure, but generally they cannot be identified and distinguished with certainty. The likely factors responsible for the difficulties in tracing these units include the tight folding and accompanying shearing, and perhaps some shifting of blocks attributable to the faulting, or even primary sedimentary thinning of members towards the edges of the basin. The Saksagan sequence rocks appear to lie conformably on, and are folded with, the Skelevat Group rocks and include phyllites and talc schist.

The location of the faults/unconformity along the contact between the Gdantsev and Saksagan sequences can often be recognized readily by the type of mineralization/alteration intersected and the drilling difficulties due to highly fractured and friable rock. Many of the historic drill holes that were collared from the granite basement on the western part of the Property to test the supergene iron mineralization situated along the Gdansev-Saksagan contact were terminated when little mineralization was encountered, or they were lost when the faults were intersected. Drill holes that did penetrate the fault zones at some depth below the surface often encountered martite mineralization, which replaced magnetite taconite in the Saksagan sequence adjacent to the contacts between the Gdantsev and Saksagan rocks. Nearer the surface, these drill holes encountered more goethite and limonite in place of martite, or martite and magnetite taconite, which made drilling and core recovery difficult.

A significant portion of the Property surface is covered by mine waste rock from the adjacent YuGOK mine. Comparison of the present topography, as determined by Abitibi Geophysics surveys in April 2011, with the historic Soviet cross-sections, shows this waste rock is up to 30 m thick in some areas. Below this there is a thin soil which overlies Cenozoic karsted fossiliferous limestone. The limestone is generally 10 m to 25 m thick and drapes the flat, lying to the rolling weathered Paleoproterozoic surface. The upper surface of the Paleoproterozoic rocks immediately under the limestone is weathered. Where the upper weathered surface is iron formation, the magnetite has often been oxidized and some or all of the magnetite, depending on depth, has been converted to goethite/limonite. In some places, iron enrichment that is caused by silica leaching occurs. The strong weathering is generally restricted to a depth of less than 6 m. This zone of sub-surface weathering thickens and merges with the fault zones or unconformity-controlled weathering and supergene iron enrichment, which exist on the western margin of the deposit along the Gdantsev-Saksagan contact. The oxidized iron layer can extend into areas not underlain by iron formation, and this material may be akin to canga.

Occasional narrow mafic dikes were intersected in some Black Iron drill holes.

7.3 Mineralization

7.3.1 General

Mineralization of economic interest on the Property is the oxide facies iron formation (OIF) or oxide facies banded iron formation and it is magnetite-rich taconite that contains minor hematite throughout. The Soviet literature commonly refers to this mineralization as "un-oxidized ferriferous quartzite". As mentioned above, concentrations of martite and goethite/limonite mineralization also occur on the Property. This latter type of mineralization is an alteration product derived from the taconite. In the Soviet literature, this type of mineralization is called "rich iron ore" or "oxidized quartzite mineralization." This supergene enriched iron mineralization is commonly associated with the faults and fault zones, perhaps coincident with an unconformity that occurs along the western margin of the Shymanivske deposit adjacent to the Archean basement. It has been suggested that this mineralization, rather than being controlled by faults and fluids running in the faults, is related to weathering on the paleo-surface between the Saksagan and Gdantsev sequences, which now constitute the unconformity. Also a layer of oxidized iron mineralization commonly lies along the upper surface of the taconite immediately under the Cenozoic cover rocks. It is usually no more than a few metres thick, but in some areas it is thicker. This mineralization was the target of early drill programs in the 1960s. In some places, this oxidized iron material is sufficiently enriched in iron and it approaches the commercial DSO grade.

The Novaya was an underground iron ore mine located immediately south of the Property, where high-grade oxidized iron mineralization was mined from the mid-1960s to 1989, when it flooded and was shutdown. Various underground workings and mines also operated on the Property along its northwest margin, but little is known about them because records are poor and all their shafts are now under layers of mine waste from the adjacent open pits. One of Black Iron's drill holes was lost when it intersected an underground gallery in one of these mines.

Several underground iron mines are still operating in the KrivBass; however, on the Property only the magnetite-rich taconite is considered of immediate economic interest. WGM understands that under Ukrainian law martite mineralization, if not exploited, must be stockpiled for possible later use.

The iron formation on the Property is mainly confined to the Saksagan sequence and is folded into a NE gently plunging anticline (west part of the deposit) and an adjacent open syncline (central and east parts of the deposit). The taconite extends the entire NE-SW extent of the Property, 2.2 km and beyond, and occurs over a width of 800 m to 1 km in a NW-SE direction. The taconite is folded and its true thickness varies throughout because of tectonic thickening, erosion and possibly the original basin topology. The true thickness of the iron formation package, including the intervening inter-oxide iron formation "slate" members, is in the order of 200 m to 250 m. Because of the folding, there is no consistent relationship between drill hole orientation and the true width of mineralization. Drill testing has been completed, generally to a vertical depth of 300 m to 500 m. Mineralization along the western margin of the deposit, particularly the steeply dipping NW limb of the main anticline, extends to an unknown depth and has been tested by drilling to a maximum vertical depth of 500 m.

The Saksagan ferruginous members (f-members) are in gradational contact with the non-ferruginous “slate-schist” members (s-members) of the group. No sharp contacts between these members are discernible and % Fe_{tot} and % Fe_{mag} grades are also gradational between these members. Small-scale folding likely contributes to the gradational affect. Maximum iron grade is often reached in the centre of the drill hole intersections in magnetite taconite (f) members, while minimum grade is reached in the middle of the “slate-schist” intersections (s) members and the iron grade generally is smoothly progressive between these extremes. These slate-schist members are mainly composed of amphibolite, with lesser amounts of chert and magnetite. Where the slate members contain more than 15% Fe, then the rock could be called silicate iron formation (SIF). SIF consists mainly of amphibole and chert, often associated with carbonate (often iron carbonate) and it can contain magnetite or hematite in minor amounts. According to historic records, the amphibole commonly associated with magnetite on the Shymanivske Property is cummingtonite, but Black Iron’s mineralogical studies completed by SGS Lakefield (see below) have named the iron silicate grunerite. Wherever carbonate becomes more prevalent, the rock is named silicate-carbonate or carbonate-silicate iron formation, although infinite variations exist between the OIF and silicate-carbonate iron formation end members. Little carbonate iron formation appears to be present on the Property.

The lithological coding nomenclature used by GEORESOURCE for logging the Shymanivske drill cores consists of a stratigraphic component and a rock composition component. Black Iron and WGM have elected to minimize the stratigraphic part of the code because the company believes it isn’t very reliable, particularly for the individual members of the Saksagan sequence rocks. The composition portion of the code is based on the proportion of iron oxide, silicate and chert in the rocks. The rock composition codes used for logging Black Iron’s programs are summarized in Table 7-2. The composition codes are in reverse mineral prominence. For example, for the code QSM, which is code for Quartz - Silicate - Magnetite, magnetite is estimated to be the most prominent mineral in the rock and quartz is the least prominent mineral.

Table 7-2: Rock/Unit Coding for Shymanivske Drill Core Logging

Code	Rock Name	Comment	Formal Unit
LS	Limestone		Cenozoic
Mafic Dike	Mafic Dike		Upper Proterozoic
QC	Quartz-Carbonate rocks		Gdantsev Group
QHMR	Quartz-Hematite-Martite Iron Ore	Oxidized IF	Saksagan Group
QH	Quartz-Hematite	Oxidized IF	Saksagan Group
QMH	Quartz-Magnetite-Hematite	Partially oxidized	Saksagan Group
QHM	Quartz-Hematite-Magnetite		Saksagan Group
QSHM	Quartz-Silicate-Hematite-Magnetite	Partially oxidized	Saksagan Group
QM	Quartz-Magnetite		Saksagan Group
QSM	Quartz-Silicate-Magnetite		Saksagan Group
QSMH	Quartz-Silicate-Magnetite-Hematite	Partially oxidized	Saksagan Group
QMS	Quartz-Magnetite-Silicate		Saksagan Group
QA	Quartz Amphibolite		Saksagan Group
QAS	Quartz Amphibolite Slate		Saksagan Group
QB	Quartz Biotite		Saksagan Group
QBS	Quartz Biotite Slate		Saksagan Group
QS	Quartz-Silicate		Saksagan Group
Slate	Slate		Saksagan Group
PS	Phyllite Schist		Skelevat Group
TS	Talc Schist		Skelevat Group

Twelve drill cross-sections oriented NW-SE approximately perpendicular to the general strike of the rocks are laid out at uneven intervals. The principal cross-sections, 1 to 7, vary from 200 m to 500 m apart and extend from the SW edge of the Property to its NE boundary. The cross-section nomenclature is historic. In places, there are intermediate cross-sections designated with a letter suffix, such as 1c or 3b. Cross-section 1 or 1a is located towards the SW edge of the Shymanivske Property and is also the north-easternmost section of the Zelenivske magnetite deposit. Cross-section 7 is towards the NE end of the Shymanivske deposit and is also the south westernmost cross-section for Arcelor Mittal's Kryvyi Rih Skelevatsky magnetite deposit–open-pit mine. Figure 7-5 and Figure 7-6 (Cross-sections 2 and 5), located 800 m apart along the strike of the deposit are two of these Shymanivske deposit drill cross-sections selected to illustrate the description of geology and mineralization on the Property.

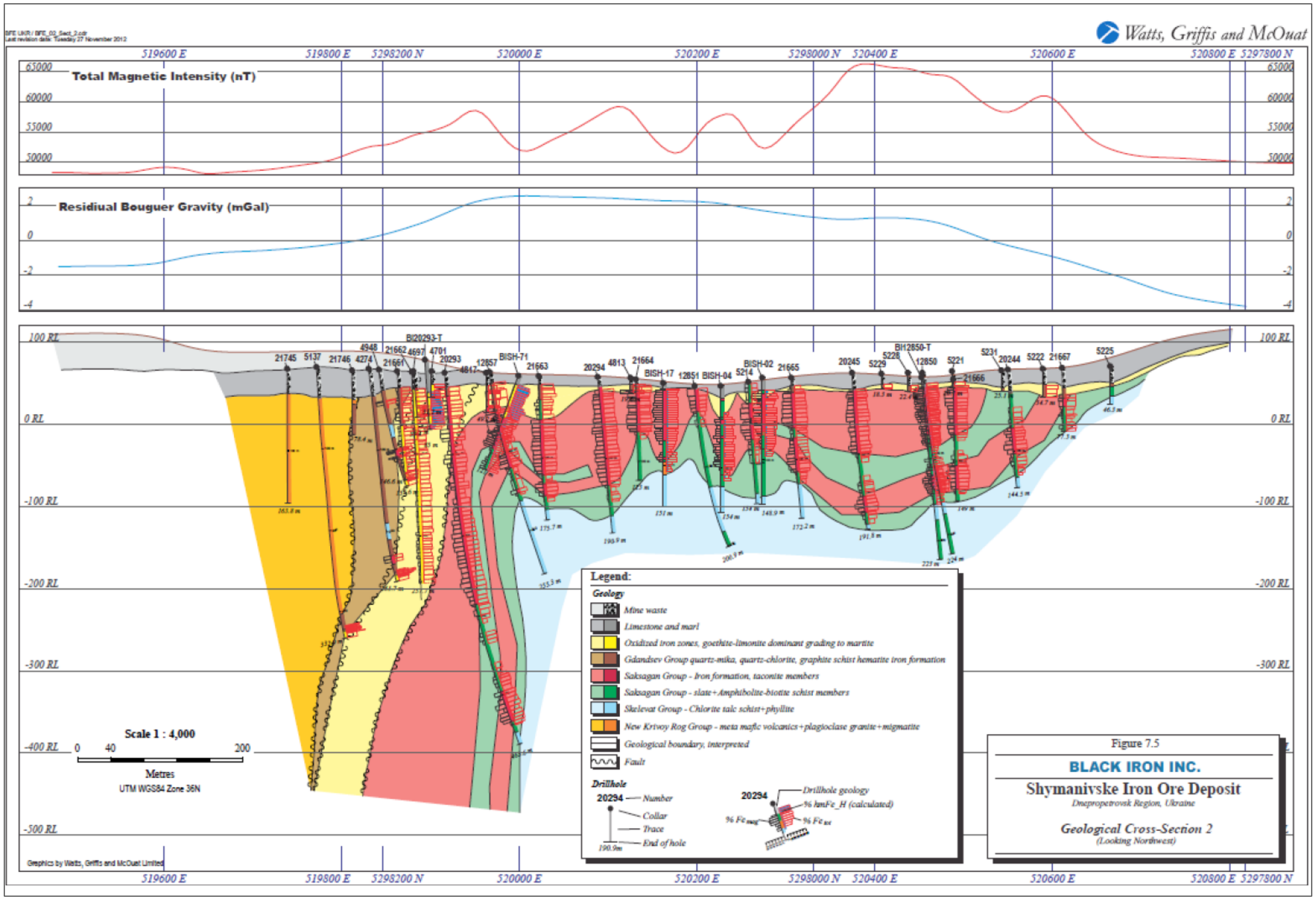


Figure 7-5: Shymanivske Deposit Cross-section 2

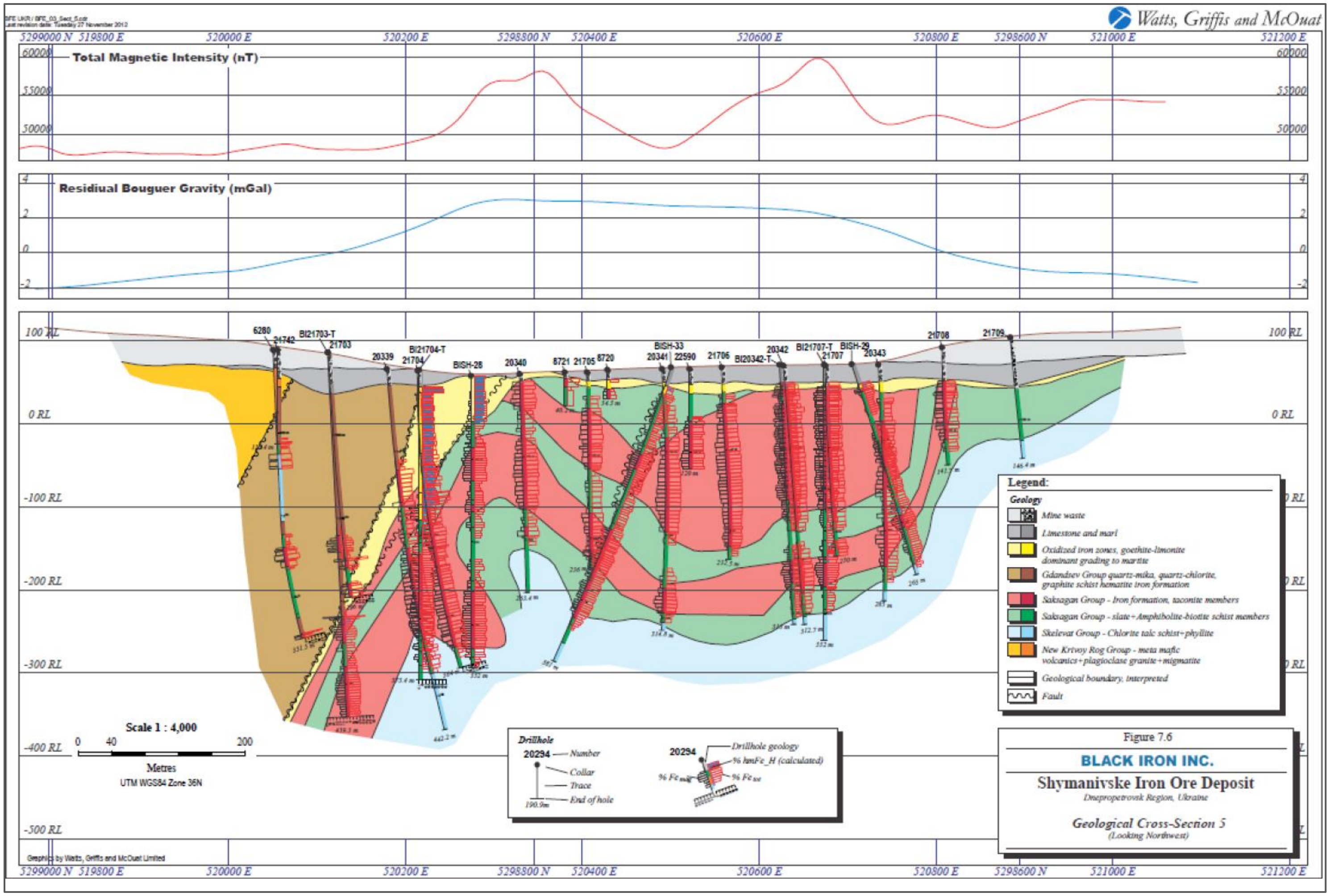


Figure 7-6: Shymanivske Deposit Cross-section 5

Figure 7-5 is Cross-section 2, looking northeast. It shows the intense drilling density characteristic of the work completed, with many of the drill holes collared less than 50 m apart along the section. The oldest drill holes are assumed to be the holes with four-digit numbers and are believed to represent the programs completed prior to 1965. Magnetic Fe was seldom determined in samples from these drill holes. The Fe_{mag} assays that are present may have been completed at a later date on archived drill core, but records are insufficiently detailed for certainty. There are two sets of these older drill holes (see Chapter 10, Drilling). The first set of holes tested the NW contact of the deposit. Drill holes, such as 5137, 4948 and 4274 (the westernmost holes on the section) were designed to explore for "rich-iron ores," (i.e., supergene mineralization along the lithological contact between Gdantsev and Saksagan rocks). Drilling these holes was stopped not far beyond the contact because the taconite mineralization was not of interest. The second set of pre-1965 drill holes are represented by Drill holes 4813, 5229, 5228, 5231 and 5222, etc. Generally, these drill holes were drilled vertically and were very short. In many cases, drilling was stopped immediately after penetrating the supergene mineralization lying along, and immediately adjacent to the interface between the Cenozoic limestone and the Saksagan iron formation. A few of these drill holes were drilled further into the taconite to provide some information for evaluation. The remaining drill holes were drilled throughout the 1980s. Figure 7-6 also shows Black Iron's 2011 drill holes named BISH or BI#####-T (# represents a digit and T is for Twin).

The three westernmost drill holes (21745, 5137 and 21746) intersected Archean tonalite basement rock. Drill holes 5137 and 21746 below the basement intersected Gdantsev sequence metasediments in fault or unconformable contact with the basement. Drill holes 5137, 4274 and 4948 stopped in martite mineralization in the upper part of the iron formation sequence just below the Gdantsev rocks. Drill holes 21661, 21662 and Black Iron Twin Drill hole BI20293-T intersected extensive martite mineralization beneath upper goethite/limonite. In Drill hole BI20293-T, calculated Fe^{+++} (in this report), also designated % hmFe is coincident with oxidized iron mineralization. The martite defines a fault zone along the contact between the Gdantsev metasediments and Saksagan iron formation. Alternatively, part or all of this martite could represent a paleo-weathering surface, now an unconformity.

Many of the more recent drill holes penetrated sufficiently deep to pass through the Saksagan iron formation to terminate in the underlying Skelevat Group rocks that include phyllite and characteristic talc schist. The Skelevat rocks, including their talc schist component, are folded together with the younger iron formation.

The general distribution of lithologies from drill hole intersections defines a western anticline fold with a steep SW limb (up against the Gdantsev and basement rocks), giving way to a more gently folded syncline centred approximately on Drill holes 20245 or 5229. Several other lesser folds are indicated between the SW anticline and the NE gentle syncline.

Most of the iron formation, except for the martite mineralization, comprises magnetite, quartz and iron silicate. Fe_{mag} and Fe_{tot} grades are symmetrically distributed and correspond well with intervals logged as OIF. An intervening inter-iron formation “slate” horizon, which occurs towards the lower margin of the Saksagan sequence, is prominent. This member is likely 2s. For many drill holes, this member has not been entirely sampled. % Fe_{tot} assays drop off in this rock type and % Fe_{mag} assays drop off more sharply that % Fe_{tot}. The principal and most persistent of the inter-iron formation sedimentary horizons is 2s, which can be traced across the entire cross-section and is in the range of 15 m to 40 m thick. Intense small-scale folding no doubt obscures refinement.

The magnetic and residual Bouguer gravity profiles from Abitibi’s survey roughly map out the location of the concentrations of the iron formation and deposit.

Figure 7-6 is Cross-section 5 looking northeast; 750 m along general strike to the NE from Cross-section 2. Despite being 750 m from Cross-section 2, the geology of Cross-section 5 is similar to that of Cross-section 2.

Mine waste covers the surface on both the NW and NE margins of the cross-section. Beneath the mine waste there is a layer of flat-lying Cenozoic limestone and marl. Beneath this layer, there is a thin horizon of limonite/goethite and this is the upper limit of the folded Proterozoic sequence of iron formation interlayered with slate. This thin hydroxide iron layer merges with the thicker martite mineralization on the NW margin of the deposit, which is thickest in Drill holes BISH-28 and 21704. This mineralization shows up clearly as calculated hematitic Fe. In the older holes this mineralization is obvious from assays that show normal level Fe_{tot}, but minimal Fe_{mag} (magnetite oxidized to hematite/martite). The martite zone follows down the interface between the iron formation sequence and the Gdantsev metasediments. This interface is a fault zone or an unconformity, or a fault zone superimposed on an unconformity. The steep western margin of the deposit has not been well drilled. The Archean basement occurs further west of the NW margin of the cross-section, and it is in contact with the Gdansev sequence.

Because the fold structures plunge gently NE, both the tighter antiform on the NW edge of the deposit and the central gentle synforms are at lower elevation on Cross-section 5 than on Cross-section 2. The SX2S inter-iron formation sedimentary unit is still prominent within the gentle syncline, but it occurs at a lower elevation. Another inter-iron formation sedimentary unit that might be SX3s or SX4s occurs close to surface in the tops of Drill holes BISH-033, 21706 and 21705. On the western margin of the deposit along the steep west dipping limb of the anticline, there is a sedimentary unit just below the martite mineralization. On Figure 7-6 this is correlated with SX2S, but may or may not be SX2S. If it is SX2S, then a thickness of iron formation along the Archean Proterozoic sequence has been eroded away with much of the remnant magnetite converted to martite and goethite/limonite.

The iron formation sequence is underlain by slates and talc schist of the Skelevat sequence, which are folded with the younger overlying metasediments.

7.3.2 Whole Rock Chemistry

MCM's assays grouped by rock type are shown on Table 7-3. SGS-Lakefield's Whole Rock ("WR") assays for WGM's independent samples are summarized in Table 7-4. The results from SGS-Lakefield are included here because they provide more complete assays than either the samples done at MCM or ALS, and are a more complete guide to the composition of mineralization and associated rock types.

On Table 7-3 and Table 7-4 the potential "ore" lithologies are shaded, but the ore will also contain some other lithologies as the oxide iron formation members are interlayered with the metasedimentary units. These samples of potential ore have higher levels than other rock types of contained magnetite, indicated by % Fe_{mag} values. Variations designated with "H" and or "M" in their Lith Code also contains appreciable martite or goethite/limonite, as indicated by elevated calculated hmFe values.

The estimates of % Fe in the form of hematite, (% hmFe) or more correctly Fe^{+++} where goethite/limonite is present have been made by WGM. For all cases, the distribution of Fe^{++} and Fe^{+++} to magnetite was done assuming the iron in magnetite is 33.3% Fe^{++} and 66.6% Fe^{+++}. The estimation method also assumes that all iron in silicates, carbonates and sulphides is Fe^{++}. This assumption is generally believed to be substantially true for the Shymanivske deposit, but this will not be known with certainty until detailed mineral chemistry is completed.

For the drill core samples from the field submitted to MCM, % Fe_{tot} was determined by wet chemical methods and at SGS-Lakefield by XRF (see Chapter 11). % FeOT at both labs was determined by titration and % Fe_{mag} using Saturization Magnetization Analysers. Hematitic Fe, where Fe_{mag} and FeO_H assays are available, was estimated by subtracting the iron in magnetite (assayed as Fe_{mag}) and the iron from the FeO analysis, in excess of what can be attributed to the iron in the magnetite from % Fe_{tot}, and then restating this excess iron as hematitic Fe, as below:

$$(1)\quad \%\ hmFe = \%\ Fe_{tot} - (Fe^{+++}_{(computed\ from\ Femag)} + Fe^{++}_{(computed\ from\ FeO)})$$

In practice, % OtherFe was computed as the first step in the calculation and % hmFe = % Fe_{tot} - (% Fe_{mag}+% OtherFe), where % OtherFe is assumed to represent the Fe in sulphides, carbonates and/or silicates is the iron represented by Fe++ from FeO that is not in magnetite. Where Fe++ from magnetite exceeds Fe++ from % FeO, negative values can accrue.

Some of these magnetite taconites, such as those coded QMS or QSM, with the "S" being silicate, also contain appreciable silicate iron. P and Mn values are mainly low throughout all rock types averaging approximately 0.1%.

The various inter-oxide iron formation metasedimentary rocks coded QA (quartz amphibolite), QAS (quartz amphibolite silicate), QB (quartz biotite), and QBS (quartz biotite slate) have elevated levels of Fe_{tot}, but low levels of Fe_{mag}, with most of the iron in OtherFe. These rocks also have elevated levels of aluminum befitting higher clay content and levels of sulphur much higher than in oxide iron formation.

The QC (quartz carbonate) code is used for rocks of the Gdantsev sequence. As shown by the results presented in both tables, these rocks are more siliceous and have lower Fe_{tot} than Saksagan slates.

The TS (talc schist) rocks of the Skelevat Group have higher levels of MgO and chromium appropriate for ultramafic rocks.

Rock type designations from logging agree well in general with composition from assays.

7.3.3 Mineralogy Details

The magnetite-rich taconite iron formation on the Property consists mainly of semi-massive bands, or layers, and disseminations of magnetite containing very minor hematite (specularite), not readily visible, in re-crystallized chert[1] and interlayered with bands (beds) of chert with carbonate and iron silicates and amphibolitic slate.

[1]Soviet literature refers to this re-crystallized chert as quartzite

Table 7-3: Composition by Rock Type Based on MCM Assays

Lith Code	QC	QA	QAS	QB	QS	QBS	QH	QHM	QSMH	QSHM	QHMR	QMH	QSM	QM	QMS	TS	PS	Total
Count	19	5	233	3	70	126	55	117	3	2	4	38	1697	86	1392	15	4	**3869**
Avg Fe_{tot} (%)	7.01	17.32	19.15	12.67	19.45	15.83	37.25	35.94	31.73	35.15	49.08	33.51	32.92	33.38	26.99	8.65	20.23	
Avg Fe_{mag}(%)	1.1	1.1	2.0	1.3	2.4	1.3	2.2	1.8	7.4	9.5	15.0	9.7	20.6	22.5	8.7	0.8	3.3	
Avg hmFe (%)	4.86	1.47	2.84	0.27	2.01	2.27	34.06	33.39	18.55	19.13	32.55	20.67	2.28	3.05	2.45	0.85	2.30	
Avg OtherFe (%)	1.08	14.75	14.31	11.10	15.01	12.27	1.00	0.76	5.78	6.52	1.57	3.16	10.04	7.85	15.85	6.97	14.60	
Avg FeO (%)	1.83	19.44	19.26	14.83	20.34	16.33	2.23	1.74	10.60	12.45	8.43	8.21	21.73	19.72	24.12	9.32	20.20	
Avg SiO2 (%)	67.85	56.64	55.06	53.98	54.45	53.91	43.64	46.10	45.72	46.71	26.37	47.56	45.51	45.53	50.20	42.51	54.89	
Avg P (%)	0.05	0.06	0.06	0.05	0.07	0.06	0.03	0.03	0.06	0.10	0.03	0.05	0.09	0.08	0.08	0.02	0.08	
Avg S (%)	0.14	0.32	0.36	1.25	0.32	9.21	0.01	0.01	0.04	0.03	0.05	0.12	0.13	0.10	0.97	0.15	0.32	
Count of BDensity	0	0	9	0	3	5	3	9	0	0	0	2	102	6	68	0	0	**207**
Avg BDensity			2.88		2.82	2.85	3.43	3.25				3.10	3.33	3.32	3.18			
Count of SG	2	0	23	0	8	13	5	14	0	0	0	4	155	9	123	0	0	**356**
Avg SG	3.05		3.05		3.00	2.95	3.73	3.56				3.53	3.44	3.49	3.29			

Table 7-4: Composition by Rock Type Based on SGS-Lakefield Assays for WGW Sample

Lith Code	QC	QAS	QBS	QS	slate	QH	QHM	QMH	QMS	QM	QSM	TS	Total
Count	1	5	5	2	3	3	2	2	36	6	48	2	115
Avg Fe_{tot} (%)	4.31	14.56	14.66	19.15	13.87	44.70	37.30	26.55	27.24	34.10	33.77	7.48	
Avg Fe_{mag} (%)	0.29	0.74	0.75	1.99	0.75	1.23	3.00	10.09	10.23	24.69	23.61	0.00	
Avg hmFe (%)	1.2	1.5	1.0	1.2	0.6	42.7	33.9	9.0	2.1	1.2	1.0	0.4	
Avg OtherFe (%)	2.9	12.3	12.9	16.0	12.6	0.8	0.4	7.4	15.0	8.3	9.1	7.1	
Avg FeOT (%)	3.80	16.10	16.90	21.40	16.47	1.52	1.84	13.89	23.63	21.18	21.87	9.13	
Avg SiO2 (%)	68.80	57.46	57.74	55.40	52.83	34.56	46.55	50.80	50.25	44.97	44.79	41.40	
Avg Al_2O_3 (%)	13.70	10.77	10.06	8.26	9.67	1.00	0.18	4.44	4.21	1.68	1.82	7.25	
Avg MgO (%)	1.47	3.05	4.03	4.13	9.15	0.07	0.08	2.10	3.31	2.53	2.85	25.70	
Avg CaO (%)	0.05	0.42	0.63	0.46	2.66	0.03	0.03	0.56	0.90	1.08	1.21	3.21	
Avg Na_2O (%)	0.09	0.25	1.48	0.18	0.16	0.01	0.01	0.09	0.11	0.08	0.11	0.08	
Avg K_2O (%)	3.65	3.42	1.36	1.70	1.76	0.03	0.02	0.58	0.78	0.20	0.32	0.03	
Avg TiO_2 (%)	1.13	0.28	0.32	0.23	0.25	0.02	0.01	0.11	0.11	0.05	0.05	0.27	
Avg P_2O_5 (%)	0.040	0.114	0.116	0.145	0.087	0.018	0.030	0.120	0.163	0.155	0.179	0.020	
Avg MnO (%)	0.030	0.122	0.068	0.095	0.170	0.005	0.005	0.105	0.120	0.087	0.091	0.135	
Avg Cr_2O_3 (%)	0.03	0.02	0.08	0.02	0.10	0.04	0.05	0.02	0.02	0.02	0.02	0.29	
Avg LOI (%)	4.77	3.17	3.19	2.24	3.66	0.38	0.40	3.54	1.37	0.08	0.35	10.55	
Avg ST (%)	1.240	0.408	0.852	0.335	0.183	0.012	0.008	0.020	0.156	0.057	0.122	0.200	
Count Bulk Density	1	0	1	0	1	1	1	0	4	3	10	1	23
AvgOfBD	2.59		2.94		2.92	3.32	3.49		3.18	3.48	3.46	2.84	
Count SG	1	5	5	2	3	3	2	2	36	6	48	2	115
AvgOfSG	2.84	2.98	2.97	3.11	3.02	3.98	3.71	3.18	3.31	3.52	3.52	2.92	

Note: For more information on WGM's samples see Chapter 11 – Data Verification.

As a component of BBA's 2011 PEA, a program of metallurgical work was undertaken (BBA, December 14, 2011 and SGS Canada Inc., January 9, 2012). This metallurgical testwork program included the selection of two bulk composite samples from mineralization intersected in Phase I (Twin Program) drill holes. Both composites were taken from the SE part of the deposit where modeling of mineralization is simpler. Composite 1 was taken to represent Saksagan iron formation, Member 2, (SX2F) and Composite 2 to represent the lower iron formation member or Saksagan Member 1 (SX1F). This work on the composites, as well as being aimed at achieving measurements of iron recovery, included mineralogical components, both optical (by MCM) and instrumental, QEMSCAN™ (by SGS-Lakefield).

It is not completely clear if the mineralization comprising Composite 1 is strictly SX2F or a merged unit of SX2F and SX3F or even includes some SX4F, but it is clear that along the SE part of the Property this mineralization forms a coherent, mappable lithological sub-unit. Similarly, the SX1F member along the SE part of the Property also forms a coherent, mappable lithological sub-unit.

Table 7-5: Location Information for Metallurgical Composites 1 and 2

Composite ID	Black Iron Twin Drill Hole				Historic Equivalent		
	Drill Hole	From (m)	To (m)	Length (m)	From (m)	To (m)	Length (m)
1	BI20342-T	24.0	185.0	161	29.5	190.1	160.6
	BI21674-T	22.0	87.8	65.8	17.0	90.0	73.0
	BI5485-T	14.3	106.5	92.2	14.6	109.3	94.7
	BI21733-T	18.5	133.1	114.6	17.3	137.0	119.7
	Total			**433.6**			**448.0**
2	BI20342-T	237.0	271.0	34.0	233.0	275.0	42.0
	BI21674-T	128.0	152.0	24.0	129.0	156.0	27.0
	BI21733-T	161.5	185.3	23.8	Drill hole not sufficiently long		
	BI5485-T	173.5	201.0	27.5	Drill hole not sufficiently long		
	BI12850-T	114.0	142.5	28.5	116.0	148.0	32.0
	BI13302-T	216.5	260.0	43.5	210.0	264.0	54.0
	BI20291-T	205.0	231.0	26.0	186.5	231.5	45.0
	Total			**207.3**		**200.0**	

Note 1: In the December 14, 2011 BBA report the meterage intervals for BI5485_T and BI21733_T are interchanged. It is unknown if the sample material that went for the test was also selected incorrectly or if this error is an error in the report.

The composites collected comprised two fractions: a -35-mesh (500 microns) portion, which was sub-sampled from the coarse assay rejects by MCM; and the coarser fraction, which was made up from selected drill core fragments. The finer fraction was used by MCM for mineralogical, Davis Tube and gravity table tests. Two, 2 kg sub-samples of this fraction (one for each of the two composites) were forwarded to SGS-Lakefield for size-by-size assays and mineralogy by QEMSCAN™. These results are presented in SGS-Lakefield report 13219-001 Progress Report #1, dated January 10, 2012, and in BBA's December PEA report. MCM's results for mineralogy and testwork were provided to Black Iron as a series of spreadsheets in the fall of 2011.

The coarse material was picked by MCM personnel, under instruction from BBA, from the core trays containing the second half core (i.e., the remaining half drill core not sent for routine assay). MCM personnel selected a representative sample by picking periodic pieces of core from the designated sample intervals. A 30 kg sample of this coarse material for each composite was sent to SGS-Lakefield for Bond rod mill and ball mill grindability tests under BBA's auspices. Results for this program component are presented in BBA's 2011 PEA.

MCM was provided a list of samples. From each sample bag, after thoroughly mixing the contents, MCM extracted a portion of material. The sub-samples for each of the composites were combined and composites of required size were prepared by a process of successive cone and quartering. A representative sample was sent to its microscopy department for mineral identification and description. Another portion of each was subject to composition determination by a process of sequential chemical analysis. The results for the distribution of minerals and iron for Composites 1 and 2 are presented in Table 7-6 and Table 7-7. A portion of the composites was forwarded to SGS-Lakefield for further testwork. MCM also computed normative mineralogy, based on a sequence of selective digestions and chemical analysis. These results are shown in Table 7-8.

The mineral abundance as measured by QEMSCAN™ after SGS-Lakefield is presented in Table 7-9. No optical microscopy was included to differentiate the magnetite and hematite; instead, both phases are reported as "Fe-Oxides."

SGS-Lakefield found that both composites were predominantly composed of Fe-Oxides (30.9% and 26.4% in Composite #1 and Composite #2, respectively), quartz (28.4% and 31.8%) and Fe-silicates (23.8% and 20.9%) which were identified by X-Ray Diffraction as mainly grunerite. Micas/clays were present in both samples, especially in Composite #2, at 11.4%, compared to 5.75% in Composite #1. Pyroxene (3.61% and 2.56%), chlorite (2.54% and 2.68%), amphiboles (1.09% and 1.59%) and dolomite (1.39% and 0.60%) were also present, as well as apatite (0.23% and 0.24%). Both samples contained similar levels of pyrite (0.17% and 016%) and pyrrhotite (0.17% and 0.18%).

Table 7-6: Main Characteristics of Main Minerals in the Composite 1 Sample (after MCM 2011)

Minerals Designation	Shape of Grains and Aggregates	Grains and Aggregates Size, mm (dominant size)		Intergrowths with other Minerals
		Ore Layer and Mixed Metallic and Non-metallic Layer	Non-metallic Layer	
Magnetite	Irregular, (seldom) polygonal	- grains 0.02-0.09 (0.03-0.06); - aggregates 0.15-0.36 (0.10-0.12)	- grains 0.006-0.036	with silicates, quartz, sulphides and Fe oxides
Ferric hydroxide	Irregular, filling-type	- aggregates 0.096-0.24 (0.12)		with silicates, carbonates,
Martite	Rim-type and acicular	- grains 0.003x0.036	-	with magnetite
Iron sulphides (pyrite, pyrrotine)	Isometric and crevice-like	- grains 0.012-0.060 (0.024-0.048); - aggregates 0.10-0.24	- grains 0.012-0.060 (0.024-0.048); - aggregates 0.12-4.0	with magnetite, silicates, quartz
Silicates: - cummingtonite (dominant mineral) - tremolite, actinolite - biotite - muscovite - chlorite	- acicular - columnar - isometric - isometric - lamellate	- grains 0.010x 0.050-0.02x0.07	- grains 0.008x0.320-0.032x1.2 (0.020x0.270) - grains 0.20x0.50-0.40x0.70 - grains 0.2-0.32 - grains 0.096-0.48 - grains 0.020-0.040	with magnetite, quartz

Table 7-7: Main Characteristics of Main Minerals in the Composite 2 Sample (after MCM 2011)

Minerals Designation	Shape of Grains and Aggregates	Grains and Aggregates Size, mm (dominant size)		Intergrowths with other Minerals
		Ore Layer and Mixed Metallic and Non-metallic Layer	Non-metallic Layer	
Magnetite	Irregular, (seldom) polygonal	- grains 0.025-0.084 (0.03-0.06); - aggregates 0.12-0.54 (0.12-0.16)	- grains 0.006-0.025	with silicates, quartz, sulphides and hematite
Hematite	Irregular, plate-type	- grains 0.003x0.048-0,012x0,060 - aggregates 0.060x0.120-0,084x0,180	-	with magnetite, quartz and silicates
Martite	Irregular, polygonal	- grains 0,048-0,060 - aggregates 0,072-0,12	-	with magnetite, quartz and silicates
Iron sulphides (pyrite, pyrrotine)	Irregular, isometric and crevice-like	- grains 0,024-0,084 (0,024-0,048); - aggregates 0,12-0,32	- grains 0,024-0,084 (0.024-0.048); - aggregates 0,12-0,32	with magnetite, silicates, quartz
Silicates: - cummingtonite, cummingtonite turning into riebeckite (dominant mineral) - hornblende	- acicular - columnar	- grains 0,010x0,050-0,016x0,120	- grains 0,010x0,300-0,025x1,1 (0,025x0,280) - grains 0,04x0,16-0,045x0,025	with magnetite, quartz

Table 7-8: Mineral Composition of the Ore Composite Sample 1 and 2 Based on the Results of Phase Chemical Analysis (after MCM, 2011)

Size Fractions, mm	Mineral weight percent (M) and iron content therein (Fe), %															
	Magnetite		Hematite, martite / Fe-Hydroxides[(1)]		Carbonates		Silicates		Iron Sulphide				Quartz	Apatite	Total	
									Pyrite		Pyrrotine					
	M	Fe	M	Fe	M	Fe	M	Fe	M	Fe	M	Fe	M	M	M	Fe
Composite 1	27.9	20.2	7.5	4.5	4.3	1.2	33.4	7.16	0.11	0.05	0.14	0.09	26.15	0.5	100.0	33.2
Composite 2	25.0	18.1	4.7	3.3	2.12	0.9	41.74	9.17	0.07	0.03	0.17	0.10	25.7	0.5	100.0	31.6

Note [(1)]: In Composite 1 MCM noted Fe-hydroxides but in Composite 2 the mineral phases and iron distribution values are for hematite-martite only.

Table 7-9: Overall Mineral Abundance (after SGS Minerals Services)

% Mineral Mass	Composite 1	Composite 2
Calculated ESD Particle Size	23	21
Fe-Oxides	30.9	26.4
Fe-Silicate	23.8	20.9
Siderite	0.28	0.12
Calcite	0.45	0.32
Dolomite(Fe)	1.39	0.6
Mn-Oxide/Carbonate	0.02	0.01
Other Carbonates	0.2	0.05
Quartz	28.4	31.8
Plagioclase	0.33	0.41
K-Feldspar	0.03	0.03
Micas/Clays	5.75	11.4
Chlorite	2.54	2.68
Amphiboles	1.09	1.59
Pyroxene	3.61	2.56
Other Silicates	0.39	0.43
Pyrite	0.17	0.16
Pyrrhotite	0.17	0.18
Other Sulphides	0.02	0.01
Apatite	0.23	0.24
Other	0.14	0.2
Total	**100.00**	**100.00**

The elemental distributions within the different mineral phases were calculated with iExplorer. The distribution of Fe is presented in Table 7-10. Most of the Fe occurs in Fe-Oxides (68.2% and 65.1%) and Fe-silicates (22.4% and 20.4%). The other major carriers of Fe are micas/clays (3.30% and 8.50%) and pyroxene (2.98% and 2.50%). Pyrrhotite carries more Fe (0.32% and 0.39%) than pyrite (0.24% and 0.26%).

Table 7-10: Average Fe Deportment (after SGS)

Mineral	Composite 1	Composite 2
Fe-Oxides	68.2	65.1
Fe-Silicate	22.4	20.4
Siderite	0.42	0.21
Dolomite(Fe)	0.15	0.05
Other Carbonates	0.16	0.04
Micas/Clays	3.3	8.5
Chlorite	1.29	1.72
Amphiboles	0.39	0.43
Pyroxene	2.98	2.5
Other Silicates	0.07	0.13
Pyrite	0.24	0.26
Pyrrhotite	0.32	0.39
Other Sulphides	0.02	0.01
Other	0.15	0.29
Total	**100.00**	**100.00**

QEMSCAN™ does not have the ability to resolve hematite from magnetite. Consequently, it is not known how much of the iron in iron oxides is magnetite and how much is hematite and hydroxides.

7.3.4 Density and Specific Gravity

MCM completed both bulk density and pycnometer specific gravity (SG) measurements on routine drill core samples submitted to the lab as part of the analytical package for Black Iron's 2011 drill programs. Sampling and assaying are described more completely in Chapter 11 of this report. The samples were selected on a periodic basis by GEORESOURCE to represent mineralization intersected in the drilling.

In addition, WGM collected samples for independent analysis to validate the work of Black Iron and GEORESOURCE. These samples were submitted by WGM to SGS-Lakefield for an analytical package that also included measurements of bulk density and SG. At SGS-Lakefield, bulk density measurements and pycnometer SG were determined on half-split drill core samples; pycnometer SG was determined on all of the pulp samples selected by WGM previously prepared by MCM. Results for these samples are found in Chapter 12, "Data Verification".

At MCM, a total of 175 samples had both bulk density on spit core and pycnometer SG completed. Of these 175 samples, 157 samples are taconite while 18 samples contain substantial martite or goethite-limonite. On these figures, "substantial martite-goethite-limonite" is designated by samples with greater than 5% hmFe calculated. Figure 7-7 shows bulk density plotted against pycnometer SG.

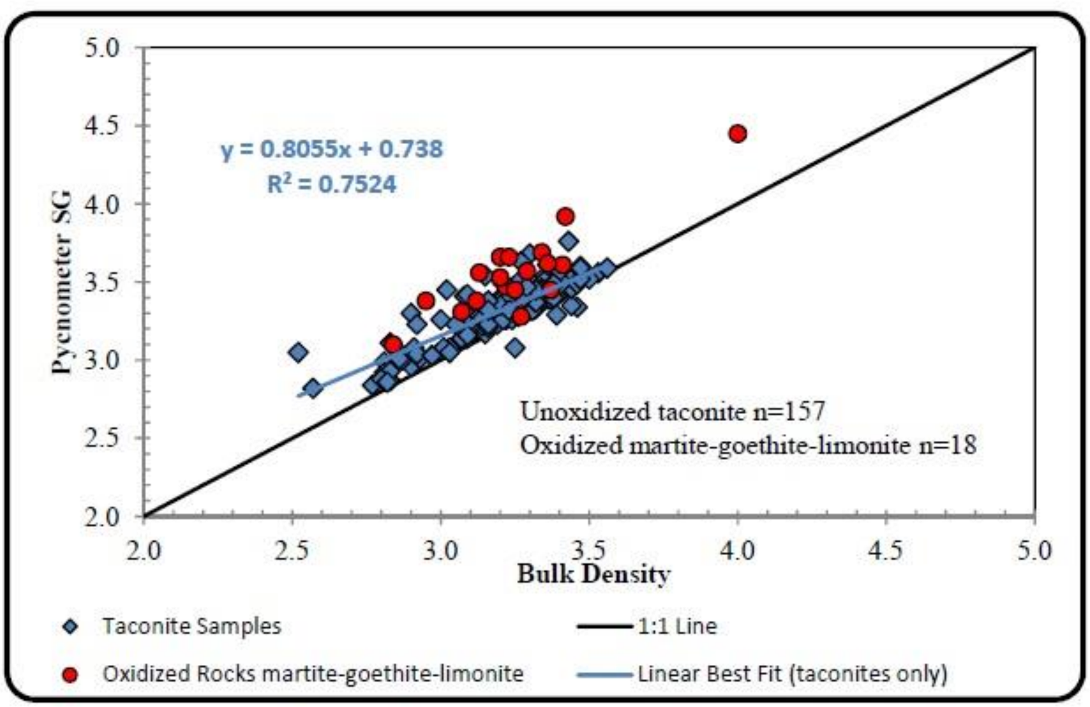


Figure 7-7: SG vs. Bulk Density – MCM Determinations

SG pycnometer values are a little higher than bulk density values. This can occur and would be expected for the oxidized altered iron samples due to development of internal porosity in the altered weathered rocks, but would not be expected for dense fresh massive taconite. This result may thus point to a problem in instrument calibration for individual measurements, but this same pattern is shown in results for samples submitted by WGM to SGS-Lakefield (Chapter 12, Data Verification), so additional work is warranted to further address the issue.

During the course of Black Iron's drilling programs, 356 Routine samples were selected by GEORESOURCE for determination of SG by pycnometer. Figure 7-8 shows pycnometer SG plotted against % Fe_{tot} Heads; in Figure 7-9, SG is plotted against % Fe_{mag} Heads.

Also shown in Figure 7-9 is the polynomial best-fit trendline (orange) for the samples submitted to SGS-Lakefield from Chapter 12, "Data Verification." The black trendline is fit only to the taconite sample results from MCM.

Figure 7-10 and Figure 7-11 show MCM bulk density results for 206 samples.

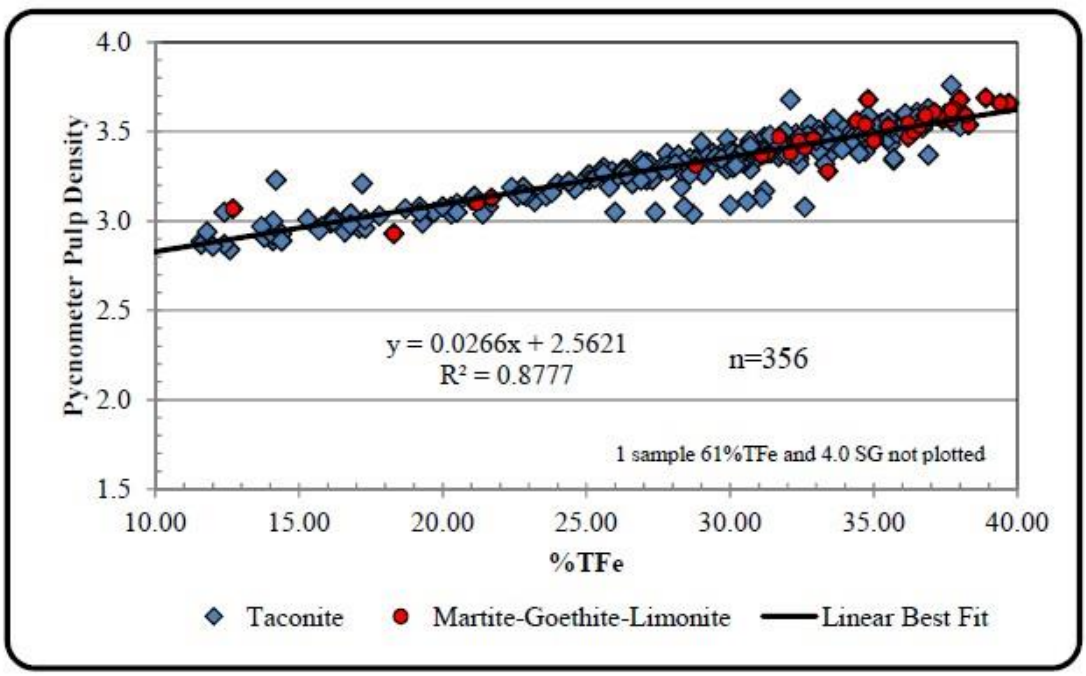


Figure 7-8: SG vs. % Fe_{tot} – Determinations by MCM

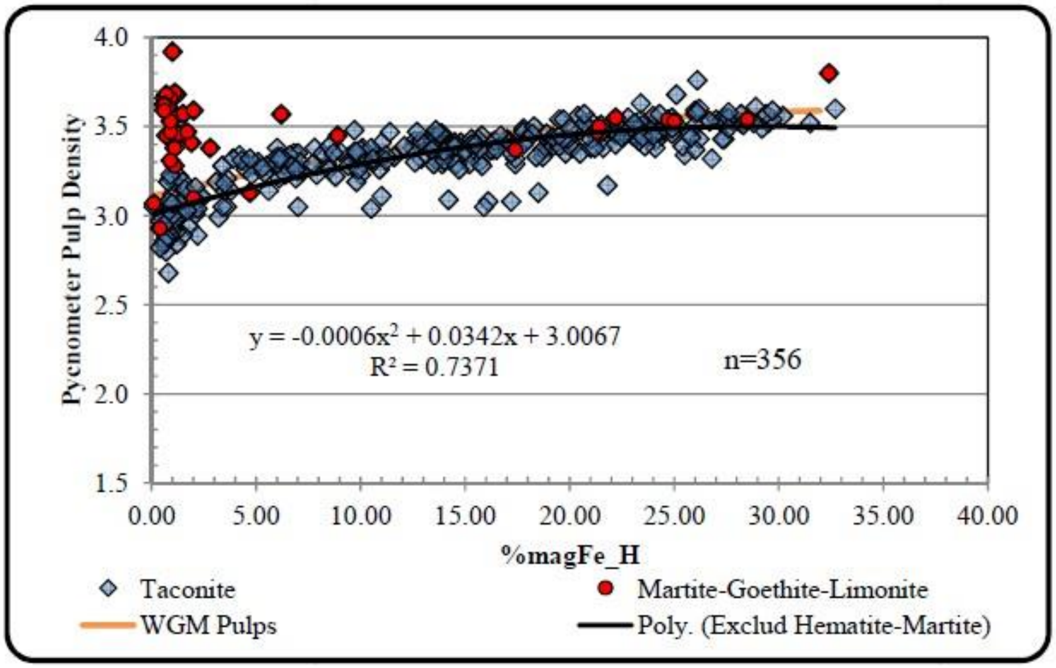


Figure 7-9: SG vs. % Fe_{mag} – Determinations by MCM

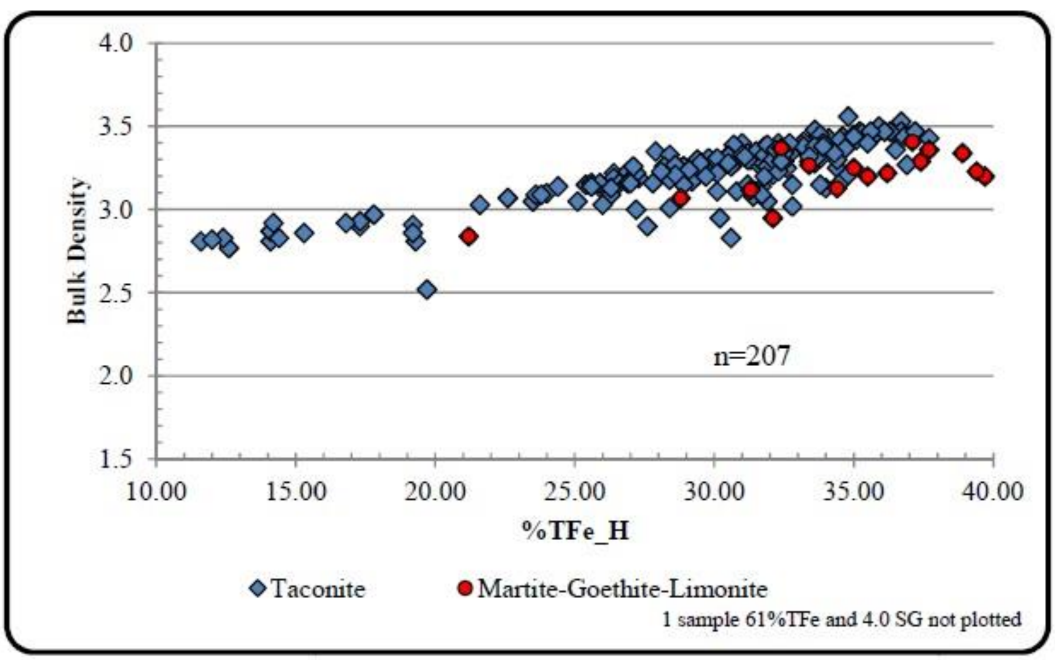


Figure 7-10: Bulk Density vs. % Fe_{tot} – Determinations by MCM

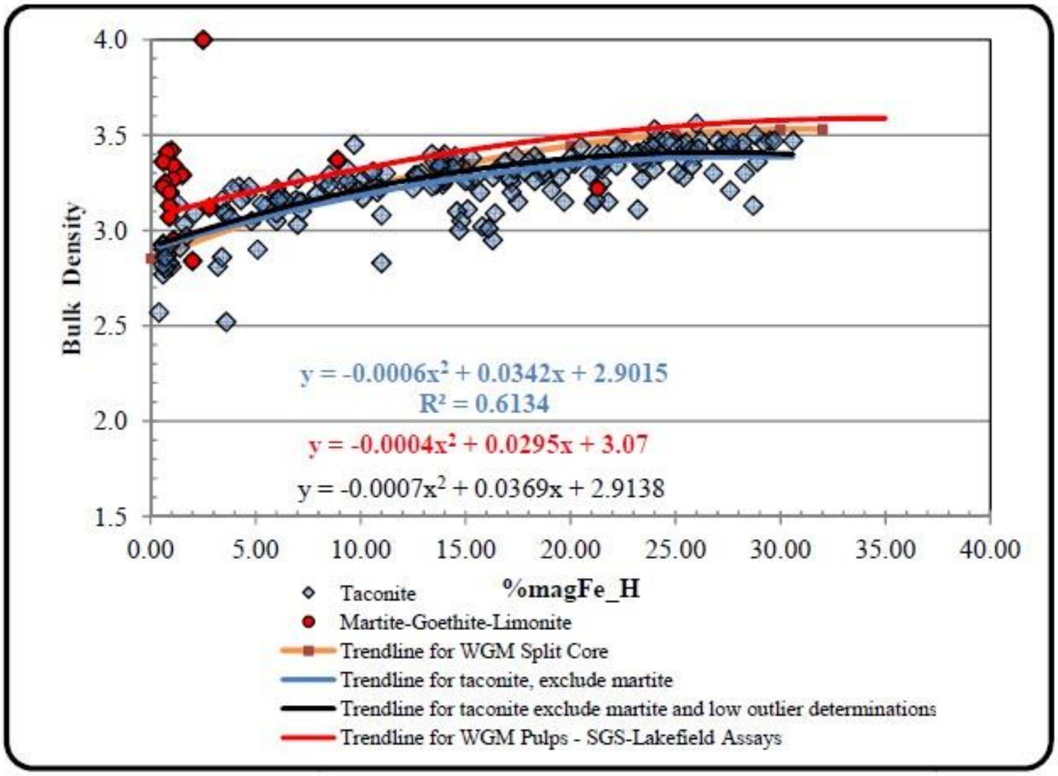


Figure 7-11: Bulk Density vs. % Fe_{mag} – Determinations by MCM

Four polynomial trendlines are shown in Figure 7-11. The blue is fit through all taconite samples (excluding the martite-goethite-limonite samples); the black trendline excludes 20 samples that plot below the main trend (the data points are still shown on the plot). These samples reported lower density than expected for the iron Head grades. WGM believes these samples have incorrect results (see Chapter 12, "Data Verification"). The red trendline (density = -0.0004*% Fe_{mag} + 0.0278*% Fe_{mag} + 3.1089) is one based on WGM's pulp samples submitted to SGS-Lakefield, described in "Data Verification.

The red trendline was used for the Mineral Resource estimate, Chapter 14. It may be a little too high. It is WGM's understanding that the Mineral Resources models were also run with the other model lines for comparison and the global difference in tonnage was deemed insignificant, i.e. a difference of approximately 10% lower global tons.

More investigation of rock SG/density and verification throughout the deposit is required as the project advances but if the Mineral Resource is updated in the future without more of this work being completed then WGM recommends that the Mineral Resource estimate be completed using the SG/density function defined by the blue/black lines shown in Figure 7-11.

8. DEPOSIT TYPES

The iron formation on the Property is of the Lake Superior-type. This type of iron formation consists of banded sedimentary rocks composed principally of bands of iron oxides, magnetite and hematite within quartz or chert-rich rock with variable amounts of silicate, carbonate and sulphide lithofacies. Such iron formations have been the principal sources of iron throughout the world (Gross, 1996). Table 8-1 (after Eckstrand, editor, 1984) presents the salient characteristics of the Lake Superior-type iron deposit model.

Lithofacies that are not highly metamorphosed or altered by weathering and are fine grained are referred to as taconite. Taconite generally ranges in iron content from 15% to 45%. The ferruginous quartzite (meta-chert) horizons characteristic of the Saksagan sequence that comprise the majority of mineralization on the Property and are mined throughout the KrivBass are identified as magnetite taconite. In general, the Property and the KrivBass also hosts a certain amount of supergene: weathered oxidized taconite leading to martite-magnetite, martite and goethite/limonite – martite mineralization. In the historic interpretations, this mineralization on the Property has been mainly attributed to SX5F unit; the fifth ferruginous horizon of the Saksagan Group associated with the regional NE-SW oriented fault zones that form the western margin of the KrivBass (see also the “Mineralization” section). WGM believes that for the Shymanivske Property, it is not clear that the martite mineralization actually belongs to SX5F, but may be lower down in the stratigraphy. WGM believes the main control on the location of the oxidized mineralization is the fault or uniformity interface between the Gdantsev and Saksagan, which may cross cut stratigraphy and the mineralization may represent multiple units.

Supergene weathered taconite becomes enriched in iron through oxidation, the leaching of silica and the concentration of oxide iron. Strongly enriched variations of this type of material are often known as Direct Shipping Ores (DSO). Such mineralization was prevalent through the KrivBass, especially prior to WWII, but is still mined underground in the KrivBass today. The Novaya Mine, a former underground producer located just south of the Property, exploited this type of mineralization and a number of small underground mines were located on the Property, but little is known of them. Any surface evidence is covered now by mine waste but, according to hearsay, Soviet drill holes intersected some of these underground workings. One of Black Iron’s drill holes also intersected one and was terminated when it intersected the underground opening.

For non-supergene-enriched iron formation to be mined economically, oxide iron content must be sufficiently high, but also the iron oxides must be amenable to concentration (beneficiation) and the concentrates produced must be low in deleterious elements such as silica, aluminum, phosphorus, manganese, sulphur and alkalis. For bulk mining, the silicate and carbonate lithofacies and other rock types interbedded in general, within the iron formation must be sufficiently segregated from the iron oxides. Folding can be important for repeating iron formation and concentrating iron formation beds to create economic concentrations of iron.

Table 8-1: Deposit Model for Lake Superior Type Iron Formation (After Eckstrand, 1984)

	Fe (Mn)
Examples: Canadian – Foreign	Knob Lake, Wabush Lake and Mont-Wright areas, Que. and Lab. - Mesabi Range, Minnesota; Marquette Range, Michigan; Minas Gerais area, Brazil.
Importance	Canada: the major source of iron. World: the major source of iron.
Typical Grade, Tonnage	Up to billions of tonnes, at grades ranging from 15 to 45% Fe, averaging 30% Fe.
Geological Setting	Continental shelves and slopes possibly contemporaneous with offshore volcanic ridges. Principal development in middle Precambrian shelf sequences marginal to Archean cratons.
Host Rocks or Mineralized Rocks	Iron formations consist mainly of iron and silica-rich beds; common varieties are taconite, itabirite, banded hematite quartzite, and jaspilite; composed of oxide, silicate and carbonate facies and may also include sulphide facies. Commonly intercalated with other shelf sediments: black.
Associated Rocks	Bedded chert and chert breccia, dolomite, stromatolitic dolomite and chert, black shale, argillite, siltstone, quartzite, conglomerate, redbeds, tuff, lava, volcaniclastic rocks; metamorphic equivalents.
Form of Deposit, Distribution of Ore Minerals	Mineable deposits are sedimentary beds with cumulative thickness typically from 30 to 150 m and strike length of several kilometres. In many deposits, repetition of beds caused by isoclinal folding or thrust faulting has produced widths that are economically mineable. Ore mineral distribution is largely determined by primary sedimentary deposition. Granular and oolitic textures common.
Minerals: Principal Ore Minerals **- *Associated* Minerals**	Magnetite, hematite, goethite, pyrolusite, manganite, hollandite. Finely laminated chert, quartz, Fe-silicates, Fe-carbonates and Fe-sulphides; primary or. metamorphic derivatives.
Age, Host Rocks	Precambrian, predominantly early Proterozoic (2.4 to 1.9 Ga).
Age, Ore	Syngenetic, same age as host rocks. In Canada, major deformation during Hudsonian and, in places, Grenvillian orogenies produced mineable thicknesses of iron formation.
Genetic Model	A preferred model invokes chemical, colloidal and possibly biochemical precipitates of iron and silica in euxinic to oxidizing environments, derived from hydrothermal effusive sources related to fracture systems and offshore volcanic activity. Deposition may be distal from effusive centres and hot spring activity. Other models derive silica and iron from deeply weathered land masses, or by leaching from euxinic sediments. Sedimentary reworking of beds is common. The greater development of Lake Superior-type iron formation in early Proterozoic time has been considered by some to be related to increased atmospheric oxygen content, resulting from biological evolution.
Ore Controls, Guides to Exploration	1. Distribution of iron formation is reasonably well known from aeromagnetic surveys. 2. Oxide facies is the most important, economically, of the iron formation facies. 3. Thick primary sections of iron formation are desirable. 4. Repetition of favourable beds by folding or faulting may be an essential factor in generating widths that are mineable (30 to 150 m). 5. Metamorphism increases grain size, improves metallurgical recovery. 6. Metamorphic mineral assemblages reflect the mineralogy of primary sedimentary facies. 7. Basin analysis and sedimentation modelling indicate controls for facies development, and help define location and distribution of different iron formation facies.
Author	G.A. Gross

9. EXPLORATION

9.1 General

For descriptions of exploration program results, WGM has relied solely on the basis of historic reports, notes and communications with Black Iron personnel and various other geophysical and geological contractors. Additional results and descriptions have been summarized in previous technical reports. Pre-2011, during the ramp-up to exploration, Black Iron commissioned Genivar to prepare a NI 43-101 report for the Property and to review and validate the historic Soviet mineral resource estimates. This work by Genivar in 2011 resulted in the definition of NI 43-101 compliant Mineral Resources for the Property, which is on file with SEDAR.

The historic exploration is summarized under Chapter 6 – History of this Report. Black Iron initiated the exploration of the Property in 2011 and conducted Phase I and Phase II diamond-drilling programs. The drilling components are described in Chapter 10, of this Report. Black Iron's programs also included ground magnetic, gravity surveys and satellite imaging to construct a digital topographic model for the Property and environs and complete the survey of known historic casings for validation of historic drilling information.

9.2 Abitibi Geophysics GPS - Integrated Magnetic Field and Ground Gravity Survey

On behalf of Black Iron, Abitibi Geophysics of Val d'Or, Québec, performed a GPS-Integrated ground magnetic field and a ground gravity survey over the Property. The goal of this geophysical work was to improve the geological understanding of the Property and to delineate magnetic and gravity highs related to taconite and supergene iron mineralization.

From April 1 to April 25, 2011, a total of 72 line-km of magnetic surveying and 1,239 gravity readings with a 50 x 50 m nominal sampling were recorded using a GSM-19 Proton precession magnetometer and two CG-5u Autograv gravimeters (Scintrex), positioned in DGPS fashion using dual frequency Trimble systems R7 GNSS. Survey specification, instrumentation control, data acquisition and processing were, according to Abitibi, all successfully performed within its quality system framework.

The magnetic survey grid consists of 46 WNW-oriented cross lines, extending from L0+00 to L22+50N. The lines vary in length from about 0.55 km to roughly 1.50 km and are spaced as close as possible to 50 m apart. The magnetic survey lines were accurately positioned, using the GPS guidance system integrated into the GSM-19 magnetometers. GPS readings were recorded every second. The magnetometer readings were corrected for diurnal variations, using readings from a synchronized mag-base station.

The gravity survey was completed with an expected Bouguer anomaly accuracy of better than 0.05 mGal (before terrain corrections). The survey is not tied to the International Absolute Gravity Base Station Network (IAGBN) of the Ukrainian government. A local base station (Shymanov #9999) located at the survey grid was established and used daily. Each survey loop began and ended with a reading at the Project base station. These readings were used to calculate the instrumental drift. The drift correction was then linearly applied to all the data contained within the loop. The Bouguer anomaly grid was calculated employing standard reductions using a mean crustal rock density value of 2.67 g/cm^3. To resolve (i.e., isolate or separate) the local gravity anomaly from the regional component, the upward continuation of the potential gravity field was implemented. For this purpose, a simple Fourier method was used to continue the Bouguer field upward to level 1200 m. The residual anomaly was then generated in a straightforward way, by subtracting the regional field from the Bouguer grid.

Three-dimensional magnetic susceptibility and density-contrast models of the iron formation were built. Overall, the 3D inversions allowed the identification of a complex-shaped and rather large gravity and magnetic anomalies, reaching 4 mGal and 1.5 SI, respectively.

Figure 7-3 (see "Geological and Mineralization") includes Abitibi's total magnetic field survey results while Figure 7-4 (also previously shown) shows Abitibi's residual Bouguer gravity results.

9.3 Satellite Imaging and Topographic Model

Effigis Geosolutions (Effigis) of Montréal was contracted by Black Iron to generate a Digital Elevation Model (DEM) for a 100 km$_2$ area covering the Property and environs.

The production of a DEM involves the extraction of elevation information using stereoscopic imagery from the American satellite WorldView-2. The satellite has a resolution of 50 cm and can be programmed to acquire the sets of stereoscopic images, which are necessary for the extraction of elevation information covering the area of interest. For this project, the work was carried out on SOCET SET photogrammetric workstations. The absolute accuracy of the DEM was produced to reach 50 cm in X and Y and 1 m in Z at CE90 (90% of cases). To obtain such results, ground control points (GCP) were used, with an accuracy of 25 cm.

Effigis delivered the product as raw images and Geotiff with a 1 m contour interval. The information was used for site planning.

9.4 Search and Survey for Historical Drill Hole Casings

GEORESOURCE was requested to search out and locate all possible drill hole casings on the Property that were not yet identified, in order to provide further validation of historic collar locations. WGM understands that a thorough search was never undertaken, but some of known historic casings that were located were surveyed.

The surface survey contractor for the Project, TNT TPI LLC (TNT TPI) of Dnepropetrovsk, Ukraine, has provided coordinates for seven casings identified (see Table 9-1). No labels were found with the casings, and so absolutely positive identifications cannot be made. On the other hand, these casings are reasonably coincident with historic collars described in historic documents. Tentative identities for the casings are also listed in the Table 9-1. These drill holes all represent holes from the later Soviet programs. All but one of these, C5, is identified with drill holes for which historic Pulkovo 42 datum coordinates are available. The locations for each of the casings surveyed by TNT TPI are generally 4 m to 8 m offset from the coordinates listed for drill holes in the database, but not systematically in the same direction. It is possible that some of the differences may be attributable to data transformation inexactitudes.

Table 9-1: Historic Casings Surveyed by TNT TPI

ID	Probable Drill Hole ID	Comment	Easting (WGS84, Zone 36N)	Northing (WGS84, Zone 36N	Elevation (m)
C1	21724	~8 m offset	5297570.24	520258.47	48.233
C2	20244	~1 m offset	5297913.908	520550.773	66.456
C3	20285	~8 m offset	5298244.665	520541.138	62.304
C4	20622	~2 m offset	5298608.959	520415.144	62.444
C5	21657	~4 m offset	5297798.353	520040.842	49.097
C6	21719	~4 m offset	5297635.945	519882.671	47.597
C7	21720	~4 m offset	5297596.835	519939.13	58.312

WGM knows of at least six other casings on the Property. Most of these were identified by GEORESOURCE prior to program start-up or during initial spotting of drill holes for the program. These other six casings have not been surveyed by TNT TPI. For further information about these casings, see Chapter 12, “Data Verification.”

In WGM’s opinion, the survey results for the casings support the validation of the historic drill hole collar locations. However, WGM still recommends that a thorough search be completed and all casings that are found be surveyed towards building more confidence in the historical exploration/drilling record.

10. DRILLING

For descriptions of exploration program results, WGM has relied solely on historic reports, notes and communications with Black Iron personnel and various other geological contractors. Additional results and descriptions have been summarized in previous Technical Reports.

10.1 Historic Drilling

According to the records available, the historic drilling completed on the Property was done in several phases in the 1960s through 1989. These holes, drilled mostly steep to vertical, were placed along cross-sections generally oriented 111.5 degrees azimuth crossing the Property. The basic cross-section nomenclature comprises Sections 1 to 7, but some intermediate cross-sections, such as 2a and 2b, etc., also contribute. Based on available records, total historic drilling, including several twin drill holes, aggregates to approximately 40,772 m in 217 drill holes, as tabulated in Appendix E. Black Iron is also aware that an additional series of at least 13 short drill holes (probably vertical) were drilled along a section approximately 300 m northwest of Cross-section 7, in the north part of the Property, but records are scant. These collars are, however, shown on the Soviet 1989 geological surface plan of the Property.

For most of the historic drilling, no drill logs or journals have been located. The few logs that have been acquired for the 1982 to 1984 drill holes are from the 1985 Soviet report on the Property. Good-quality plans showing the collar locations and cross-sections for all of the known historic drill holes are available from the 1989 Soviet report (and earlier ones from the 1985 report). These plans show the collar locations, and the cross-sections show the traces of the drill holes in plan and down dip. One limitation of the plans is that they do not include any coordinate grids or topographic features for indexing their locations. Original Soviet lists of collar coordinates in Pulkovo 42 datum, Baltic elevation system, assumed to be the Gauss Kruger Zone 6 projection, are available for only the 1980, 2000, 2100, 2200 and 2300-series drill holes. Volumes attendant to the 1985 and 1989 Soviet reports include lists of sample assays and lithological coding.

GIC, as part of their work mandate for Oberon Coal, was to compile a digital database for all drilling. It is understood that GIC had the same list of Soviet-era collar coordinates that Black Iron has in its possession and it used this partial list, supplemented by the 1989 Soviet geological plan, to define collar locations for all drill holes known. It is understood that GIC also transformed each of the Pulkovo coordinates available for the drill holes that have coordinates into WGS84, Zone 36N UTM datum coordinates. Using interpolation and a best-fit method, GIC generated new WGS84, Zone 36N UTM coordinates for the collars with no historic Pulkovo coordinates. From the Soviet cross-sections and attendant traces of the drill holes on plan, GIC generated digital listings of collar and down hole azimuth and dip information. From the cross-sections it also generated down hole lithological codes —Tos and Froms— and acquired sample locations and assays from the various volumes containing lists of assays in the 1989 report. This database is available and Black Iron, after some checking and minor revision, has used this database as the fundamental source of information for the historic drilling and the input into the Mineral Resource estimate.

From the core logs available for this period, it is known that many of the Soviet drill holes were drilled either at an azimuth of 107 degrees to 115 degrees, nominal 111.5 degrees, or the reverse orientation of 291.5 degrees. Most holes were drilled steeply with collar dips of 85 degrees to vertical. The drill hole diameter for the 1985 drill holes was 76 mm. It is expected that the 1989 program drill holes were of similar diameter. It is unknown if the early drill holes were of similar diameter or smaller.

The logs available for the 1982 to 1984 program are of good quality. They provide rock description and lists of assays and include collar elevation, but do not report collar eastings and northings. They also include down hole inclinations; infrequently, they report down hole azimuth, even when gyro surveys are known from other sources to have been completed. The logs also report rod diameter and drilling dates. Book 4, Appendix 38, of the 1989 Soviet report is a Table that summarizes collar and down hole azimuth, drill hole-inclination and down hole deviation for all project holes including older pre-1980, 4000, 5000, 6000 and 7000-series drill holes. Gyroscopic down hole surveys were completed for most of the drill holes, completed during the 1980s as were down hole geophysical surveys. Most of the pre-1980 drill holes had no down hole attitude surveys completed, but for a few of these older holes down hole azimuths were surveyed.

Many of the later Soviet drill holes had down hole attitude and geophysical surveys completed, while the earlier drill holes had no down hole surveys. This is generally appropriate and reasonable because these older drill holes were often vertical and short. The geophysical information for the 1985 and 1989 program drilling is compiled on cross-sections attached to the 1985 and 1989 reports. The down hole attitude surveys were completed by gyroscopic methods, as described in the text of the 1989 report. Similar to other early drill holes, they were targeted on the oxidized quartzite type of enriched iron mineralization.

The early drill holes were drilled mainly for exploring for enriched iron ore, either along the steep NW dipping lithological/fault/unconformity contact between the Gdantsev and Saksagan sequences, adjacent to the basement gneisses; and/or the uppermost parts of the Saksagan iron formation units immediately under the Cenozoic limestone cover. Many of these early holes were apparently terminated as they entered fresh taconite. Sampling and assaying for the historic holes is described in Chapter 11. It is known that many of the earliest drill holes were assayed only for Fe_{tot} and that Fe_{mag} was generally not determined. It is known that in addition to Fe_{tot} and Fe_{mag}, FeO_T was also determined in some of the drill holes. FeO_T assays are compiled in the 1985 logs, but are not listed in the assay compilation of the 1989 report, or in GIC’s 2005 database, nor have they been added to Black Iron’s database. The Soviet 1989 assay Tables do include tabulation of rock code and core recovery by sample. Composites of samples were assayed for additional elements.

There are a number of steeply dipping drill holes where no end-of-hole azimuths were reported in Appendix 38 of the 1989 Soviet report. In the 2005 database, these holes are often listed with an end-of-hole azimuth equivalent to their collar azimuth. WGM understands that there is no end-of-hole azimuth for these steep holes because the gyro instrument could not resolve azimuth where inclinations were so steep (i.e., close to vertical). Accordingly, WGM recommended to Black Iron that the drill holes with no end-of-hole azimuth (as shown in Appendix 38) were revised to have no azimuth and only vertical dips per conventional practice.

WGM presumes that the down hole dips posted in the 2005 database, and maintained in the current database, are largely interpolated between collar inclination and end-of-hole inclinations. This is because few of the available documents report incremental down hole inclinations. However, the 1985 logs do contain complete listings of down hole dips. WGM does not consider this matter serious.

WGM recommends that Black Iron, before mining commences, complete a search of the archives in Moscow for additional missing documentation, particularly the missing drill core logs, collar coordinates for the 4000, 5000, 6000 and 7000-series of drill holes (i.e., pre-1980) and any down hole orientation information for post-1980 drill holes.

WGM believes the data available is generally reliable regarding drill hole location and attitude, and sufficiently complete and suitable to support a Mineral Resource estimate. However, only a small proportion of it can be absolutely independently verified. WGM believes that additional documentation can likely be found to support the geotechnical database and that research and acquisition should continue to provide a more complete record.

10.2 Black Iron's 2011 Phase I – Twin Drilling Program

10.2.1 General

To date, Black Iron has conducted two drilling programs on the Property. The Twin Drilling Program also known as Phase I Drilling Program comprised 22 holes aggregating 6,041.8 m; immediately following this, the Phase II Drilling Program was initiated. It consisted of 48 holes aggregating 11,435 m, including seven holes (totaling 695 m) that were drilled to acquire larger diameter core for comminution testwork. Total drilling thus aggregated 70 holes and 17,477 m. The primary purpose of the Phase I program was to collect material for metallurgical testwork by drilling a selection of drill holes as close as possible and at similar attitude to historic locations. The secondary goal of the drilling program was to validate the historic drilling completed on the Property. The purpose of the Phase II program was to provide additional information to advance deposit interpretation to support an updated and upgraded categorized Mineral Resource estimate. Drill hole details for Black Iron's Phase I (Twin) and Phase II programs are summarized in Table 10-1.

Table 10-1: Drilling Summary – Phase I and II Programs

Drill Hole ID	Easting	Northing	Elv	Azm	Dip	FDepth	Date Started	Date Finished
Phase I								
BI21674-T	520524.57	5298064.49	66.242		-90	190.00	28-Mar-11	21-Apr-11
BI20342-T	520629.26	5298716.63	71.054	109.00	-87	313.00	03-Apr-11	19-Apr-11
BI5485-T	520406.79	5298120.41	61.098		-90	196.00	07-Apr-11	20-Apr-11
BI21733-T	520514.98	5298299.71	63.194		-90	250.00	08-Apr-11	22-Apr-11
BI12850-T	520451.02	5297946.61	57.47	94.00	-84	223.00	12-Apr-11	02-May-11
BI13302-T	520533.00	5298534.13	65.7	114.00	-85	313.40	20-Apr-11	06-May-11
BI21711-T	520490.31	5298960.11	69.888		-90	430.00	22-Apr-11	10-May-11
BI20291-T	520645.54	5298491.83	68.247		-90	267.00	23-Apr-11	12-May-11
BI21704-T	520209.97	5298832.50	64.84		-90	373.40	23-Apr-11	15-May-11
BI21732-T	520555.74	5298288.42	62.862		-90	235.50	23-Apr-11	13-May-11
BI21689-T	520646.31	5298356.66	64.482	111.50	-87	200.00	01-May-11	12-May-11
BI20349-T	520779.22	5299192.58	80.282	107.00	-85	447.40	07-May-11	28-May-11
BI21707-T	520675.76	5298687.66	71.199		-90	332.00	09-May-11	23-May-11
BI20289-T	520128.40	5298702.38	66.065		-90	351.00	09-May-11	04-Jun-11
BI12009-T	520578.76	5298918.66	72.091		-90	330.00	12-May-11	26-May-11
BI21687-T	520488.15	5298396.44	64.058		-90	251.80	14-May-11	30-May-11
BI20287-T	520339.70	5298649.83	55.663	112.00	-87	283.00	16-May-11	10-Jun-11
BI21668-T	520076.60	5298260.86	66.512		-90	190.00	17-May-11	27-May-11
BI20347-T	520427.19	5299299.67	85.822		-90	266.00	26-May-11	23-Jun-11
BI21703-T	520121.82	5298912.54	85.927	111.50	-87	439.30	27-May-11	23-Jun-11
BI20293-T	519885.28	5298159.71	78.837	108.00	-86	85.00	28-May-11	18-Jun-11
BI21735-T	520200.75	5298521.56	67.364		-90	75.00	29-May-11	27-Jun-11
Subtotal Phase I		**22 Drill Holes**				**6041.8 m**		
Phase II								
BISH-02	520264.32	5298001.94	57.13		-90	154.00	16-Aug-11	23-Aug-11
BISH-03	519786.65	5297687.79	64.584	111.50	-75	220.50	08-Jul-11	29-Jul-11
BISH-04	520219.62	5298026.19	46.926		-90	154.00	25-Aug-11	31-Aug-11
BISH-05	519858.26	5297907.06	60.123	111.50	-80	466.00	20-Jun-11	05-Aug-11
BISH-06	519841.60	5298023.44	54.91	111.50	-80	527.00	17-Jul-11	15-Sep-11
BISH-07	519892.33	5297999.66	49.19	111.50	-80	337.00	19-Jun-11	17-Jul-11
BISH-08	519954.74	5297966.69	47.632	111.50	-80	202.00	12-Jun-11	18-Jun-11
BISH-09	520013.77	5297940.86	46.921		-90	247.00	25-Jun-11	11-Jul-11
BISH-10	520148.83	5297903.70	47.65		-90	212.00	01-Aug-11	08-Aug-11

Drill Hole ID	Easting	Northing	Elv	Azm	Dip	FDepth	Date Started	Date Finished
BISH-11	520235.49	5297867.50	55.652		-90	151.40	12-Jun-11	24-Jun-11
BISH-12	520306.40	5297843.33	57.296		-90	136.50	25-Jun-11	06-Jul-11
BISH-13	520431.16	5297806.06	56.462		-90	35.30	03-Aug-11	
BISH-14	520503.74	5297770.53	63.248		-90	123.00	02-Jun-11	10-Jun-11
BISH-17	520155.02	5298053.04	50.541		-90	151.00	03-Sep-11	08-Sep-11
BISH-18	519994.80	5298269.32	65.12	111.50	-78	310.00	31-Oct-11	28-Nov-11
BISH-19	520117.95	5298227.03	64.094	111.50	-80	217.00	25-Jun-11	01-Aug-11
BISH-21	520463.57	5298566.65	64.73	291.50	-70	400.00	08-Aug-11	07-Sep-11
BISH-22	520083.57	5298361.84	68.947	111.50	-70	229.00	22-Jul-11	12-Aug-11
BISH-24	520382.41	5298705.86	62.4	291.50	-70	336.00	12-Aug-11	29-Aug-11
BISH-25	520211.38	5298767.97	65.069	111.00	-80	153.50	05-Jun-11	29-Jun-11
BISH-26	520384.55	5298701.54	62.616	111.50	-85	308.00	02-Jul-11	09-Aug-11
BISH-28	520276.44	5298832.86	57.697		-90	352.00	03-Oct-11	31-Oct-11
BISH-29	520705.30	5298671.82	71.746	111.50	-70	265.00	04-Aug-11	22-Aug-11
BISH-31	520287.60	5298988.37	60.079		-90	375.80	23-Oct-11	16-Nov-11
BISH-33	520505.42	5298758.42	68.11	291.50	-75	381.00	14-Jul-11	14-Sep-11
BISH-35	520372.78	5298975.39	65.853	111.50	-75	400.50	16-Sep-11	19-Oct-11
BISH-57	519832.53	5297778.28	62.149	111.50	-70	253.00	19-Sep-11	30-Sep-11
BISH-58	519910.66	5297747.42	56.431	111.50	-70	152.00	11-Sep-11	18-Sep-11
BISH-59	520198.22	5298192.95	61.033	111.50	-65	280.00	24-Aug-11	06-Sep-11
BISH-60	520225.30	5298282.09	63.111	111.50	-75	321.70	10-Sep-11	23-Sep-11
BISH-61	520023.89	5298387.06	69.421	111.50	-70	288.40	18-Sep-11	13-Oct-11
BISH-62	520084.22	5298559.31	68.687	111.50	-80	450.30	21-Sep-11	08-Nov-11
BISH-63	520620.55	5298597.69	69.22	111.50	-70	290.00	11-Sep-11	02-Oct-11
BISH-64	520167.74	5298777.15	66.004	111.50	-70	174.80	25-Sep-11	
BISH-65	520456.87	5298667.89	65.8	111.50	-75	332.00	31-Aug-11	16-Sep-11
BISH-66	520056.82	5298472.75	70.38	111.50	-85	43.00	11-Dec-11	
BISH-67	520090.69	5298577.51	68.69		-90	447.00	12-Nov-11	07-Dec-11
BISH-70	520084.77	5298225.15	65.176	291.50	-70	354.00	19-Nov-11	
BISH-71	519991.23	5298118.00	59.5	291.50	-70	121.00	12-Nov-11	
BISH-72	520026.39	5298386.75	69.42	291.50	-70	236.50	16-Nov-11	16-Dec-11
BISH-78	520053.20	5297929.90	48.8	111.50	-76	152.00	01-Dec-11	09-Dec-11
Subtotal Phase II		**41 Drill Holes**				**10,740.2 m**		

Drill Hole ID	Easting	Northing	Elv	Azm	Dip	FDepth	Date Started	Date Finished
Bulk Sample Collection								
BISHHQ-1	520484.92	5298321.39	63.522		-90	150.00	27-Jul-11	09-Sep-11
BISHHQ-1a	520487.20	5298322.47	63.355		-90	134.70	11-Sep-11	26-Sep-11
BISHHQ-1b	520526.04	5298064.92	66.332		-90	94.00	27-Sep-11	12-Oct-11
BISHHQ-2	519906.01	5297837.80	59.795		-90	34.00	20-Oct-11	27-Oct-11
BISHHQ-2a	519912.64	5297820.95	59.175		-90	42.30	15-Oct-11	18-Oct-11
BISHHQ-2b	520080.60	5298259.47	66.39		-90	136.00	31-Oct-11	08-Dec-11
BISHHQ-2c	520081.04	5298245.88	65.813		-90	104.00	22-Nov-11	
Subtotal Bulk Sample		**7 Drill Holes**				**695.0 m**		
Total Drilling		**70 Drill Holes**				**17,477.0 m**		

Note: Coordinates are WGS 84 Zone 36N.

The initial drill hole selection and collar location planning for the Twin drill hole program was completed by SGS Geometallurgy, a division of SGS Canada Incorporated (SGS). Primary data for this review were derived from a drill hole database created by GIC in 2005. WGM reviewed SGS's drill hole selection and provided some revisions. GEORESOURCE subsequently made some further revisions, in consultation with Black Iron's representatives.

The original drill hole selection was not fully completed, but the majority of the selection was successfully completed. Reasons for non-completion mainly consisted of drilling difficulties in strongly weathered rock oxidized Iron mineralization along the northwest margin of the deposit. No drill holes were successfully completed through this style of mineralization. In addition, the locations for a couple of drill holes were revised due to local on-site conditions.

Drilling was carried out between early April and the end of November 2011 by drillers under contract to GEORESOURCE, operating 24 hours per day. The rigs were mainly mobile on wheels. The drills were equipped for drilling core of various irregular standards from 59 mm to 96 mm. The drilling nominally took place on a two-shifts-per-day basis, 20 h/d, seven days per week. The number of drills working on the Property varied during the program. At times, up to seven rigs were at work or were located on the Property. The rig-geologists from GEORESOURCE supervised the drills ensuring that the drills were properly setup and properly aligned on the collar and foresight markers established by the surveyors.

Descriptions of mineralization and estimated true widths are discussed in this Report in Section 7.3 – Mineralization.

10.2.2 Black Iron 2011 Program Drill Hole Collar and Down - Hole Surveying

Drill hole collars were spotted prior to drilling by the Project surveyors TNT TPI. For the Phase I program, holes were staked out using DGPS. Later in Phase II, conventional transit was used. The surveyors also surveyed the foresights to be used for aligning the drills during set-up and for aligning the gyroscopic down hole attitude survey at termination of the holes. Drilling azimuths were established by lining up the drill visually on collar picket and foresight. Drill inclinations were established using an inclinometer on the drill head. Drill set-up was supervised by the rig-geologist.

After the holes were completed and the drill dismounted and moved off, the collar locations were again re-surveyed by TNT TPI and a picket planted to identify the drill hole. These final surveys are the coordinates listed in Table 10-1.

As well as surveying the collars of the Black Iron drill holes, the surveyors also surveyed the historical casings that had been located. This program component is described in Section 9.4 of this report.

Downhole geophysical and gyroscopic attitude surveys were systematically performed by Pivnichgeologiya, a Ukrainian company under contract to GEORESOURCE. WGM understands that Pivnichgeologiya is certified according to ISO 9001: 2008 and ISO 14001: 2004. The down hole geophysical surveys included measurement of natural radioactivity (gamma ray survey), rock density (gamma-gamma survey using a cesium radioactive source), electrical conductivity, magnetic susceptibility, caliper and flowmeter. Almost all of the drill holes were surveyed.

The gamma-gamma rock density survey results were provided by Pivnichgeologiya as instrumental readings, but were not translated into density units. Pivnichgeologiya was requested to convert the data, but this work was not completed. Density values determined by the down hole surveys may be of value for estimating the tonnage for the martite mineralization and perhaps some of the goethite-limonite mineralization as laboratory measurements of bulk density/pycnometer SG completed to date for these types of mineralization may be misleading. The geophysical survey results provided by Pivnichgeologiya have not been compiled or used for the geological interpretation or Mineral Resource estimate and have not been reviewed by WGM.

The gyroscopic down hole azimuths and drill hole inclinations are used to establish the trace of the drill hole. Given that most of the drill holes were vertical, these surveys did not provide much relevant information. Where deviations from vertical were less than four degrees, the instrument could not resolve azimuth. For the few non-vertical holes, the gyro surveys provide dip and azimuth.

After the holes were completed, they were reclaimed by cementing.

10.2.3 Results of the Twin Hole Drilling Program

For most of the Twin holes, the positional relationship between the original historical collar and the new Twin collar is not precisely known. The exact positional relationship can only be determined for the historic holes where the old casings have been identified; otherwise, locational relationships must be inferred from historic database coordinates. For a few of the Twin hole locations, a historic casing or sump was located adjacent, providing some assurance of approximately correct location -say ±10 m. However, the number of Twin holes with a historic casing was small and no holes were labelled. WGM observed four or five of these historic casings (see Chapter 12 - Data Verification). GEORESOURCE found an additional seven casings (see Chapter 9 - Exploration), but none of these corresponds to historic holes that were twinned by Black Iron.

In all cases, these historic casings were within several metres (10 m to 12 m) of the location of the Twin hole collars, as spotted by TNT TPI. The various reasons for the known difference in location between the casings and the drill hole collar locations, as surveyed for the present program, are not known. The differences may be attributable to differences between traditional survey methods and datum or conversion errors from original datum. Also, the actual coordinates are not known for all the historic drill holes (see Chapter 10) and it is believed that, by capturing the locations from those shown on the Soviet plan maps and cross-sections, GIC determined collar locations for these other holes for which Soviet coordinate lists are not available. Therefore, the lack of perfect coincidence between casing locations and database locations for some holes is probably partly due to small measuring errors from the Soviet plan maps but this is not absolutely verified or verifiable.

Figure 10-1 to Figure 10-4 show selected Twin holes, compared against their corresponding historic drill holes with respect to geology and sample/assay results. Each of the cross-sections show % Fe_{mag} assays as histograms down the drill holes with different colors based on grades. Also shown are composite averages (length weighted averages) for % Fe_{tot} and % Fe_{mag} over intersection length. The composite locations were selected to represent as best as possible the equivalent intervals in the Twin and historic drill holes, so that assay averages for close-to-equivalent material could be compared. In some cases, the locations were selected to calculate average grade for distinct units of OIF; in other cases, the assayed portions of nearly-whole holes are considered. In many cases, the limits on the composite intervals have been selected on the basis of a Fe_{mag} cut-off of 10%.

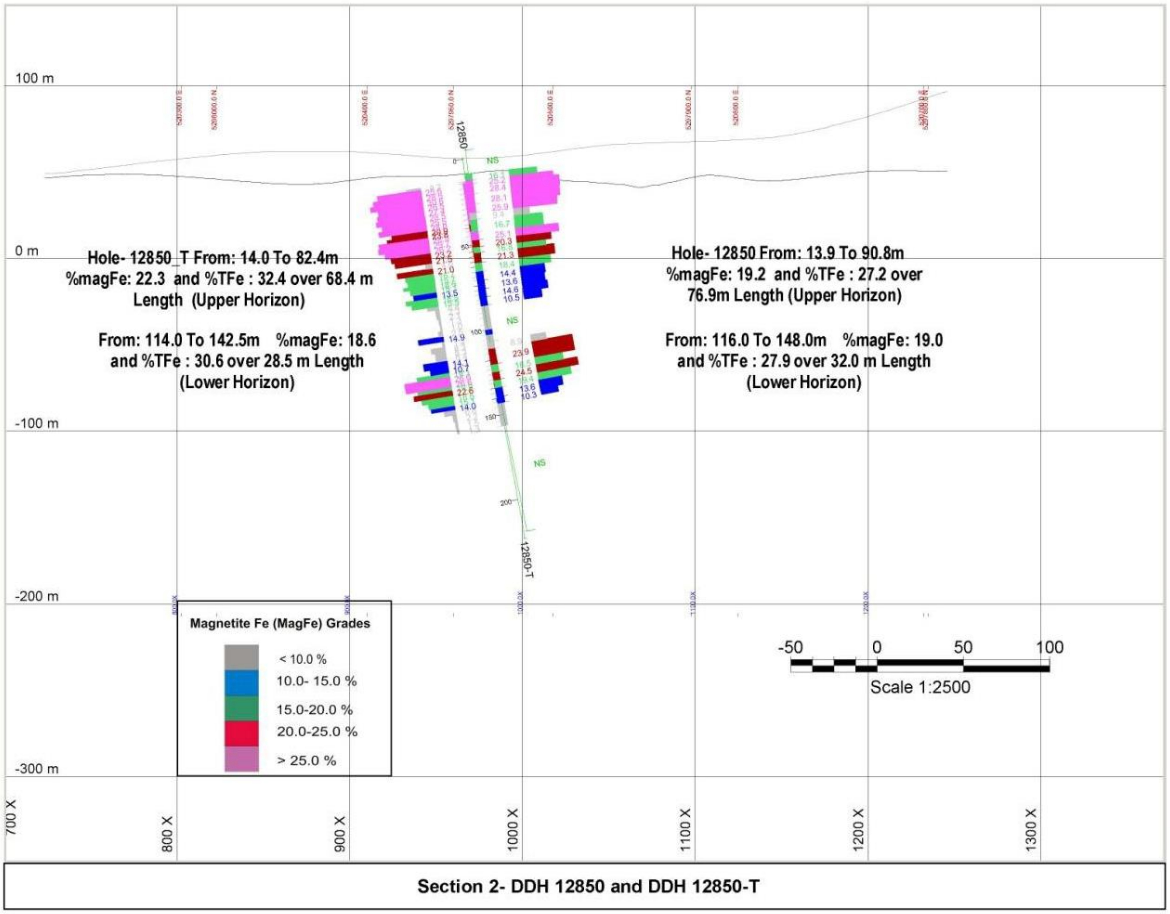


Figure 10-1: Twin Drill Hole Comparison DDH 12850

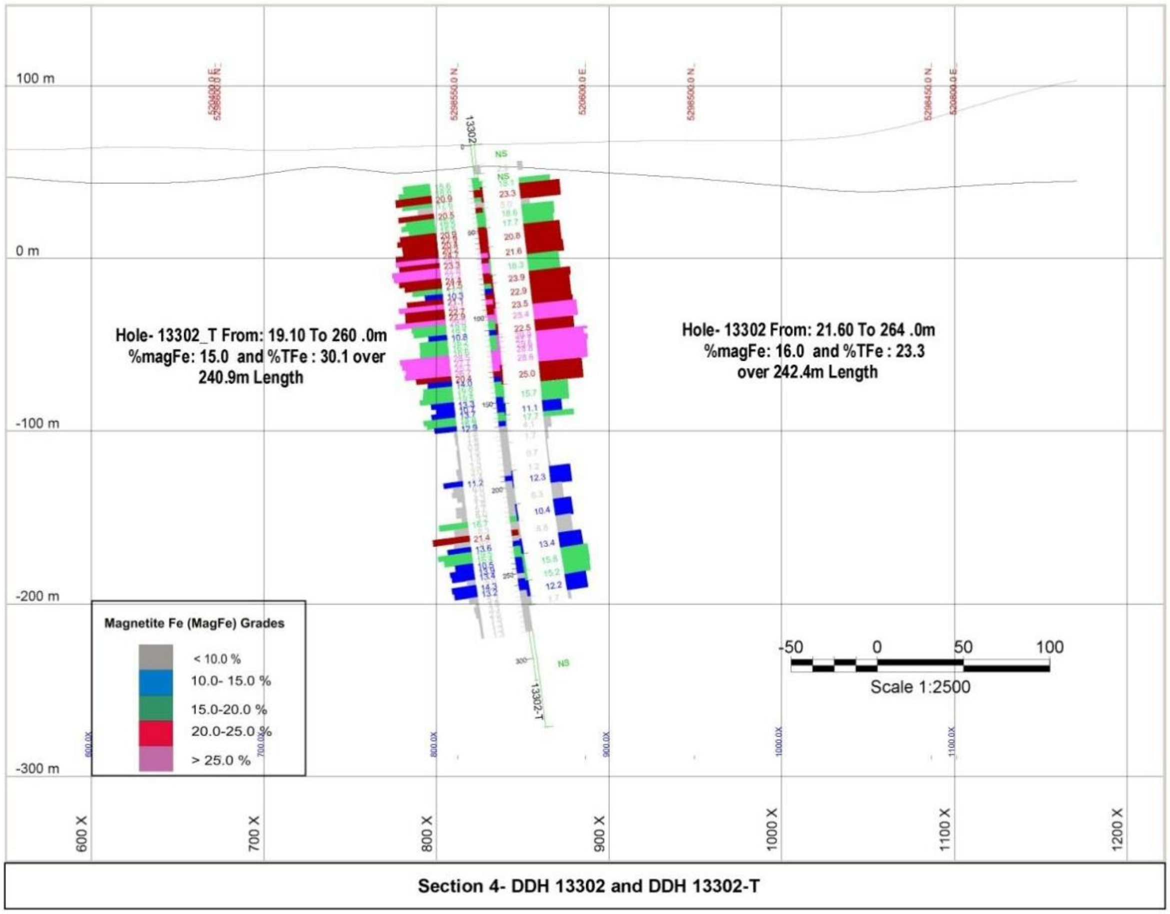


Figure 10-2: Twin Drill Hole Comparison DDH 13302

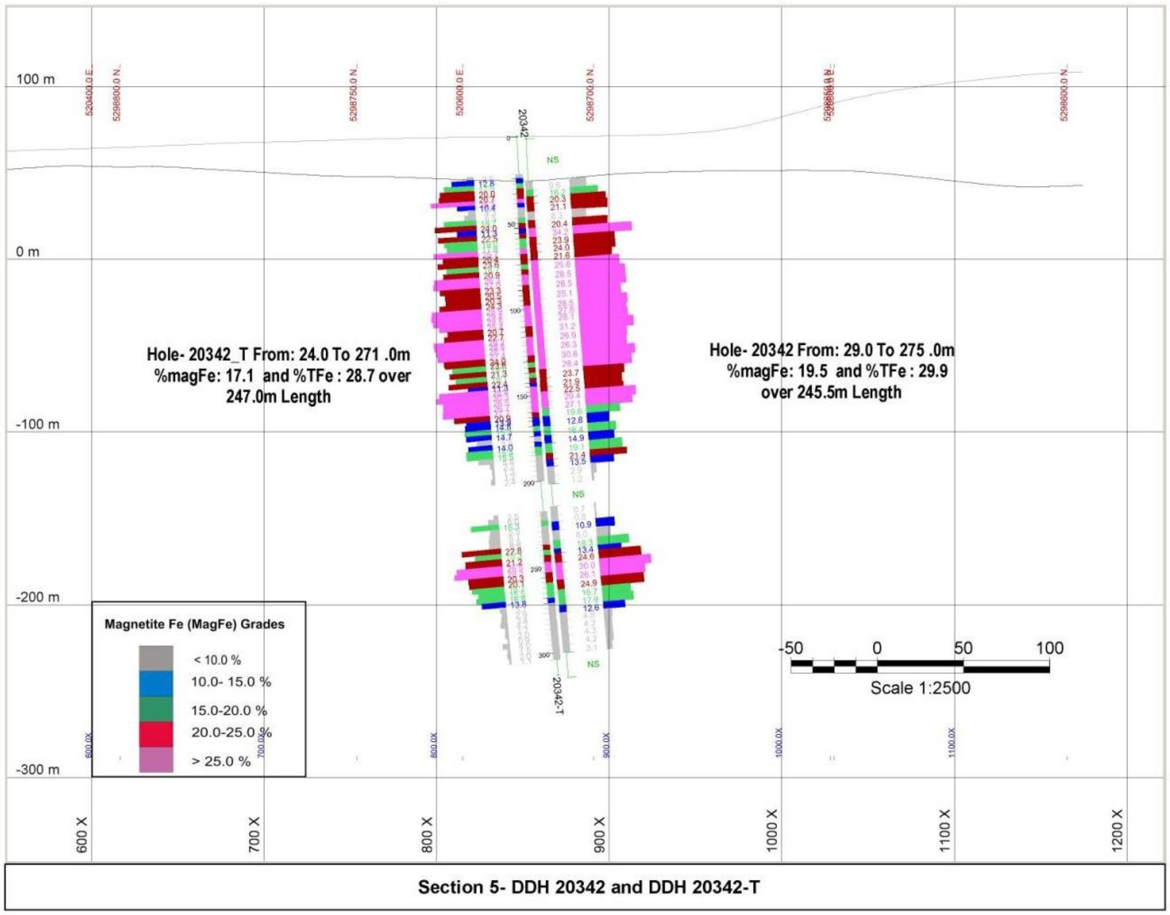


Figure 10-3: Twin Drill Hole Comparison DDH 20342

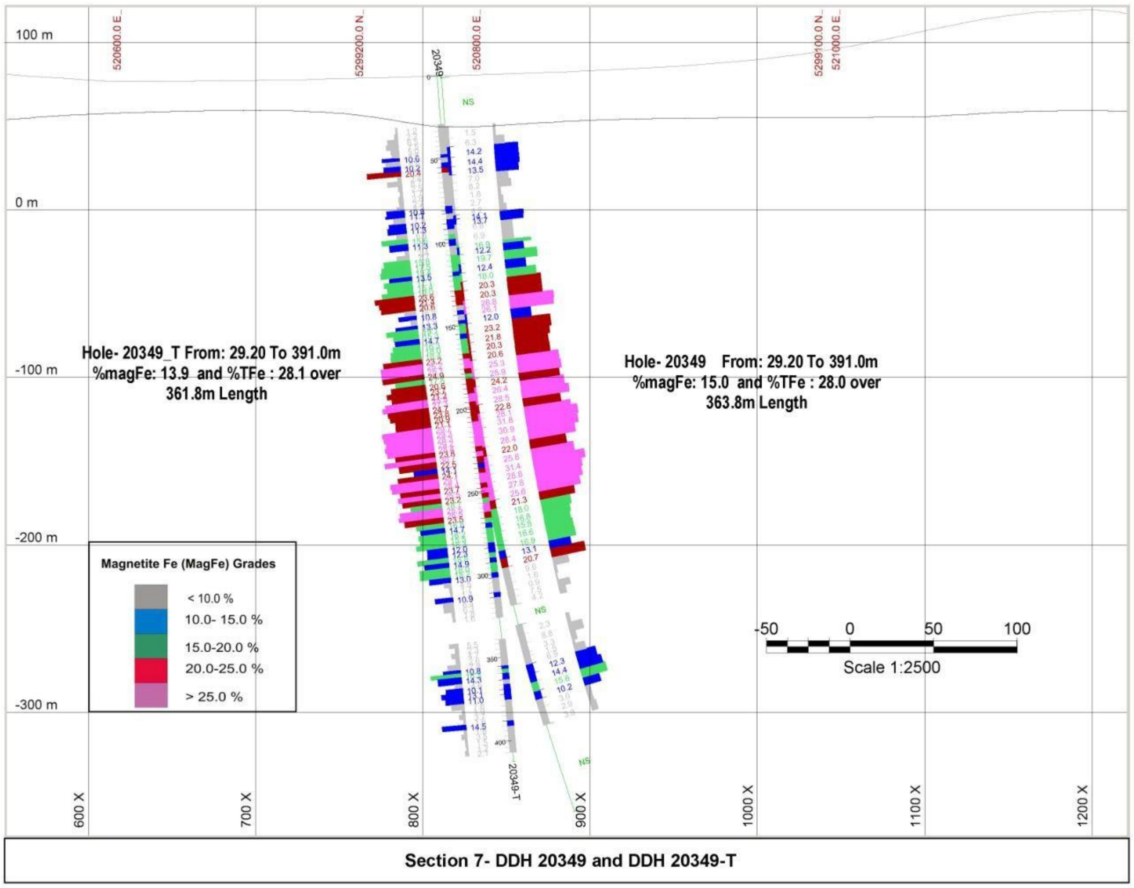


Figure 10-4: Twin Drill Hole Comparison DDH 20349

Usually, this approach was applicable because the general pattern of assay results between drill hole pairs was quite similar. However, the method was not completely objective and required some subjective licence. The overall aim was to provide minimally biased results, so that the analysis would be more effective at discerning significant differences. In WGM's opinion, selection bias was minimal and had a minimal effect on composite average assay. Table 10-2 summarizes sample assay results and composite averages for comparison.

Generally, agreement is very good with respect to intersected lithology and assays between Twin and historical drill holes. Also notable, as described in Section 7.3, "Mineralization," is the martite or strongly oxidized mineralization that often occurs immediately under the limestone cover. The calculated % hmFe spikes for this type of mineralization are caused by increased Fe^{+++}. The % Fe_{mag} decreases sharply due to the oxidization of any magnetite. For the "slate-schist" intervals, where they have been sampled and assayed, % Fe_{tot} often decreases only slightly compared with the OIF intervals, but % Fe_{mag} decreases much more considerably. In these intervals, the iron is hosted largely in silicates.

Although the patterns of highs and lows in assays are very similar between historic and the Twin drill holes, certain assay biases appear to be present. For certain historic drill holes, % Fe_{tot} appears to be significantly biased low (drill holes 13302 and 12009). Figure 10-5 is a plot of Fe_{mag} versus Fe_{tot} for Twin and historic samples for the drill holes that were twinned by Black Iron. For most samples, the ratio of Fe_{mag} to Fe_{tot} is similar. However, a population of samples does not correspond, as indicated by the oval outline. These largely represent samples from drill holes 5485, 13302 and 12009. These two latter drill holes are holes where Fe_{tot} is biased low. An observation of a similar plot of all historic samples shows many more samples that are similar. WGM can't be sure if these are all because Fe_{tot} is low or if Fe_{mag} is too high. It would have been helpful if drilling dates for each of the historic drill holes were available, so that drilling by campaign could be determined. This might make it possible to determine which historic drill holes or campaigns had low-biased assays. However, very few of the historic drill core logs are available to allow for this analysis.

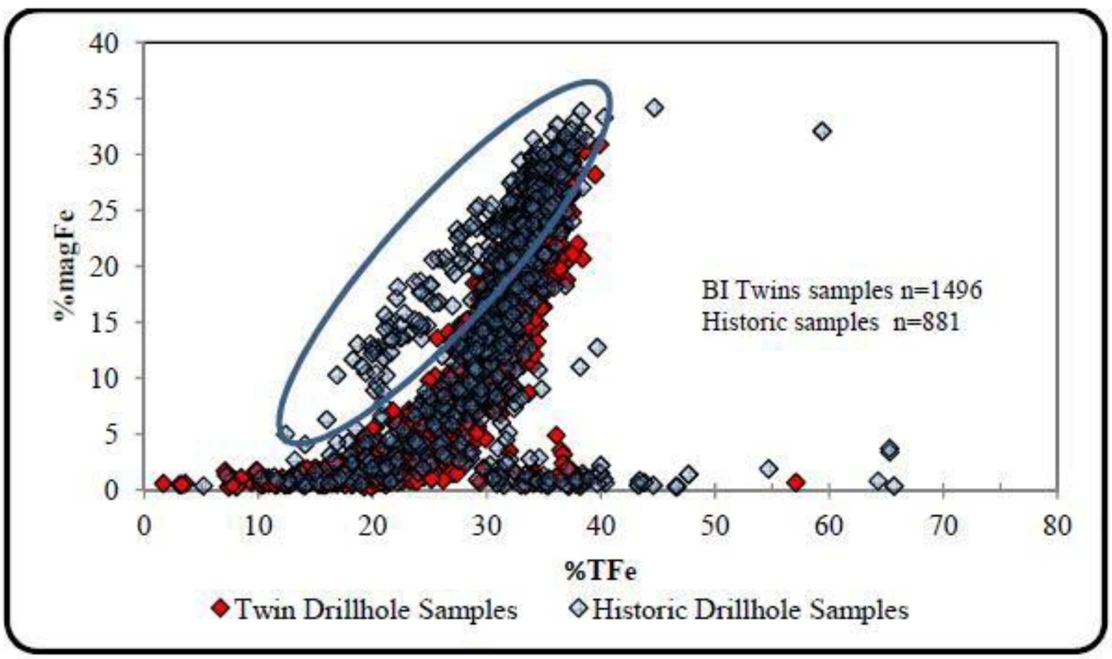


Figure 10-5: % Fe_{mag} vs. % Fe_{tot} in Historic and Twin Drill Hole

Table 10-2: Summary of Comparison Between Historic and Black Iron Twin Drill Holes

Drill Hole Pair	Section	Zone	Historic		Twin		Historic	Twin	Difference	Historic	Twin	Difference	Historic	Twin	Difference	Historic	Twin	Difference	Historic	Twin	Comment
			from(m)	to(m)	from(m)	to(m)	% Fe_{tot} wt avg	% Fe_{tot} wt avg	% Fe_{tot} wt avg	% Fe_{tot} Med	% Fe_{tot} Med	% Fe_{tot} Med	% Fe_{mag} wt avg	% Fe_{mag} wt avg	% Fe_{mag} wt avg	% Fe_{mag} Med	% Fe_{mag} Med	% Fe_{mag} Med	Length (m)	Length (m)	
12850	2	UIF	13.90	90.75	14.00	82.40	27.2	32.4	5.2	27.00	33.3	6.3	19.2	22.3	3.1	17.6	23.5	5.9	76.85	68.4	Composite limits based on 10% Fe_{mag} cut-off.
12850	2	LIF	116.00	148.00	114.00	142.50	27.9	30.6	2.7	27.1	30.6	3.5	19.0	18.6	-0.4	17.9	18.8	-0.9	32	28.5	Composite limits based on 10% Fe_{mag} cut-off.
20293	2																				No comparison completed.
21674	2A	UIF	17.00	90.00	22.00	87.80	33.2	32.1	-1.1	33.2	31.8	-1.4	20.1	20.5	0.4	18.7	20.2	-1.5	73	65.8	Composite limits based on 10% Fe_{mag} cut-off.
21674	2A	LIF	129.00	156.00	128.00	152.00	31.8	31.4	-0.4	31.4	31.7	0.3	19.1	20.5	1.4	18.6	21.9	3.3	27	24	Composite limits based on 10% Fe_{mag} cut-off.
5485	2A	UIF	14.60	109.80	14.30	106.50	28.5	32.1	3.6	30.2	31.2	1.0	21.0	21.7	0.7	23.3	19.9	-3.4	95.2	92.2	
21668	2A		20.10	160.00	22.00	163.00	30.1	29.6	-0.5	30.7	30.8	0.1	15.1	15.1	0	16.1	15.3	-0.8	139.9	141	
21732	3A	UIF	16.10	142.20	16.50	143.00	33.3	33.0	-0.3	33.4	32.9	-0.5	22.0	20.9	-1.1	21.0	19.6	-1.4	126.1	126.5	Composite limits based on 10% Fe_{mag} cut-off.
21733	3A	UIF	17.30	137.00	18.50	133.10	33.2	32.7	-0.5	33.5	33.2	-0.3	21.6	22.9	1.3	23.8	23.5	-0.3	119.7	114.6	Composite limits based on 10% Fe_{mag} cut-off.
21687	3B	UIF	16.40	158.80	24.00	169.00	33.9	31.7	-2.2	34.2	33.3	-0.9	23.6	19.5	-4.1	24.0	19.7	-4.3	142.4	145	Composite limits based on 10% Fe_{mag} cut-off.
21735	3B																				No Comparison completed.
21689	3B																				No Comparison completed.
20289	3C		132.00	308.00	126.30	294.00	30.3	29.0	-1.3	30.6	29.9	-0.7	15.6	13.6	-2.0	13.8	12.9	-0.9	176	167.7	
20287	4		18.50	185.50	20.80	187.00	30.8	30.0	-0.8	31.8	31.5	-0.3	16.5	15.8	-0.7	17.9	17.7	-0.2	167	166.2	
13302	4		21.60	264.00	19.10	260.00	23.3	30.1	6.8	23.9	31.1	7.2	16.0	15.0	-1.0	17.9	16.5	-1.4	242.4	240.9	
20291	4		20.00	231.50	23.10	231.00	31.7	30.9	-0.8	33.2	31.7	-1.5	18.4	18.1	-0.3	20.5	18.2	-2.3	211.5	207.9	
21707	5		24.00	188.80	27.00	190.00	34.0	33.5	-0.5	34.4	34.4	0.0	22.6	22.5	-0.1	23.6	24.6	1.0	164.8	163	Composite limits based on 10% Fe_{mag} cut-off.
20342	5		29.50	275.00	24.00	271.00	29.9	28.7	-1.2	32.8	32.0	-0.8	19.5	17.1	-2.4	21.8	20.1	-1.7	245.5	247	
21703	5																				No Comparison completed.
21704	5																				No Comparison completed.
21711	6		68.10	320.00	81.00	327.00	29.6	31.2	1.6	32.8	32.3	-0.5	16.2	16.5	0.3	17.2	17.1	-0.1	251.9	246	
12009	6		113.50	308.50	118.50	311.60	19.1	26.1	7.0	24.2	31.6	7.4	14.5	13.1	-1.4	17.3	16.1	-1.2	195	193.1	
12009	6	UIF	113.50	227.70	118.50	224.50	24.5	32.2	7.7	23.2	32.1	8.9	18.7	18.0	-0.7	17.7	17.8	-0.1	114.21	106	
20347	7		109.60	230.70	147.00	266.00	32.6	33.8	1.1	32.6	34.0	1.4	25.2	25.0	-0.2	25.5	25.1	-0.4	121.1	119	
20349	7	UIF	29.20	318.70	29.20	326.00	29.8	29.6	-0.2	30.4	30.6	0.2	17.3	15.5	-1.8	18.0	16.0	-2.0	289.5	296.8	
20349	7	Entire drill hole	29.20	393.00	29.20	391.00	28.0	28.1	0.1	29.9	30.1	0.2	15.0	13.9	-1.1	15.6	14.7	-0.9	363.8	361.8	
Average Difference									1.2			1.4			-0.48			-0.65			

Fe_{mag} results are results after the magnetic saturation recalibration

Differences in all cases are calculated as Twin result - Historic Result and use both negative and positive values; Med is Median

Average Difference in the bottom row of table is simply the average of the column (not averages of absolute values).

WGM is satisfied the historic results for Fe_{tot} are suitable for a Mineral Resource estimate, but they appear to be less reliable and biased low for certain drill holes. This bias is likely not correctable, except by re-drilling the affected historic drill holes. However, determining which drill holes are affected may not be possible with much certainty. Regardless, Fe_{tot} is not a very valuable parameter for grade estimation for this type of deposit because the mineralization has a high component of silicate Fe.

10.2.4 WGM Comment on Black Iron Phase I and II 2011 Drilling Programs

WGM is satisfied that Black Iron's drilling was reasonably well supervised and logging was reasonably well done. WGM agrees the Project drill hole database provides an excellent compilation of drill hole information. However, in WGM's opinion, the logs are not very satisfactory and they generally remain incomplete and difficult to read. This is partly because of translation issues and WGM understands that Black Iron intends to address this issue. The project database is in much better condition, and it provides a complete record for the drill holes and samples without the descriptions in the logs. The database includes a collar table with collar coordinates, drill hole azimuth dip, depth start and complete dates. A Lithology Table contains "Tos and Froms" for the various units/rock types intersected and rock-type codes, but not a lithological unit description beyond lithology coding. The Sample Table reports sample type and sample intervals. The database also includes a table containing Rock Quality Index (RQD) and the estimates of core recovery. WGM warns that the RQD calculation method may not be correct.

WGM recommends that the drill logs be compiled into a standard format and completed with all data. Also, where possible, more acquisition and verification of historical data would improve confidence in the historical record.

11. SAMPLE PREPARATION, ANALYSES, AND SECURITY

For descriptions of sample preparation and analyses, WGM has relied solely on historic reports, notes and communications with Black Iron personnel and the laboratories, as well as on our site visits. Additional results and descriptions have been summarized in previous Technical Reports.

11.1 Historical In-Field Sampling and Preparation

Information about the Soviet practice for the later programs is available from the 1989 Soviet report. No information regarding sampling methods is available for the earliest drilling programs, and WGM does not know if sampling practice as outlined in the 1989 Soviet report was the same for the earliest programs. Additional information may be available in the 1985 report, but this report has not been translated into English.

For the later Soviet programs, it is known from sample assay records that the sample lengths averaged approximately 4 m and varied generally from 2 m to 6 m, with some variation in sample lengths from program to program. Samples were split in two equal parts, one half was used for assay and the other half was returned to the core trays for use for testwork and, in some cases, for quality control. Sample composites averaging 20 m length were also created, using duplicate routine sample portions.

11.2 2011 In-Field Sampling and Preparation

Black Iron's 2011 Phase I and Phase II drilling programs were managed by GEORESOURCE, which conducted the drill core sampling under guidelines provided by WGM.

11.2.1 2011 Drill Core Handling and Logging

GEORESOURCE drill rig geologists logged the drill holes in the field adjacent to the drills. Leonid Galchansky, Chief Geologist for GEORESOURCE, established the standards and nomenclature to be applied to the logging and supervised the drill rig geologists. WGM contributed guidance. Lithological coding was recorded in an MS Excel database. The logging procedure included core photography.

11.2.2 Sampling

The intervals for sampling were determined and marked on the core with permanent markers, once the core was transferred to the GEORESOURCE core shed. Sample limits were defined by geology, where lithological variations were significant. The sample limits and the Sample IDs were marked on the core. Sampling guidelines from WGM included a nominal sample length of 3 m, with variations being based on geology and no narrow gaps to be left between samples. Shoulder or bracket samples were to be collected on the margins of all mineralized intervals.

The samples were sawn in half using diamond core saws. Guidelines called for sample sawing to be nominally perpendicular to layer banding to maximize sample symmetry. However, folding of the iron formation was often so intense that compliance was not often feasible. In the rubble zones, generally associated with the martite mineralization and limonite/goethite weathered zones, sawing of the core was not always possible and sampling was simply done by trying to take out a representative half-portion of rock. The half-core comprising the samples was bagged with a corresponding sample tag and protected by a plastic envelope. The remaining core was returned to the core trays and the other sample tag, also in a plastic envelope, was inserted in the trays under the first piece of core retained for the sample.

11.2.3 2011 Core Storage

WGM understands that the remaining drill core remains in Black Iron's core shed, cross piled hole-by-hole. The building is a large warehouse-style structure, with a concrete floor, secure doors and security fence.

11.2.4 2011 Sample Security

After being sawed, samples were trucked under GEORESOURCES supervision directly to MCM in Kryvyi Rih for preparation and assaying. GEORESOURCE provided MCM with a sample list for each shipment. WGM understands that all sample materials, rejects and pulps originally in the possession of MCM were, post Black Iron's drill programs, stored on racks in Black Iron's core shed. WGM does not know the current status of any remaining archived sample portions or drill core.

11.3 Laboratory Sample Preparation and Analysis

11.3.1 Historic Sample Preparation

Little is known about pre-1980s in-lab sample preparation for assaying. However, it is known from the 1989 Soviet report for the programs conducted in the 1980s that sample preparation and assaying were conducted at MCM, which was a government institution, and at a second lab, Krivorozhsky GRE. A third lab, Central Laboratory of NPO, "Yuzhukrgeologiya", was used to check the assaying of selected samples. Sample preparation, as described in the Soviet 1989 report, consisted of successive crushing stages (10 mm, 5 mm, 3 mm, and 1 mm) and included screening to ensure proper sizing and sample reduction using cone and quartering and mechanical splitters. Pulverization to analytical powder was to 0.074 mm, using vibrogrinder.

11.3.2 Historic Sample Assaying

Again, little is known about sample assaying in the pre-1980s period. It is known that determinations of magnetic iron were infrequent. Only assay results for Fe_{tot} are generally available for pre-1980 samples. The exploration target for these programs was the enriched iron ores; therefore, the taconite potential was not evaluated and determinations of Fe_{mag} were not completed. Assays for pre-1980 samples are compiled along with later assays in volumes of the 1989 report.

Post-1980 drill core regular samples were assayed for Fe_{tot}, Fe_{mag} and some for FeO_T**.** FeO_T results have not been compiled into the Project database and WGM recommends that they be added. Assaying for post-1980 samples was, as aforementioned, completed at MCM. Composite samples were assayed for whole rock major elements: Fe_2O_3, SiO_2, Al_2O_3, TIO_2, CaO, MgO, MnO, Na_2O, K_2O, CO_2, H_2O+ and H_2O. Selected samples also had more extensive assaying with 42-elements determined, including gold, using spectroscopy.

Mineralogical studies were performed and physical properties including density were determined. Density determination for 437 samples, averaging 0.5 kg, was completed on waxed samples by the weighing-in-air and water method.

Specific assay methods for Soviet samples are not described in the reports available. WGM queried MCM personnel about historic assay methods and was told that the historic methods were probably very similar to current methods, as the classical methods were still in use and had changed very little. WGM also inquired if MCM still possessed assay records from historic times and the answer was no.

11.3.3 Historic Quality Assurance and Quality Control

The 1989 Soviet report describes second half-core and quarter-core check assaying and secondary lab check assaying, regular assaying being done at MCM and check assaying being done on duplicates at Krivorozhsky GRE and the Central Laboratory of NPO. Results were subjected to statistical analysis and some of the drill holes were twinned. For the program documented in the 1989 report, Drill hole 20348 was twinned and there is a 20348, 20348a and 20348b version, which were compared on the basis of Fe_{tot} and Fe_{mag} assays, lithology and down hole geophysical results.

11.3.4 2011 Laboratory Sample Preparation

The primary laboratory for Black Iron's 2011 Twin Drilling (Phase I) and Phase II drilling programs was MCM, based in Kryvyi Rih. Sample preparation for assay included first-stage jaw crushing, second-stage roll crushing and finally puck and ring pulverization to provide a representative pulp for assay. Figure 11-1 illustrates the sample preparation and analysis flowsheet.

Each entire half-split core sample was jaw-crushed to 75%, passing 10 mm. At every 20th sample, the crushed product was tested by screening, using a 10 mm screen. The total weight of the sample was recorded. After each sample, the crusher was blown out with compressed air. On a plastic sheet the sample was then thoroughly mixed by trowelling the sample three times back and forth from pile to pile. The thoroughly mixed sample was then coned and quartered. One-half of the sample was returned to the original sample bag with the original sample tag, and subsequently returned to GEORESOURCE for storage. The retained half portion was weighed to ensure it amounted to one-half of the sample. The retained half was then transferred to the rolls mill where it was stage-crushed, which usually required two to three stages. After each stage, the sample material was screened at 2 mm, the oversize being returned to the mill for further crushing aimed at achieving 75% passing 2 mm. The product sub-sample was then thoroughly mixed by trowelling the material back and forth three times on the plastic sheet. It was then reduced in size again by cone and quarter. Normally two successive stages of cone and quartering were required to separate 250 g of the sub-sample. The reject was weighed, the mass being recorded on the assay certificates, and then put into a new sample bag for storage.

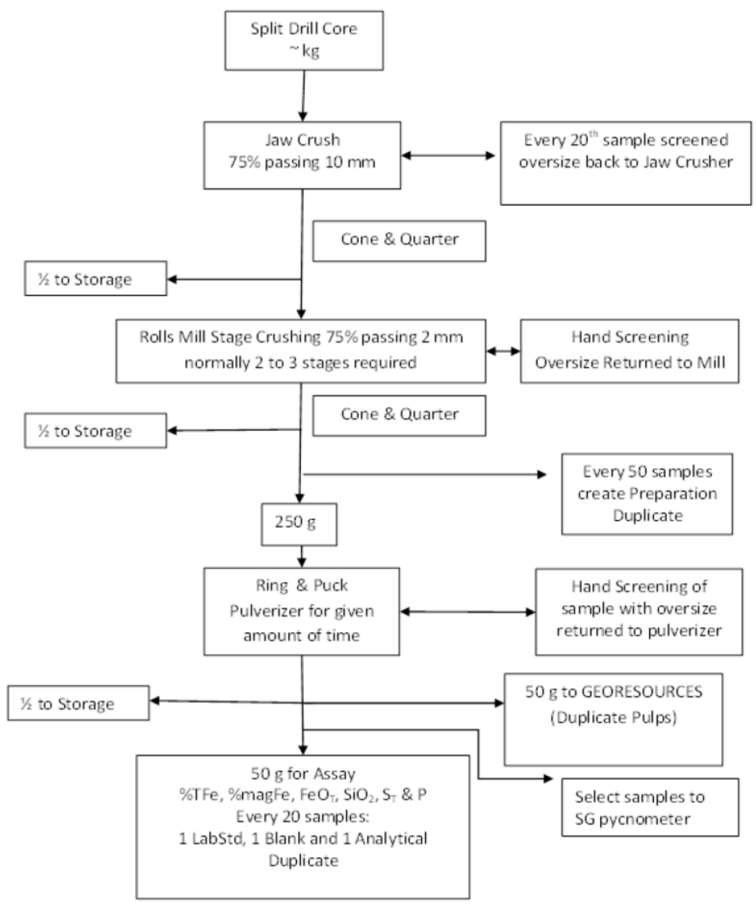


Figure 11-1: Sample Preparation and Assay Flowsheet at MCM

The 250 g (approximate) sub-sample was pulverized in a ring and puck pulverizer for a specified time, with the aim of achieving 100% passing 0.1 mm. Two pulverizers were required for each sample to handle the 250 g. The sample, after each stage of pulverization, was hand screened at 0.1 mm. The oversize was returned to the pulverizer until 100% passing 0.1 mm was achieved. After each sample, the pulverizers were blown out with compressed air and wiped clean.

The pulverized sub-sample was divided into three portions. This was done by coning the pile, flattening the pile and then using a small scoop to select material from different parts of the disc of material. Two 50 g pulps were collected, one was for assay at MCM and the other was sent to GEORESOURCE for storage and future use. The excess material was bagged and retained in storage at MCM and, apparently, moved to the core shed later.

11.3.5 2011 Sample Assaying

Assaying at MCM included determination of Fe_{tot}, Fe_{mag}, FeO_T, SiO_2, ST and P on all samples, including routine and field-inserted QA/QC samples and laboratory-inserted QA/QC materials. Table 11-1 describes the assay methods used by MCM. Sample and analysis statistics for the 2011 program are summarized in Table 11-2.

Selected samples also had their bulk density determined, by weighing in air and in water the core pieces that comprised the entire sample intervals. Other selected samples had SG determined by a pycnometer method. GEORESOURCE selected the samples for bulk density and SG. The guidelines from WGM were to try to select samples throughout the deposit that represented the entire range of rock types and mineralization intensity. Routine samples included all drill core samples, split and sampled, to evaluate their mineral content, including Bracket and or Shoulder samples. Bracket or Shoulder samples are samples of waste from the margins of mineralized intersections. A total of 3,869 routine samples were assayed during the Phase I and II programs. In-laboratory and in-field QA/QC are described in Section 11.3.6 of this report. The QA/QC program resulted in the identification of a number of sampling and assaying issues, and the follow-up of these issues generated additional samples for assaying.

Table 11-1: Summary of Analytical Methods at MCM

Methods	Description
Fe_{tot}	Method based on ferric iron reduction by stannous chloride with titration using potassium dichromate. The sample is digested with hydrochloric acid in presence of sodium or ammonium fluorides. National State Standard for Ukraine: 23581.18:2008.
Fe_{mag1}	Primary method was by magnetic saturation analyser, similar to Satmagan. Instrument requires calibration at beginning of each shift using series of samples of known saturation magnetization. National State Standard for Ukraine: 3203-95.
Fe_{mag2}	Wet chemical method. Magnetic fraction (0.5 g – 1.0 g) separated from sample using hand magnet. Fraction digested in nitric acid. After acid removed Fe_{mag} determined by bichromate titration method with diphenylamine sodium sulfonate tracer. State Standard for Ukraine: 3203-95.
FeO_T	The method is based on titration of iron (II) with a solution of potassium bichromate in presence of a tracer, i.e. sodium diphenylaminesulfonate. The sub-sample (0.5 g – 0.25 g) depending upon weight percent of ferrous oxide is placed into a conical flask (250 ml), then 50 ml of hydrochloric acid (2:1), 0.5 g sodium fluoride and 2 g sodium bicarbonate ($NaHCO_3$) are added. The flask is plugged with a cork with a long glass tube in it, promptly heated and boiled for 20 to 40 minutes to avoid iron (II) oxidation with air. After cooling of the solution, a tracer is added and iron (II) is titrated with potassium bichromate solution.
SiO_2	Gravimetric hydrochloric acid method. This method is based on silicic acid release from hydrochloric acid solution in presence of gelatin at the temperature of not more than 60°C. Sample decomposition is carried out by sintering with mixture (sodium carbonate, top-quality flour and magnesium oxide at a ratio of 3:2:0.05 in a platinum crucible at 750-800°C (for 15-20 minutes).
P	Photometric method of determination of phosphorus in iron ores. This method is based on formation of phosphomolybdic heteropolyacid with its further recovery by Fe(II) ions in presence of hydrochloric acid hydroxylamine until a blue complex compound is formed and on photometric measurements of a dyed solution at 730 nm wave length. The sample batch of 0.1 g is dissolved in hydrochloric acid adding nitric acid during heating then it is boiled for nitric oxides removal and the solution is evaporated dry. The salts are dissolved by heating in a small quantity of hydrochloric acid then filtered and the phosphorus is determined in the filtrate.
ST	Determination of Total sulphur. The method is based on ignition of sample in oxygen at temperature of 1,250–1,350°C, absorption of sulphur dioxide by water and titration of sulphurous acid with iodite-iodate solution in presence of starch tracer. State Standard for Ukraine: 23581.20:2008.
Bulk Density	Weighing–in–water/weighing-in-air method on full size half split core. The sample weight should not be less than 4 kg. The sample is first dried in a drying box at (105 ± 5°C). The basket is filled with a batch and weighed in air, and then it is gradually dipped into the vessel and kept in water for 5 minutes, shaken from time to time without taking the basket out of water to remove air bubbles from the surface of ore pieces. After abovementioned actions, the water-dipped basket with a batch in it is weighed in water. Then basket with the batch in it is taken out of the vessel and 2 minutes later (after water drains), it is weighed in air. The results of the batch weighing in water and in air are logged. The volume of water displaced by the basket is determined 5 times. The arithmetical average of all determination results is assumed to be the weight of displaced water which corresponds to the basket volume.
Pycnometer SG	The method is based on the determination of volume of a sample by measuring its weight by pycnometer without fluid in it and then with fluid and by calculation of ratio of weight of solid to its volume without regard for pore volume inside grains and volume of voids between them. A sample of size not more than 0.16 mm and its weight 60 g minimum is used here. After accurate agitation, the sample is dried in a drying box at (105 ±5°C) to a constant weight. The determination is done in duplicate.

Table 11-2: Summary of Geological Drill Core Samples and Analysis at MCM

Items	Description	Count of Samples
Routine	Fe_{tot}, Fe_{mag}, FeOT, SiO_2, S, P.	3,869
Field Blanks (FBLK)	Fe_{tot}, Fe_{mag}, FeOT, SiO_2, S, P.	217
Field Standard (FSTD)	Fe_{tot}, Fe_{mag}, FeOT, SiO_2, S, P.	225
Field Duplicates (FDUP)	Fe_{tot}, Fe_{mag}, FeOT, SiO_2, S, P	92
Total Field Samples submitted to MCM by GEORESOURCE		**4,403**
Pycnometer Pulp Density		356
Bulk Density		207
MCM		
Preparation Duplicate (PDUP)	Fe_{tot}, Fe_{mag}, FeOT, SiO_2, S, P	50
Analytical Duplicate (ADUP)	Fe_{tot}, Fe_{mag}, FeOT, SiO_2, S, P	83
Lab Standard (P010)	Fe_{tot}, Fe_{mag}, FeOT, SiO_2, S, P	192
Lab Blank (LBLK)	Fe_{tot}, Fe_{mag}, FeOT, SiO_2, S, P	77

11.3.6 2011 Quality Assurance and Quality Control

The 2011 QA/QC program for sampling and sample analysis included components conducted by GEORESOURCE that were initiated during core sampling in the field in addition to components operated by MCM as part of the in-laboratory QA/QC program. Samples and analysis for both these components are summarized in Table 11-2. The In-field components included the insertion of blanks, duplicates and Certified Reference Standards into the sample stream going to MCM. The in-MCM components included the use of blanks, duplicates and Certified Reference Standards throughout the sample preparation and assaying procedure.

Additional QA/QC components were operated by Black Iron and WGM. Black Iron's components are described under "Supplementary Assaying" at the end of this report section and include check assaying at SGS-Lakefield and ALS in Australia. The components performed under the auspices of WGM are described in Section 12.4 of this report, "Data Verification". WGM's work included check assaying of a selection of samples submitted "blind" to both SGS-Lakefield and MCM.

2011 In-Field QA/QC

In the field, standards, blanks and duplicate samples were inserted into the sample stream going to MCM. The Certified Standard Reference material used for field standards (FSTD) was CANMET FER-3. This material was pre-packaged in small jars and, as required, GEORESOURCE extracted a teaspoon of material, placed it into a sachet that was given a routine sequential sample number and inserted into the sample stream going to MCM. The FER-3 standards were inserted into the sample stream at a frequency of one per 20 routine samples. The relevant certified and provisional values for FER-3 are listed in Table 11-3. Unfortunately FER-3 has no Certified Reference Standards value for Fe_{mag}.

Table 11-3: Certified Reference Values for the Canmet FER-3 Standard

	TFe(%)	Fe_2O_3(%)	FeO(%)	MnO(%)	SiO_2(%)	TiO_2(%)	Al_2O_3(%)	MgO(%)
FER-3	31.15	29.4*	13.63	0.08	53.61	0.01	0.09	1.02
		CaO(%)	Na_2O(%)	K_2O(%)	H_2O+(%)	CO_2(%)	P(%)	S(%)
FER-3		0.84	0.03	0.03	0.2	1.2	0.030	0.03

Note: Fe_2O_3 is total Fe expressed as Fe_2O_3

The material used for field blanks (FBLK) was metasedimentary, amphibolitic slate rock harvested by GEORESOURCE from waste bands in the Black Iron drill holes. Field blanks were inserted into the sample stream at a frequency of one per 20 routine samples. Generally, the blanks and the FER-3 standards were consecutive samples in the sampling sequence. The natural drill core blanks used for this program have an advantage over prepared blanks in that natural blanks are “blind” to the lab. However they do contain some varying uncontrolled levels of iron, whereas prepared blank materials are more uniform.

Field duplicate (FDUP) samples were second-half core samples. These samples were cut and inserted into the sample stream at a frequency of one per 50 routine samples. Whenever FDUP samples are taken, both halves of the drill core are sampled; one half becomes the routine sample and the other half becomes the duplicate. When this type of sampling is performed, no archived core for these sampled intervals remains. These types of samples are “blind” to the lab. Duplicates in the sample sequence generally follow immediately after the “original.” In WGM’s opinion, it would have been better practice to make the sequencing more irregular, but this could not be implemented.

Figure 11-2 to Figure 11-7 present selected assay results for field blanks and field standards, showing assays plotted against the MCM certificate date. Figure 11-2 shows results for % Fe_{tot}. As indicated on the plot, 217 instances of FBLKs for Black Iron's drill program were inserted into the sample stream going to MCM. The plot also indicates that 225 instances of FER-3 were inserted and analyzed at MCM for Fe_{tot}. The figure also shows results for the Standard P-010, which is a Certified Reference Standard inserted into the analytical stream at MCM, by MCM, and is described more fully under 2011 in-MCM (Primary Assay Laboratory) QA/QC.

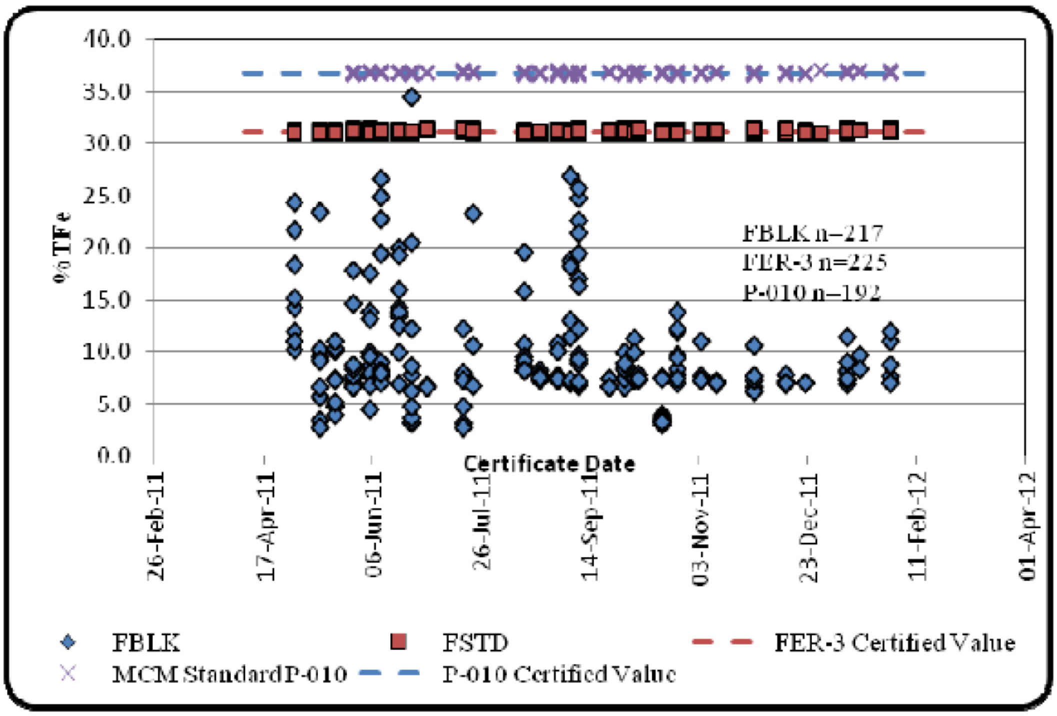


Figure 11-2: % Fe_{tot} vs. Certificate Date for Field Blanks, FER-3 and P-010

As shown on the plot, the blanks are highly variable in Fe_{tot} content and have little value for monitoring Fe_{tot} assays. However, the results for the FER-3 FSTD appear to be excellent, having all data points close to the Certified Reference Standards value.

Figure 11-3 shows Fe_{mag} results for the FBLKs and the FER-3 FSTD. The FBLK was selected to be low in Fe_{mag}, as magnetite is the principal mineral of interest on the Property. Most FBLKs returned less than 5% Fe_{mag}. One anomalous sample was noted on initial review of results and inspected in the field. No re-assays were undertaken because it is believed that the higher than expected value was the result of a poorly selected sample. FER-3 does not have a Certified Reference Standard value for Fe_{mag}, but the samples assayed within tight limits indicated the excellent performance of the lab. Table 11-4 presents summary statistics for FER-3 for all program samples at MCM.

Table 11-4: Summary Statistics for Field Standard (FER-3) at MCM

	% Fe_{tot}	% Fe_{mag}	% FeO	% SiO_2	% P	% S
Count	225	223	222	224	224	225
Avg	31.18	28.32	13.25	53.06	0.034	0.032
Median	31.20	28.30	13.30	53.04	0.034	0.030
Min	30.90	27.70	12.90	52.24	0.017	0.026
Max	31.40	30.40	13.80	53.50	0.040	0.300

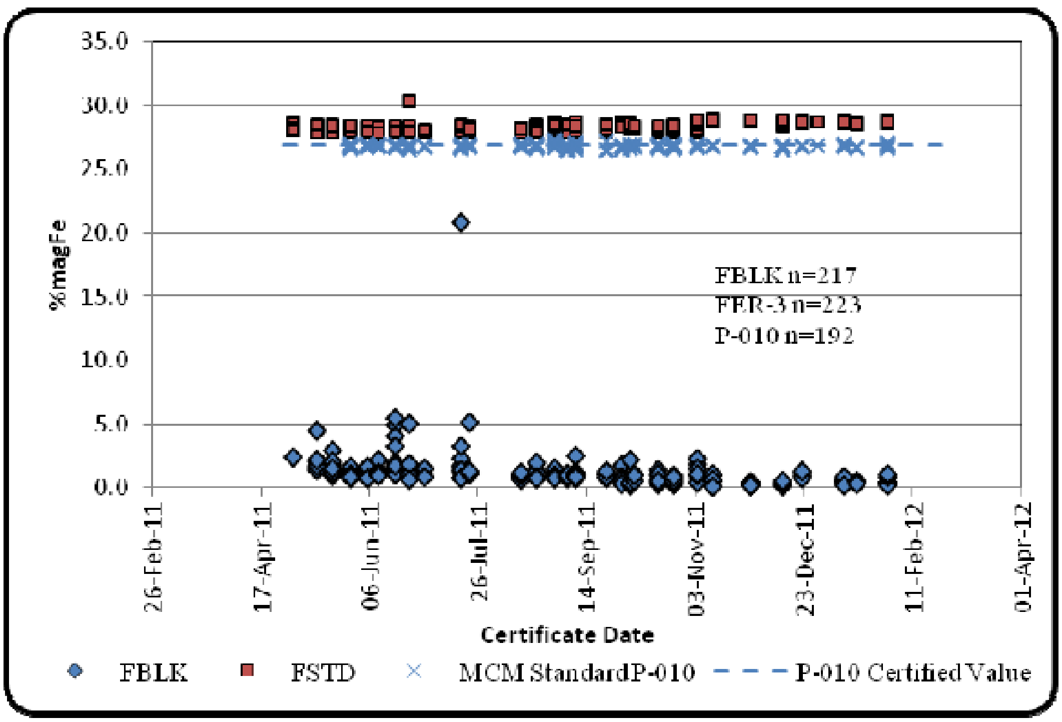


Figure 11-3: % Fe_{mag} vs. Certificate Date for Field Blanks, FER-3 and P-010

Figure 11-4 to Figure 11-7 show analytical results for FeO, SiO_2, P and S for FBLKs and the field standard FER-3. For these plots, the FBLK is not very useful because of its irregular composition, but results for FER-3 are relevant. Results for FER-3 appear to be all excellent, except for one instance of FER-3 having high S (see Figure 11-7).

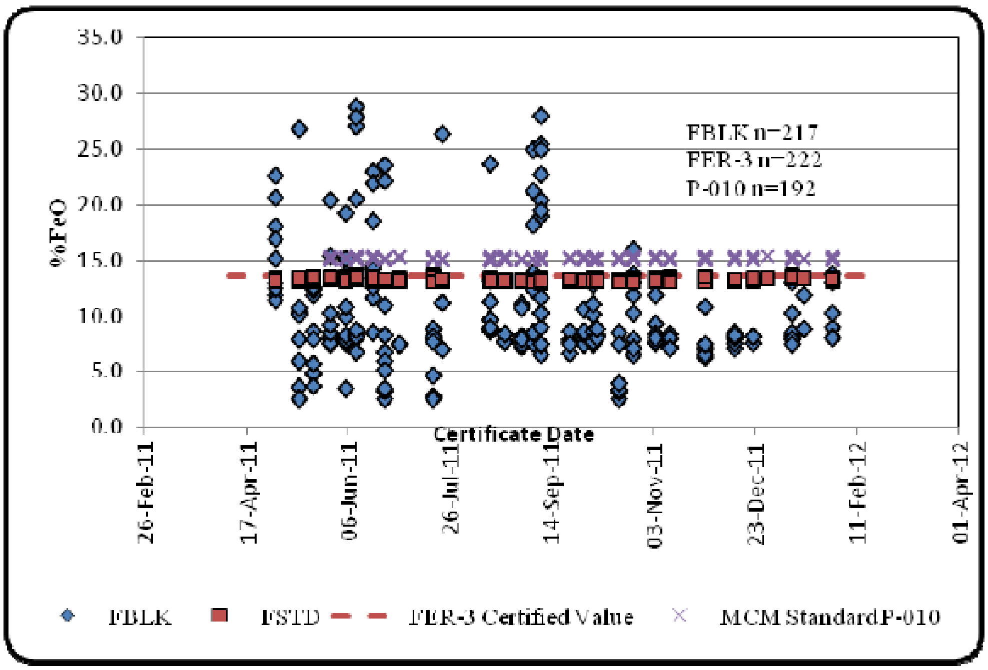


Figure 11-4: % FeO_T vs. Certificate Date for Field Blanks, FER-3 and P-010

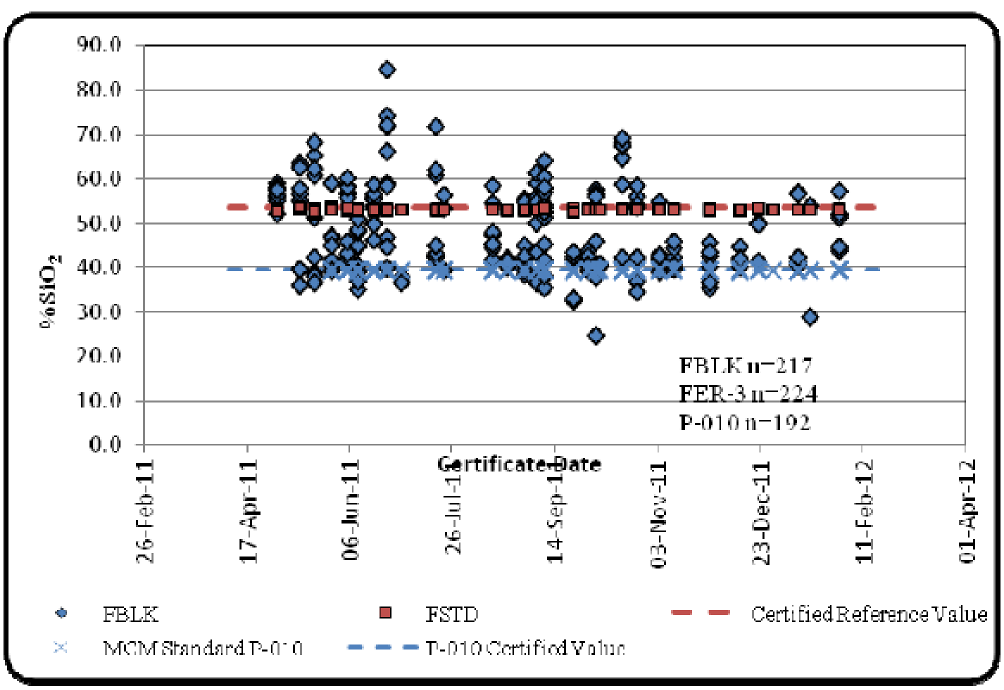


Figure 11-5: % SiO_2 vs. Certificate Date for Field Blanks, FER-3 and P-010

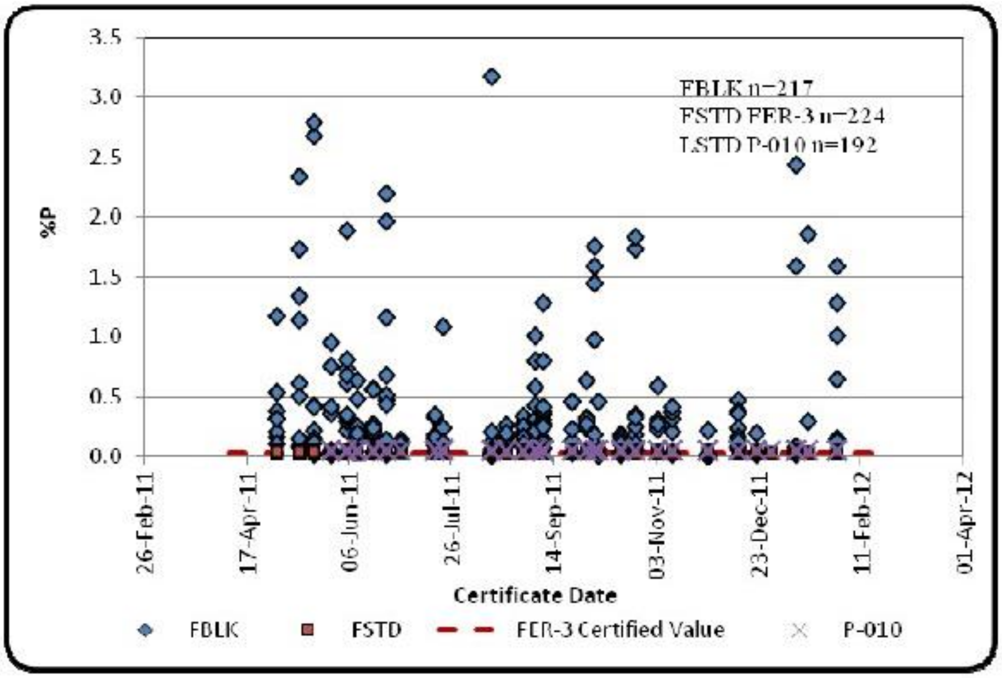


Figure 11-6: % P vs. Certificate Date for Field Blanks, FER-3 and P-010

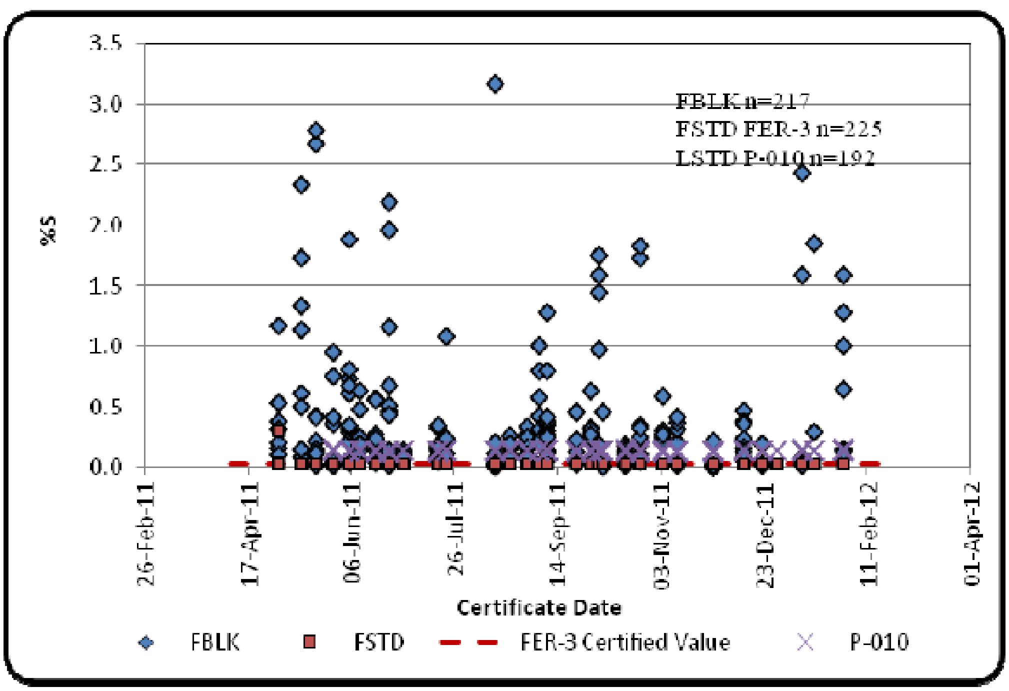


Figure 11-7: % S_T vs. Certificate Date for Field Blanks, FER-3 and P-010

Results for Fe_{tot} and Fe_{mag} for the field duplicates are shown in Figure 11-8 and Figure 11-9. Similar plots for FeO_T, SiO_2, P and S_T were reviewed to confirm good assay repeatability between original and duplicate samples.

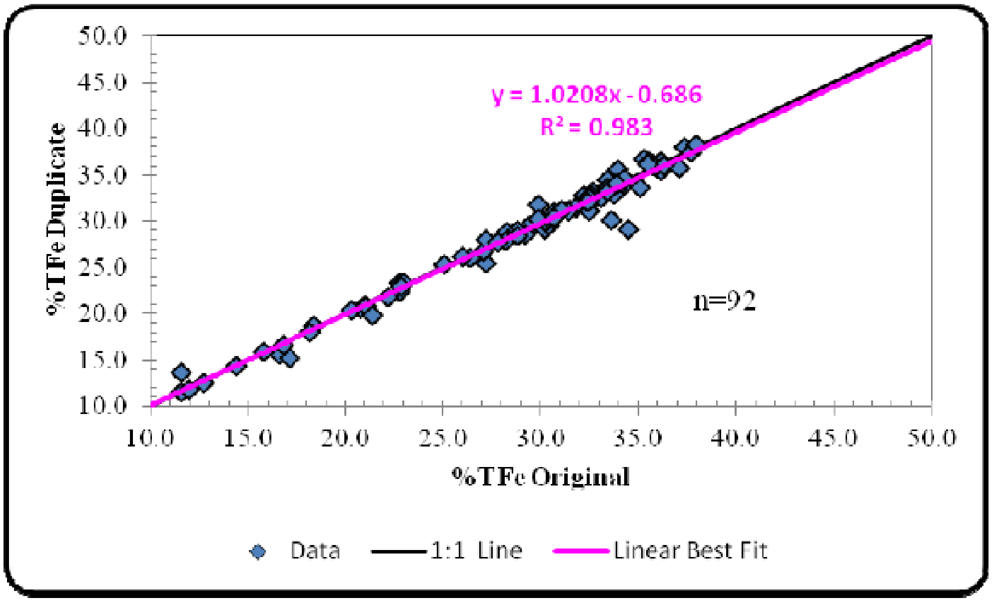


Figure 11-8: % Fe_{tot} vs. % Fe_{tot} for Field Duplicates

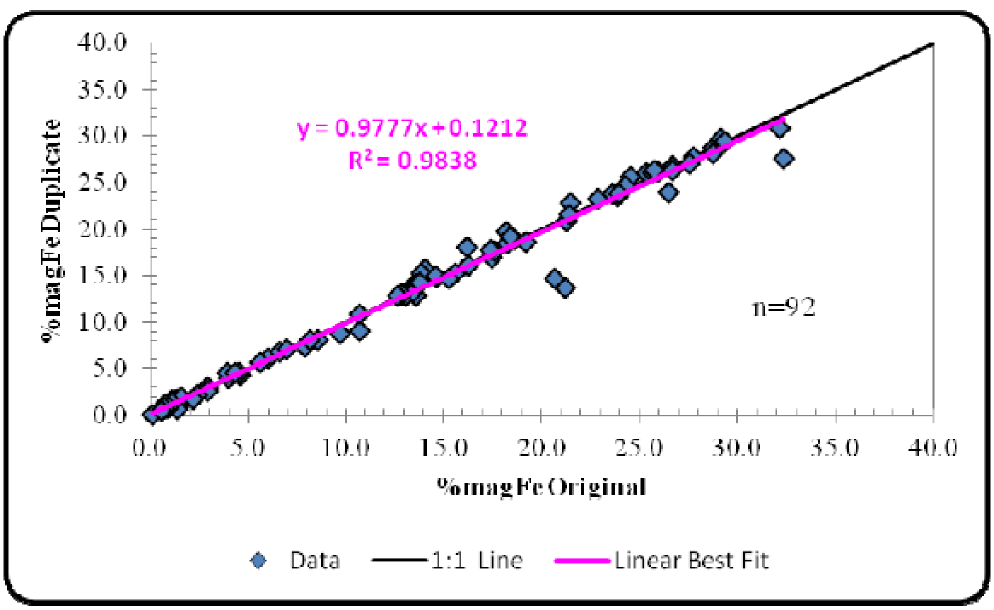


Figure 11-9: % Fe_{mag} vs. % Fe_{mag} for Field Duplicates

Generally, the results shown on the plots indicate good assay precision; however, two samples appear to plot out of pattern. WGM believes that four samples (BI04644, BI04645, BI04694 and BI04695) may be mixed up, either because of coding in GEORESOURCE's sampling records or because the samples were mixed up at the lab. No re-assaying is necessary.

2011 In-MCM (Primary Assay Laboratory) QA/QC

Supplementary to the GEORESOURCE's in-Field QA/QC program, MCM, the primary analytical laboratory for Black Iron's drill programs, operated an in-laboratory QA/QC program involving preparation duplicates (replicates), analytical duplicates, blanks and Certified Reference Standards. These QA/QC materials were analyzed along with the samples received from GEORESOURCE.

The preparation duplicates comprise a second sample, riffled out after coarse crushing to enable the monitoring of sample preparation variance. For normal samples received by the lab, one sample is partitioned off from the reject and then proceeds to pulverization. When a preparation duplicate is called for, two portions are partitioned off from the reject and two pulps are created instead of one. Preparation duplicates were prepared at a frequency of one per 50 field samples to MCM. Accordingly, for every 50 samples a second sub-sample was generated for assaying. The preparation duplicates were labelled with a (PDUP) prefix. Analytical Duplicates (ADUP) are second portions of pulps that are sub-sampled from normal pulps and assayed. These samples were also completed at a frequency of one per 50 samples to the lab.

Later in the program, a MCM in-house standard was added to the in-laboratory assay scheme to fulfill the role of a blank (LBLK) and to provide a standard with very low levels of iron.

Instances of PDUP, ADUP and LBLK were inserted into the sample stream every 50 samples from the field. MCM also assayed a Certified Reference Standard at a frequency of one per 20 field samples. This standard was a Ukrainian Certified Standard, namely P-010, characterized as magnetite iron ore. To document this material, MCM provided certificate 1063, issued December 17, 2009, by the State Committee of Ukraine for Technical Regulation and Consumer Policy. The Certified Reference Values for this Standard are listed in Table 11-5.

Table 11-5: Certified Reference Values for the P-010 Ukrainian Standard

Element	Certified Value (%)	Confidence Limit 95% (%)
Fe_{tot}	36.82	0.08
Magnetic Fe	26.9	0.2
SiO_2	39.4	0.1
CaO	1.62	0.03
MgO	2.65	0.05
Al_2O_3	1.02	0.05

WGM understands that this P-010 Standard was also used to monitor analyses from the start of the program; however, initial results, unlike later results, are not listed on the Certificates of Analysis issued by MCM.

Each of the samples was assayed for the Project's analytical package, but SG was not determined on any of the laboratory standards; MCM reports that P-010 was not suitable for pycnometer SG because it was too fine-grained for MCM to determine.

The analytical results for the P-010 Standard are shown previously in Figure 11-2 to Figure 11-7, along with the results for the field-inserted blanks and standards. The results for all analytes are indicated as excellent. Table 11-6 shows the summary of analytical results for P-010.

Table 11-6: Summary Statistics for P-010 Standard at MCM for Shymanivske Program

	% Fe_{tot}	% Fe_{mag}	% FeO_T	% P	% S_T	% SiO_2
Count	192	192	192	192	192	192
Avg	36.83	26.83	15.16	0.05	0.14	39.36
Median	36.80	26.82	15.20	0.05	0.14	39.34
Min	36.60	26.40	14.90	0.04	0.12	38.88
Max	37.10	27.30	15.40	0.06	0.15	39.72

Seventy-seven instances of the laboratory Blanks are reported by MCM. None generated anomalous results. Table 11-7: Statistical Summary for MCM-Inserted Blanks provides a statistical summary for the LBLKs.

Table 11-7: Statistical Summary for MCM-Inserted Blanks

	$pctFe_{tot}$	$PctFe_{mag}$	$PctF_eO$	pctP	pctS	$pctSiO_2$
Count	77	77	77	77	77	77
Avg	8.23	0.63	9.25	0.021	0.329	41.04
Median	8.30	0.60	9.20	0.021	0.330	41.04
Min	8.00	0.50	9.10	0.017	0.291	39.20
Max	8.40	0.80	9.50	0.024	0.351	41.50

Figure 11-10 presents Fe_{mag} results for the 50 Preparation Duplicates assayed at MCM with the Shymanivske drill core samples.

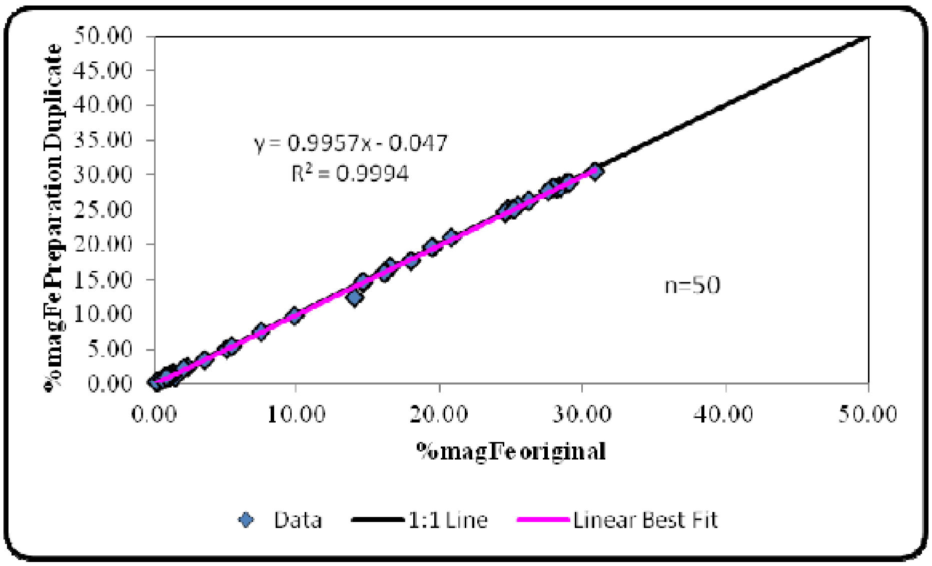


Figure 11-10: % Fe_{mag} vs. % Fe_{mag} for Preparation Duplicates

Results for the PDUPs for the other analyses are similarly well correlated.

Figure 11-11 shows results for Fe_{mag} in 83 Analytical Duplicates. Similar to PDUPs, assays for the two samples of each pair of the ADUPs are also highly correlated, indicating excellent quality assay data.

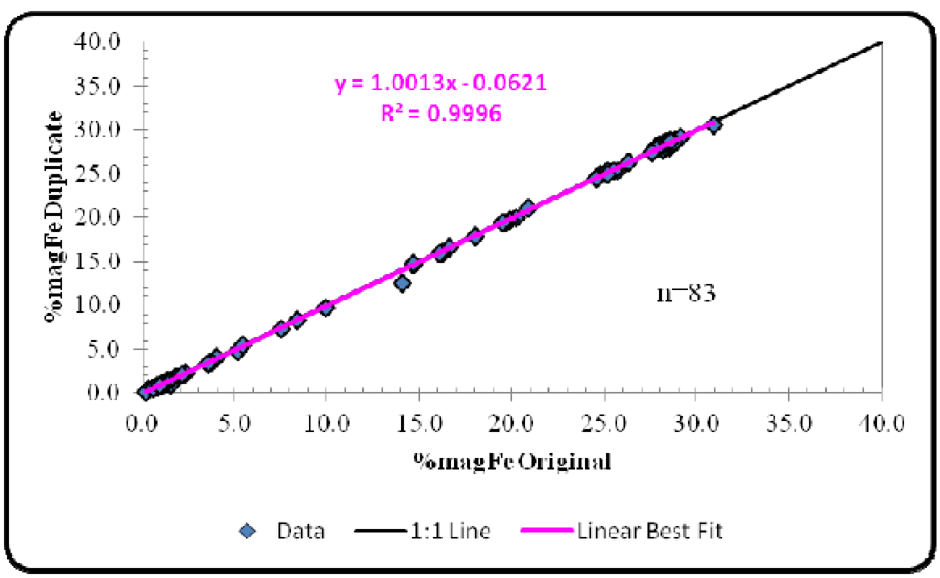


Figure 11-11: % Fe_{mag} vs. % Fe_{mag} for Analytical Duplicates

Supplementary Assaying

In addition to the in-field insertion of blanks, duplicates and standards, some follow-up check-assaying was completed, with a view to understanding and resolving particular issues. Some of this was managed by Black Iron; some, by WGM. The components managed by WGM are described in Chapter 12, "Data Verification." The components managed principally by Black Iron are described herein. These supplementary sample assaying components include:

1. Re-assaying 100 selected samples at MCM, for the purpose of validating its new calibration standard for Fe_{mag}.
2. Check-assaying at SGS-Lakefield of the 100 samples, for the purpose of validating MCM's new Fe_{mag} calibration.
3. Check-assaying of 35 samples of the aforementioned 100, at ALS in Australia, and later check-assaying of additional samples at ALS.
4. Re-assaying of selected samples from Drill hole BISH-29.
5. Re-determination of SG by pycnometer of selected samples at MCM.

1. Re-assay of 100 samples at MCM and check-assaying at SGS-Lakefield, in order to validate "new" MCM Fe_{mag} calibration

On November 18, 2011, a letter report was sent to Black Iron further to an initial draft dated 14 September, 2011. The document was titled "Draft of Review of Twin Drill Hole Program and QA/QC Results Shimanovskogo Iron Property, Ukraine". In the document, WGM brought to Black Iron's attention the fact that MCM's magnetic Iron (Fe_{mag}) assays appeared to be lower in value than historic assays in the corresponding twin drill holes and in initial check-assays of MCM pulps that WGM had collected during its second site visit (this component of WGM's verification program is described under Chapter 12, "Data Verification"). Black Iron communicated this finding to MCM, and it is the understanding of WGM that MCM acknowledged its Fe_{mag} assays were a little too low. MCM subsequently completed a recalibration of its instrumentation and provided newly adjusted Fe_{mag} assays for the previously assayed samples (all samples pre-SH18, 23 September 2011, assay certificates). The new calibration was used for all later samples. In the plots and tables concerning the analysis and interpretation of the samples and assay data contained in Section 11.2.2, all Fe_{mag} data is subsequent to the recalibration.

Following this recalibration, Black Iron selected, in October 2011, 100 pulps from samples previously assayed at MCM, which spanned the twin hole program and also various Fe_{tot} and Fe_{mag} grades. The list of samples was provided to MCM to check the newly adjusted Fe_{mag} values. WGM recommended that the samples be sent "blind" to MCM, however, the samples were not sent "blind" and included no standards, which would have been more useful. Black Iron requested MCM to re-assay these samples for Total Iron ("Fe_{tot}") and Fe_{mag}. MCM performed this service, completing the assays in duplicate.

The new and original MCM results for the 100 samples are summarized in Table 11-8.

Table 11-8: Statistical Comparison of MCM Original and October 2011 Re-Assays

	MCM Original		MCM Re-Assay		Difference
	Fe_{tot} (%)	Fe_{mag} (%)	Fe_{tot} (%)	Fe_{mag} (%)	Fe_{mag} (%)
N	100	100	100	100	
Avg	31.61	16.01	31.68	17.65	1.6
Median	32.30	16.50	32.25	17.40	0.9

Figure 11-12 and Figure 11-13 compare, respectively, MCM Original versus re-assays for Fe_{tot} and Fe_{mag} for the 100 samples.

Figure 11-12 clearly shows that Fe_{tot} original and re-assays are strongly correlated, and no assay bias is evident. Figure 11-13 shows that MCM re-assays strongly correlate with original MCM assays, but are biased, given that the re-assays report slightly higher values. The difference between MCM Fe_{mag} original assays and re-assays is similar to the difference between SGS-Lakefield's results for assays on WGM's independent samples and original MCM assays (Chapter 12), although the differential is not quite as high.

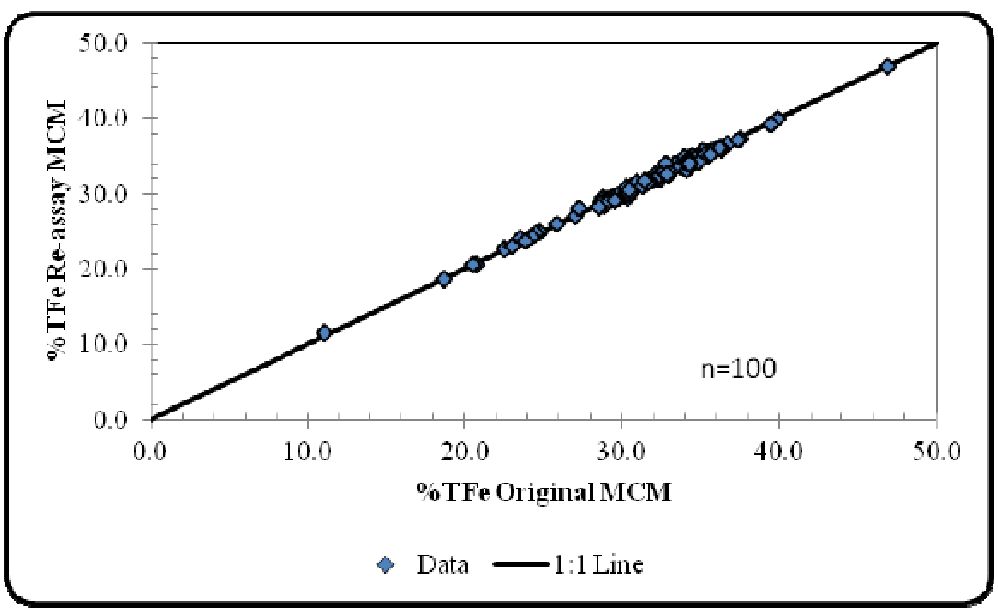


Figure 11-12: % Fe_{tot} for MCM Re-assays vs. Original MCM Assays for 100 Samples

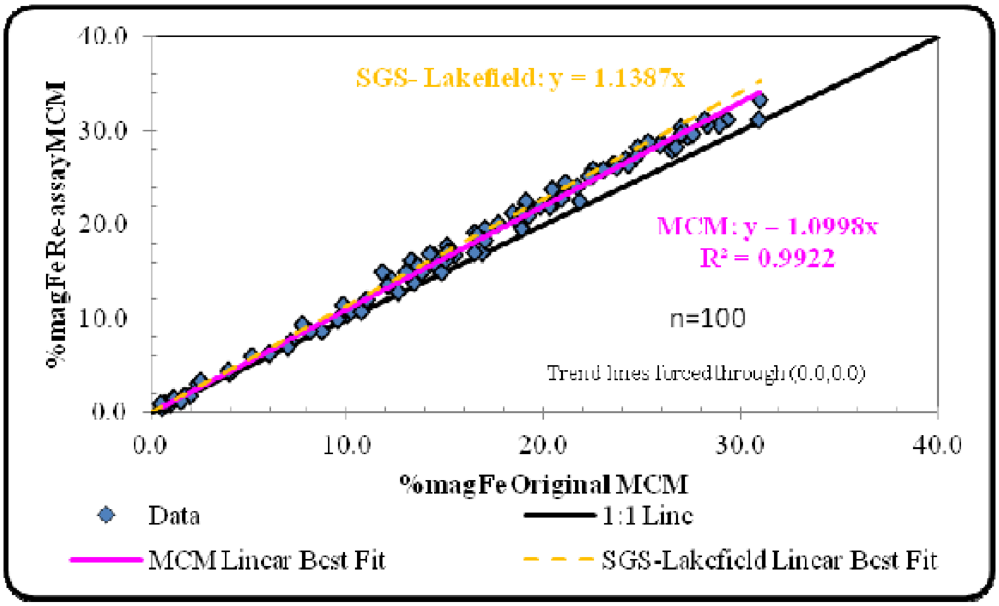


Figure 11-13: % Fe_{mag} for MCM Re-assays vs. Original MCM Assays for 100 Samples

MCM subsequently forwarded a portion of the pulps for these 100 samples to SGS-Lakefield for check-assaying.

2. Check-assaying at SGS-Lakefield of the 100 samples towards validating MCM's new Fe_{mag} calibration

SGS-Lakefield assayed the 100 samples received from MCM for WR-XRF major elements and Satmagan, and, issued its results in February 2012. A selection of 25 of these samples also had Davis Tube tests completed at SGS-Lakefield, and their magnetic concentrate products were analyzed for major elements by Whole Rock – X-Ray Fluorescence (WR-XRF). Neither FeO_T nor S_T was completed on the head samples.

Figure 11-14 and Figure 11-15 show results for % Fe_{tot} and % Fe_{mag} at SGS-Lakefield for the 100 samples, as compared to MCM's re-assays.

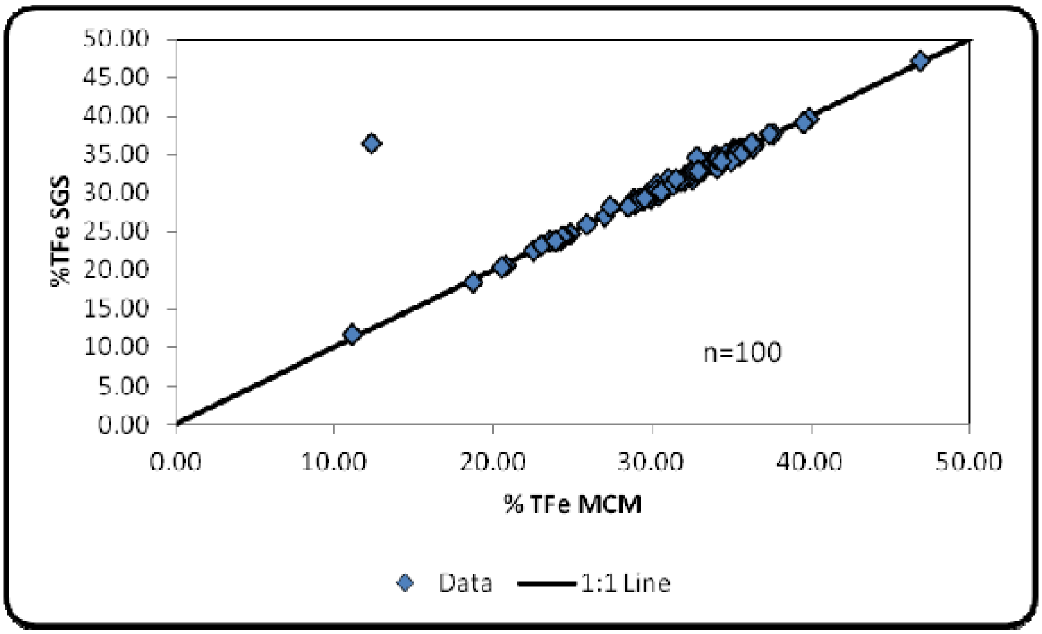


Figure 11-14: Comparison of % Fe_{tot} at SGS-Lakefield vs. MCM

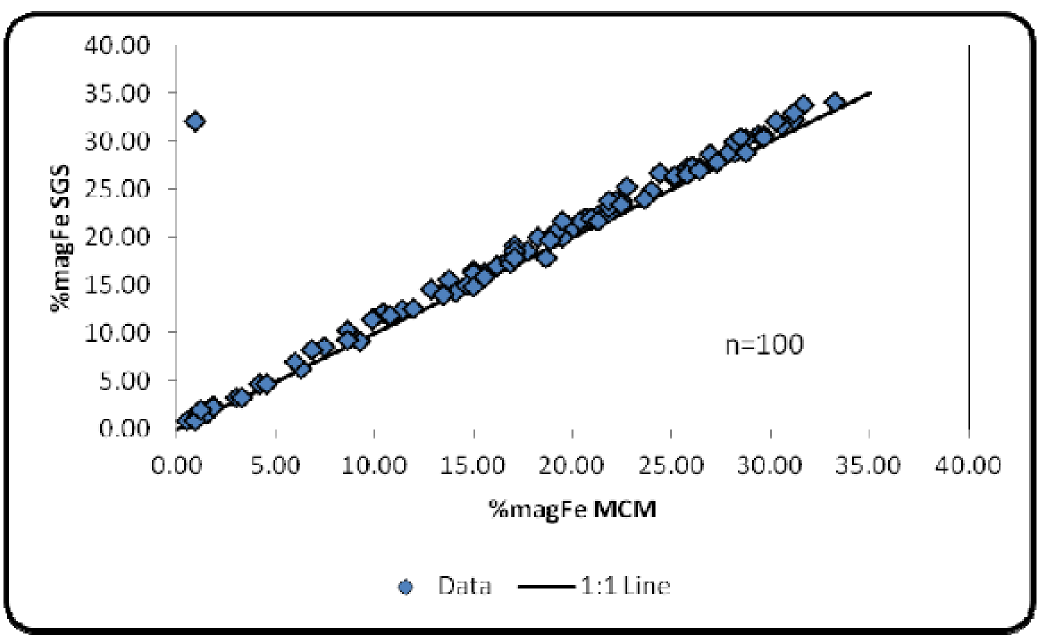


Figure 11-15: Comparison of % Fe_{mag} at SGS-Lakefield vs. MCM

Figure 11-14 shows that % Fe_{tot} at both labs is very similar, with minimal bias. Figure 11-15 shows that Fe_{mag} at SGS-Lakefield by Satmagan is highly correlated with Fe_{mag} at MCM. However, it remains a little higher at SGS than at MCM, even after the MCM recalibration. Clearly one sample is reporting an error caused by a sample mix-up. The sample that plots incorrectly on both Figure 11-14 and Figure 11-15 is the same one (BI00207). For the statistical summary in Table 11-9, this sample has been removed; therefore, only 99 samples are used in the comparison.

Table 11-9: Comparison of MCM Assays (after Mag Recalibration) to SGS-Lakefield Assays for 100 Samples

	MCM (after recalibration)		SGS-Lakefield-Assays		Difference Fe_{mag} (%)
	Fe_{tot} (%)	Fe_{mag} (%)	Fe_{tot} (%)	Fe_{mag} (%)	
N	99	99	99	99	99
Avg	31.56	17.54	31.58	18.53	-0.99
Median	32.30	17.70	32.17	18.67	-0.97

Note: one sample has been removed.

The SGS-Lakefield Fe_{mag} values from Satmagan are still higher than MCM, even after MCM's recalibration of its instrumentation.

On 25 of the 100 samples sent to SGS-Lakefield, Davis Tube tests were completed. The samples were pulverized to 95% passing 45 um (325 mesh). SGS-Lakefield results for Fe_{mag}, calculated from the Davis Tube results against Fe_{mag} from Satmagan, are shown in Figure 11-16. Results for the two methods of determination are close, but the Satmagan numbers are generally a little higher.

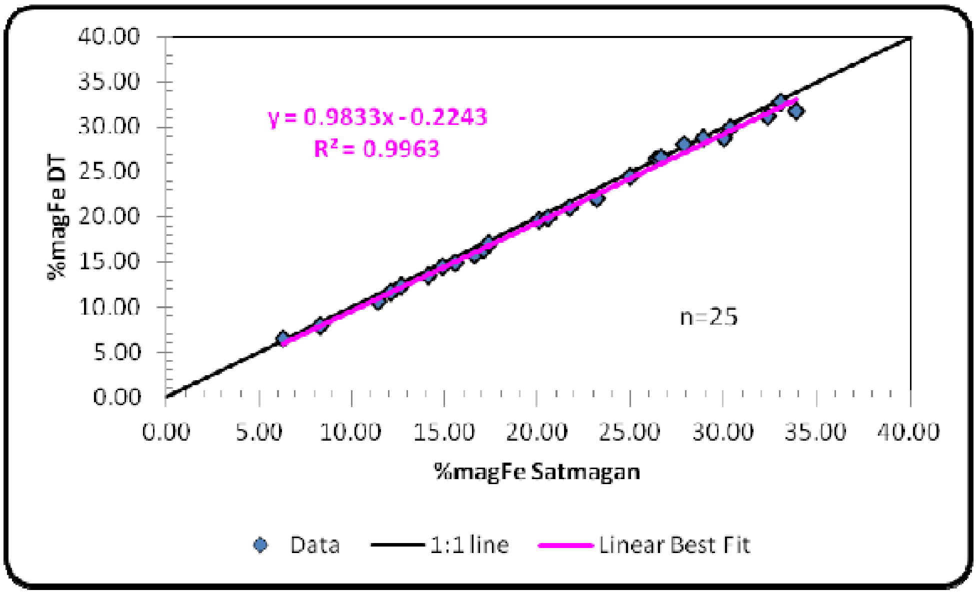


Figure 11-16: % Fe_{mag} from Davis Tube vs. Satmagan for 25 selected samples: Determinations at SGS-Lakefield

Figure 11-17 and Figure 11-18 show, respectively, the comparison of MCM and SGS for SiO_2 and P for the 99 samples.

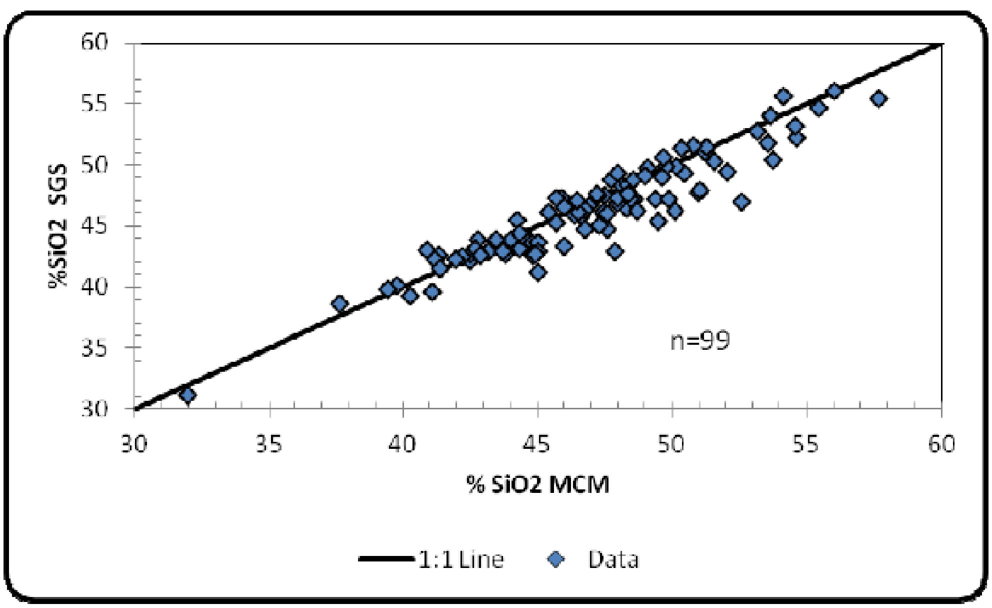


Figure 11-17: Comparison of % SiO_2 at SGS-Lakefield vs. MCM for the 99 Samples

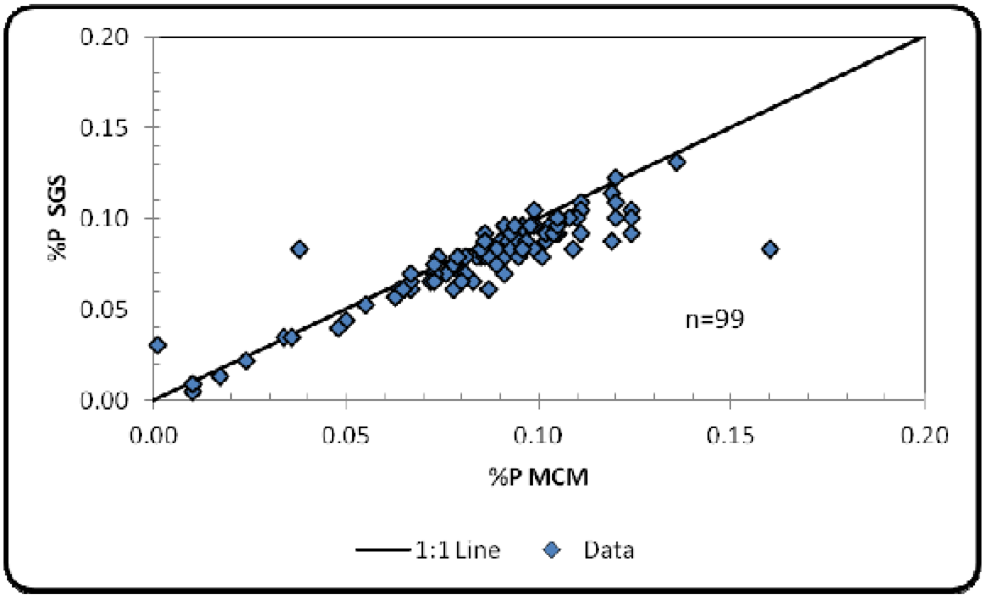


Figure 11-18: Comparison of % P at SGS-Lakefield vs. MCM for the 99 Samples

Based on the analysis of the 99 pulps at SGS-Lakefield, MCM's SiO_2 assays are a little too high and assays of P are significantly too high.

Based on the 99 samples check-assayed, Table 11-10 provides a statistical comparison summary for SiO_2 and P at MCM and SGS-Lakefield.

Table 11-10: Statistical Comparison of MCM Assays for SiO_2 and P to SGS-Lakefield Assays for 99 Samples

	SiO_2 (%) MCM	SiO_2 (%) SGS	SiO_2 Avg Diff (%)	P (%) MCM	P (%) MCM	P Avg Diff (%)
N	99	99	99	99	99	99
Avg	47.00	46.26	0.73	0.086	0.078	0.007
Median	47.24	46.20	1.04	0.090	0.083	0.007

3. Check-assaying at ALS in Australia

Early in 2012, Black Iron selected 35 of the aforementioned 100 samples and requested SGS-Lakefield to forward a portion of the pulps to ALS in Australia. The 35 samples at ALS were assayed for a variety of analysis, including major elements by XRF, magnetic susceptibility and FeO_T. Original assaying at MCM included the Project standard analytical package, including Fe_{tot}, Fe_{mag}, FeO_T, P and S_T. The above analytical summary shows that a complete comparison between all analysis cannot be completed between all labs because the samples were not analyzed for the same analysis at each lab.

Later in 2012, Black Iron selected and collected 115 routine samples and four Certified Reference Standards (2 each of FER-3 and P-010) from the archived sample pulps and rejects in storage at the Ukrainian core shed. When the samples were forwarded to ALS, magnetic susceptibility and FeO_T were determined.

Figure 11-19 and Figure 11-20 show a comparison of Fe_{tot} between SGS-Lakefield, ALS and MCM for the original 35 samples sent for analysis at ALS.

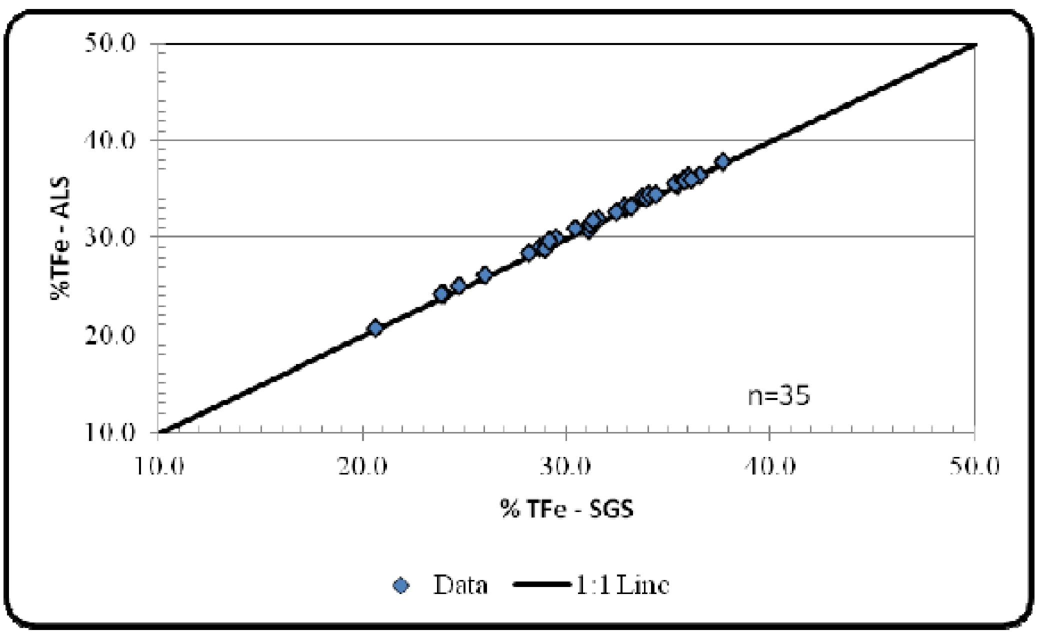


Figure 11-19: Comparison of % Fe_{tot} at ALS vs. SGS-Lakefield

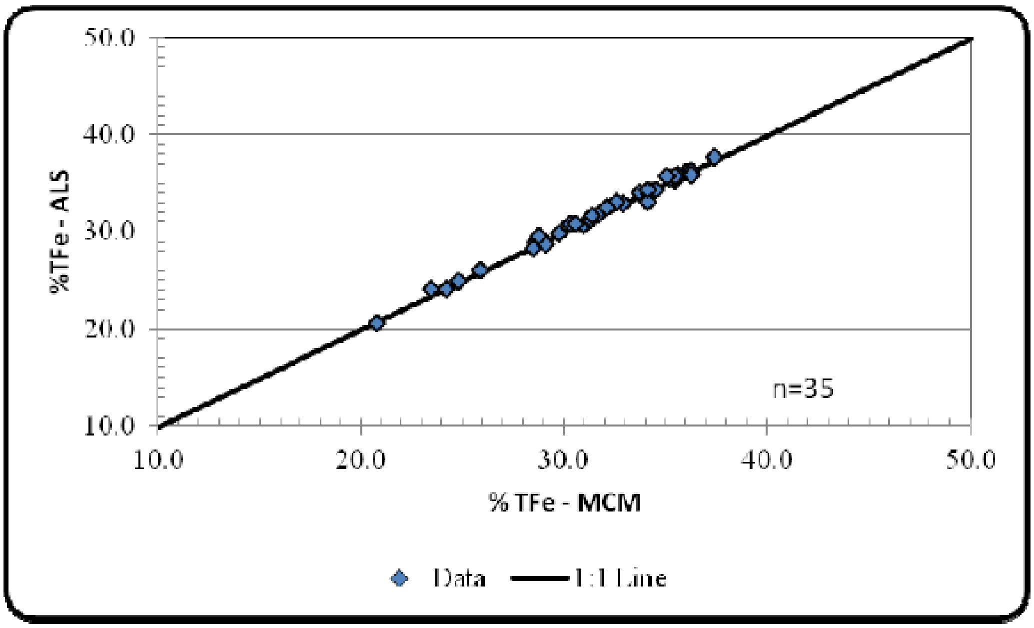


Figure 11-20: Comparison of % Fe_{tot} at ALS vs. MCM

The plots for Fe_{tot} show a very strong correlation and no bias between labs. These results are in accord with previous results, wherein previous sets of data have shown excellent agreement between MCM and SGS-Lakefield.

Figure 11-21 to Figure 11-25 show comparisons between SGS-Lakefield, ALS and MCM for magnetic components for all samples checked at ALS. As mentioned above, ALS's magnetic susceptibility is assumed by WGM to be equivalent to % Fe_3O_4. Given that MCM's results are in terms of Fe_{mag}, MCM's Fe_{mag} has been adjusted to % Fe_3O_4 by dividing MCM's values by 0.7236.

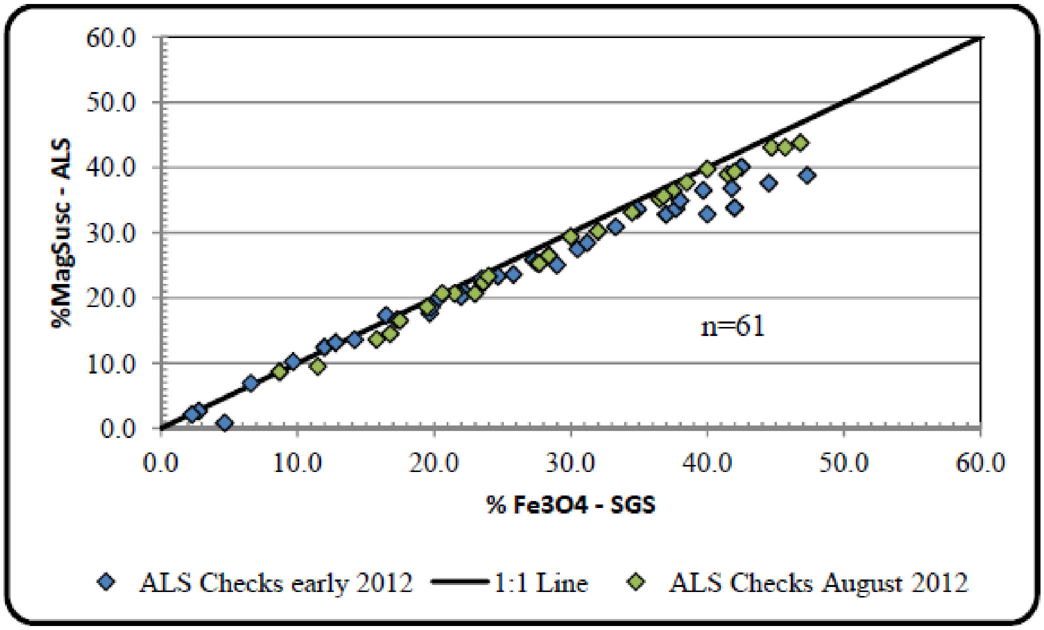


Figure 11-21: Comparison of MagSusc at ALS vs. % Fe_3O_4 at SGS-Lakefield

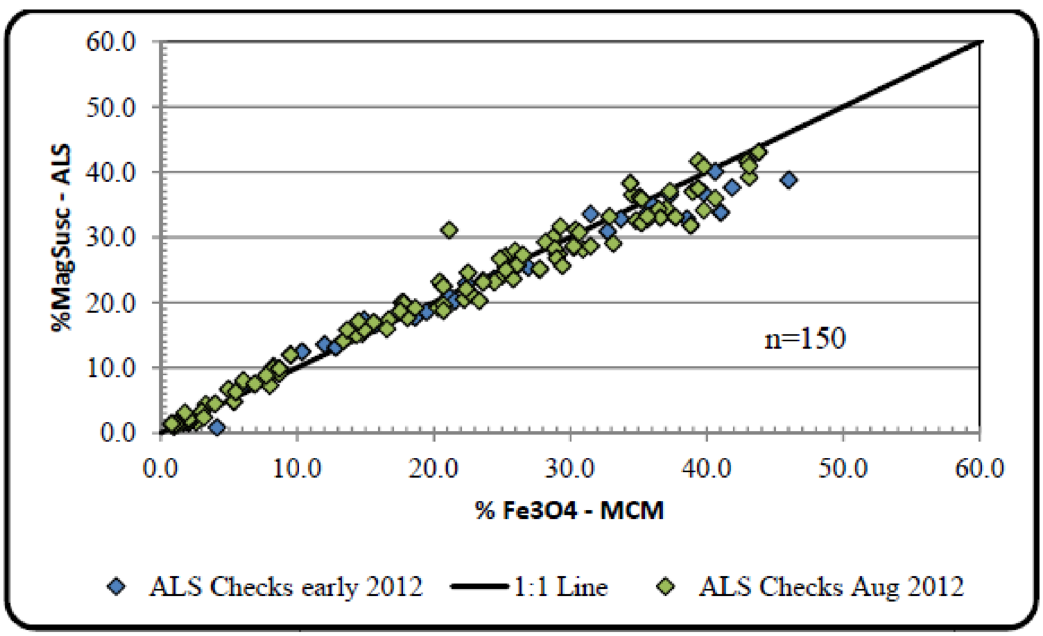


Figure 11-22: Comparison of MagSusc at ALS vs. % Fe_3O_4 at MCM

Figure 11-21 shows that results for SGS-Lakefield and ALS for magnetic iron are reasonably well correlated. At lower levels of Fe_3O_4, ALS and SGS-Lakefield results are similar; at higher levels, SGS-Lakefield's Fe_3O_4 are a little higher than they are at ALS.

The patterns shown in Figure 11-22 are similar. They reveal reasonably well-correlated values of Fe_3O_4 between MCM and ALS, while MCM shows values that are a little higher at higher magnetic iron levels. MCM is perhaps a little lower than ALS at lower magnetic iron levels.

Comparison of Figure 11-15 to Figure 11-21 and Figure 11-22 shows that magnetic iron results for SGS-Lakefield and MCM are better correlated than they are between MCM and ALS, or between ALS and SGS-Lakefield, which are very slightly higher. This latter observation is consistent with previous results.

This analysis of results for the samples are reassuring, in that MCM's magnetic Fe results post MCM recalibration seem pretty close to those of SGS and ALS, but SGS-Lakefield may be a little too high.

Figure 11-23 shows a comparison of FeO_T, at MCM and ALS. FeO was not done on this batch of samples at SGS-Lakefield.

For many of the samples, the results appear to be reasonable, showing ALS values that are very slightly higher than those from MCM. It also appears, however, that ALS mixed up some of the samples but this should be checked.

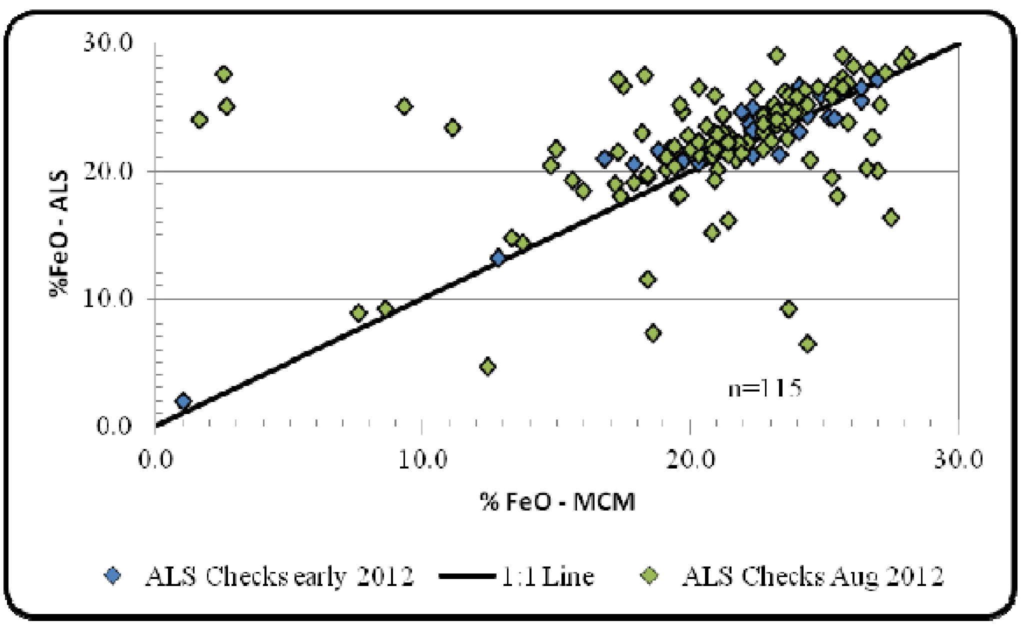


Figure 11-23: Comparison of FeO_H at ALS vs. MCM

Figure 11-24, Figure 11-25 and Figure 11-26 show comparison of assay results for P. Figure 11-24 shows that P for ALS and SGS is closely equivalent. Figure 11-25 and Figure 11-26 show that P at MCM is higher than at ALS and SGS. The comparison for P for samples done at ALS is similar to that for 99 samples that were check-assayed at SGS-Lakefield (see Figure 11-18 and Table 11-10). MCM's assays likely exaggerate the P content of the mineralization.

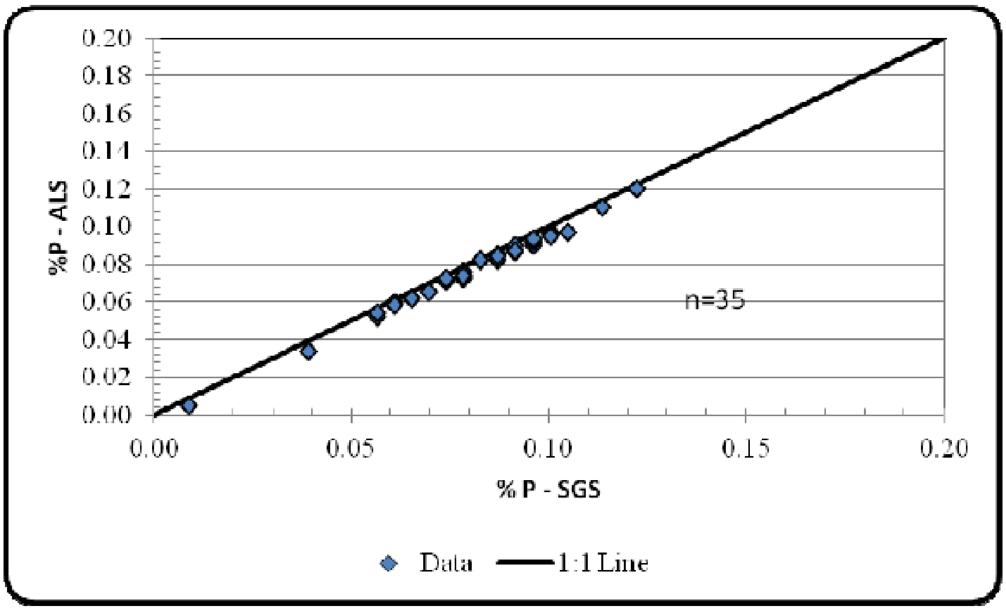


Figure 11-24: Comparison of P at ALS vs. SGS-Lakefield

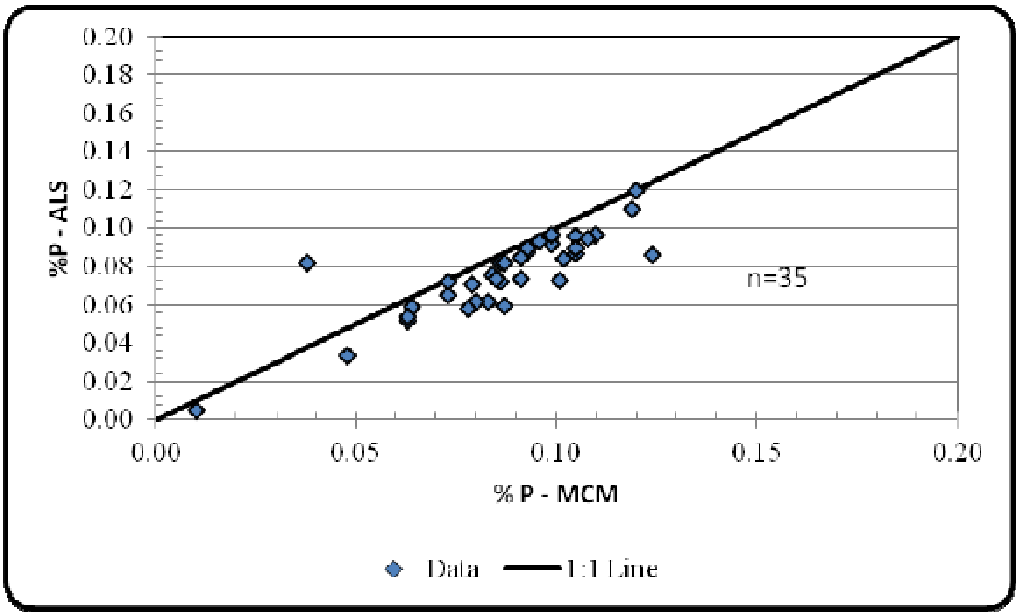


Figure 11-25: Comparison of P at ALS vs. MCM

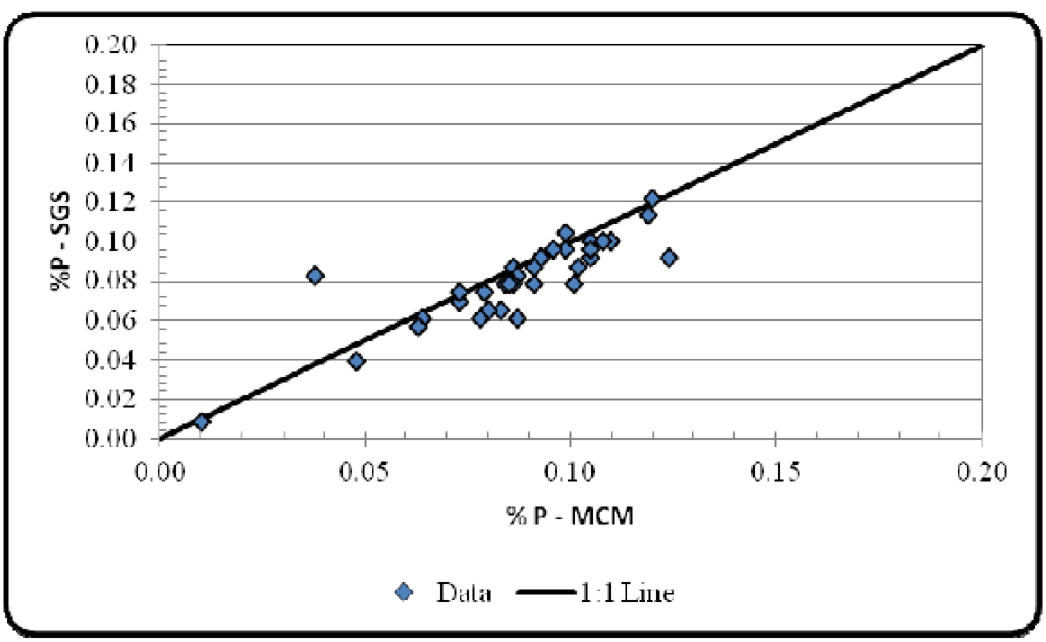


Figure 11-26: Comparison of P at SGS vs. MCM

Figure 11-27 presents results for S_T at MCM and ALS. S was not determined for this batch of samples at SGS-Lakefield.

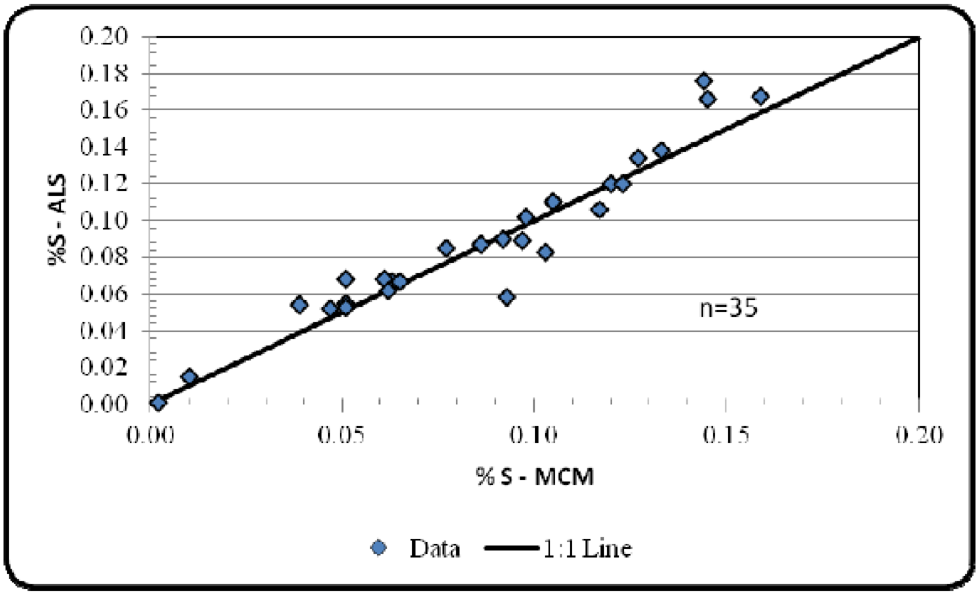


Figure 11-27: Comparison of ST at ALS vs. MCM

The plot shows that S results between MCM and ALS are unbiased, indicating good accuracy, and that they are reasonably well correlated, but not highly correlated.

4. Re-determination of SG by pycnometer of selected samples at MCM

WGM first analyzed the density/SG data being generated by MCM in the fall of 2011. To do so, the company examined SG/Density versus % Fe_{tot} and % Fe_{mag} and surmised that the data appeared reasonably accurate. However, there was significant scattering with some samples reporting lower SG/density values than predicted by density/SG iron-grade modeling. After subsequent review, the archived drill core in Ukraine that corresponded to some of the samples appeared to have lower unexplained SG/density results, although WGM could find no obvious explanation for the lower values. In December 2011, WGM selected seven samples for checking. Black Iron requested MCM to complete determinations of SG by pycnometer on each pulp.

The original and check results for the seven samples are listed in Table 11-11.

Table 11-11: Check on Density/SG of Seven Samples Done at MCM in July 2012

Sample ID	Fe_{tot} (%)	Fe_{mag} (%)	FeO (%)	SG Pycn Orig	Bulk Density Orig	SG Pycn Check
BI00255	34.00	28.70	19.50		3.13	3.53
BI00265	30.80	23.20	19.70		3.11	3.39
BI00292	31.70	21.10	20.90		3.14	3.45
BI00537	30.20	16.30	23.20		2.95	3.32
BI00647	31.90	14.80	25.80		3.05	3.20
BI00998	31.20	21.80	20.30	3.15	3.17	3.26
BI01186	32.80	15.80	26.20	3.45	3.02	3.40

Generally, the SG check values are higher than the original bulk-density values for the samples. The new values plotted against % Fe_{tot} and % Fe_{mag} Head assays fit the predicted models much better. It could be argued that the higher pycnometer values, compared to bulk-density values, could be caused by the loss of existing porosity in natural samples through pulverization. However, this possibility was the reason for examining the drill core and no extraneous features, such as weathering or vugs, were found during this review. The core appeared to be good quality, normal magnetite-rich taconite.

WGM concludes that the new check results support the supposition that the original density determinations were low outliers, attributable to some laboratory error.

11.3.7 WGM Comment on Logging, Sampling and Assaying

Core recovery for taconite mineralization from Black Iron's drilling was generally high throughout. Therefore, core recovery for the taconite mineralization is not a factor affecting the reliability of Black Iron's results. Core recovery was understandably poor when drilling the limonite-goethite mineralization, and some of the martite mineralization associated with the Gdansev-Saksagan contacts and associated faults. For the supergene mineralization, core recovery is a detrimental factor for reliability. However, this type of mineralization is not of significant economic interest to Black Iron.

Most of the historic drill holes were very steep to vertical. WGM believes that drill hole orientation for Black Iron's drilling and the historic programs was not optimal for interpreting geology and assessing some parts of the deposit, particularly the steeply dipping limbs of the anticline NW margin of the deposit. For the Twin hole Phase I program, however, drilling steep holes was required in order to mimic the historic drill holes. For Black Iron's programs, steeply inclined holes were partly required because of the difficult drilling conditions. Access to drilling sites, because of mine waste and YuGOK interference, restricted collar location and also generated less than optimal drilling orientations. Drill hole location and drilling orientation are factors that affect the reliability of information but, for most part, any potentially detrimental effect is surmounted by the high-drilling density along the cross-sections. Drill hole location and drilling orientation remain a detrimental factor for exploring, interpreting and assessing the mineralization adjacent to the Gdansev-Saksagan contact. Again, this mostly affects the martite-limonite-goethite altered mineralization occurring in this area but, to some extent, drilling orientation also affects adjacent taconite mineralization and reduces the reliability of sample assays and the distribution of mineralization information.

For the earliest historic programs, the mine waste wasn't a problem because it did not exist at that time. The historic drill holes drilled NW to SE from the Archean basement to test the NW limb of the deposit were, however, not sufficiently long to thoroughly test the taconite and zones adjacent to the Gdantsev-Saksagan contact. The assaying and sampling of these historic drill holes testing the Gdantsev-Saksagan contact area were also insufficient, as Fe_{mag} was not determined in all samples and sampling was not very extensive.

On the basis of the review of historic sampling and assaying method descriptions available for the most recent Soviet programs (Section 11.3.2), WGM believes that sampling and assaying for these programs is generally reliable. The method descriptions outline high-quality work and attention was paid to assuring quality. Nothing, however, is known about the earliest Soviet drill programs because only the sample assay results are available. On the basis of Black Iron's twin hole program results, as shown in report Section 10.2.3, WGM believes that Fe_{mag} assays of the historic campaigns are generally reliable, but assays for Fe_{tot}, for some of the campaigns cannot be relied upon and it is not clear which drill holes are affected.

On the basis of its review of drill core and "quick logs" completed, which included checking sample intervals and tags in Ukraine at Black Iron's core shed, WGM is satisfied that logging and sampling by the GEORESOURCE's personnel was of reasonable quality. Information gathered by WGM was compared against the database being built by GEORESOURCE for accuracy and representativeness. The GEORESOURCE's personnel, in addition to capturing data and recording them in the database, also collected some descriptive data. WGM has not been able to review these logs because they are not in English and they have not been fully finalized. More details concerning WGM's validation process and procedures are contained in Chapter 12 – Data Verification.

WGM provided feedback to Black Iron after its site visits. WGM recommended that logging could be improved by taking more time. Use of hand-held magnetic susceptibility meters to log core, as recommended in WGM's original guidelines for Black Iron, would have also helped the company to conduct better logging.

WGM suggested based on its initial review of MCM assay results for the twin drill holes and also on a review of check-assay results at SGS-Lakefield that MCM's Fe_{mag} assays were perhaps biased slightly low, that its assays of Fe_{tot}, FeO_T, SiO_2 and S_T assays were accurate and precise and MCM's assays of P were biased too high.

Black Iron communicated this assessment to MCM, and it is the understanding of WGM that MCM acknowledged its assay values for Fe_{mag} as being slightly too low. To address this issue, MCM performed a recalibration of its magnetic saturation analyzer. The data were presented and critiqued for the 100 samples and the 35 samples of MCM's assay results, undertaken to validate the "new" calibration. Following this validation, the Fe_{mag} assay for the early program samples were all reissued by MCM and the new calibration was used for all subsequent samples.

WGM's continued its monitoring of MCM's assay results and collected more independent samples in Ukraine. As more assay data accrued, as described in Section 12.3, further assessment of MCM's assay data proceeded. WGM became concerned with the fact that MCM Fe_{mag} assays for routine samples increased after the recalibration, but assays on the Certified Reference Standards, FER-3 and P-010, did not (see Section 12.4, "Data Verification"). Comparison of Fe_{mag} assays pre-new calibration and post-new calibration also shows some irregularities associated with samples adjacent to the Certified Reference Standards in the assay sequence.

In conclusion, on the basis of all the sample assays from secondary laboratories, WGM is satisfied that MCM's assays for the routine samples are generally reliable. As aforementioned, Fe_{tot}, FeO_T, SiO_2 and S_T assays are accurate and precise, although MCM's assays of P are biased too high. MCM's final assays for Fe_{mag} are generally reasonably accurate and precise. For very few samples, depending on the assaying sequence, Fe_{mag} values may be very slightly too low. Because of the aforementioned assay irregularities that are not understood, WGM cautions that the Fe_{mag} assays for control samples such as FER-3 and P-010, or any of the others inserted by MCM and not "blind" to MCM such as those summarized in Table 11-4, Table 11-6 and Table 11-7, and shown in Figure 11-2 to Figure 11-7 should not be relied upon.

12. DATA VERIFICATION

Drill core samples collected for Black Iron as part of the 2011 drilling programs were submitted by GEORESOURCE's to MCM, SGS-Lakefield and ALS. WGM understands that MCM is accredited under Ukrainian regulations and holds an ISO 9001:2009 certification for quality management systems. SGS-Lakefield is fully accredited under ISO 9001 and ISO 17025, for specific laboratory procedures. ALS is similarly accredited under ISO 9001 and ISO 17025, for specific laboratory procedures. Although WGM has reviewed the assay results generated by MCM and SGS-Lakefield and believes the results are generally accurate, WGM is relying on the two laboratories as independent experts in the field of analyses.

WGM Senior Associate Geologist, Mr. Richard Risto, P.Geo., QP, visited the Property four times in 2011 to assist with implementation of sampling and assaying protocols verification of drilling and to complete independent sampling. WGM's first site visit was completed between April 11 and April 18; site visit two between May 22 and May 29; site visit three between June 27 and July 3; and site visit four between December 12 and 17. WGM reviewed the Black Iron program results with Black Iron's senior Geologist, Mr. Farshid Ghazanfari, P.Geo, and the GEORESOURCE personnel conducting the program. Mr. Risto collected independent drill core samples during the second, third and fourth site visits for independent assaying. No site visits by WGM have been completed since December 2011.

Other data verification activities included:

1. Witnessing Black Iron drilling in process and confirming that the drilling was being conducted on the Property. Independently validating the collar coordinates of a number of the drill holes comprising Black Iron's drilling program to a reasonable degree using a hand-held GPS. Also checking the azimuths and the inclinations of a number of the drill holes;
2. Confirming that iron formation was being cored;
3. Confirming that the lithological information being logged by the drilling rig geologists was reasonably representative of the lithologies intersected in the drill holes;
4. Confirming that the sample information recorded by the GEORESOURCE samplers was reasonably accurate;
5. Confirming by observation the presence of previous drilling on the Property. WGM witnessed the presence of six historic drill casings on the Property that could likely be drill holes in the historic database;
6. Confirming that the geophysical surveys conducted for Black Iron by Abitibi were performed on the Property;
7. Reviewing a selection of assay information for historic drill holes in historic documents and confirming that Black Iron's assay database accurately portrayed this information;
8. Checking historic Soviet maps, cross-sections and tabulated data to validate drill hole collar locations and attitudes, as portrayed in Black Iron's database;

9. Completing analysis of Black Iron's assay data from its primary and secondary labs and confirming agreement between assays and geology in drill cores;
10. Completing geological interpretation of the deposit and verifying agreement between drill hole geology and Abitibi geophysical survey results;
11. Collecting independent samples of mineralization and submitting them independently for assaying;
12. Completing an analysis of results by comparing primary lab assays to secondary lab assays in order to verify and validate primary lab assaying and GEORESOURCE's sampling.

The most important aspects of WGM's Data Verification are explained more fully below, under separate headings.

12.1 Validating Diamond Drilling in Progress and Confirming Iron Formation was Being Cored in Black Iron Drill Holes

During its site visits, WGM visited the drills in progress for both the Phase I and II drilling programs. During these visits, WGM confirmed the coordinates of the drill hole collars to be similar to those which had been proposed and confirmed that they were located on the Property.

Table 12-1 lists the drill holes checked by WGM, using a hand-held GPS during its site visits while drilling was in progress or after drill dismount and compares these coordinates to the coordinates listed in the 2005 drill hole database for the corresponding historic holes. The final surveyed coordinates for Black Iron's drill hole collars from the Project surveyors TNT TPI are also listed.

The coordinates are generally reasonably close, within a few metres, which is the accuracy of the hand-held GPS method and therefore validate the locations of the Black Iron collars.

Table 12-1: WGM Check of Collar Locations During Drilling

Hole ID	WGM Easting	WGM Northing	2005 DB Easting	2005 DB Northing	TNT TPI Final Easting	TNT TPI Final Northing
BI21674-T	520530	5298073	520527.16	5298063.94	520527.077	5298064.176
BI5485-T	520413	5298131	520402.52	5298119.46	520409.299	5298120.096
BI20287-T	520344	5298657	520339.73	5298645.71	520342.204	5298649.517
BI21704-T	520216	5298837	520209.48	5298835.94	520212.476	5298832.183
BI20289-T	520138	5298707	520125.92	5298703.18	520130.903	5298702.064
BI21707-T	520679	5298698	520676.80	5298685.69	520678.263	5298687.338
BI20342-T	520639	5298716	520633.31	5298712.58	520631.768	5298716.313
BI21687-T	520495	5298387	520497.07	5298398.71	520490.653	5298396.119
BISH-80	520655	5297987	-	-	520656.105	5297992.943

Hole ID	WGM Easting	WGM Northing	2005 DB Easting	2005 DB Northing	TNT TPI Final Easting	TNT TPI Final Northing
BISH-67	520094	5298583	-	-	520090.582	5298577.651
BISH-62	520102	5298551	-	-	520086.724	5298558.996
BISH-66	520064	5298478	-	-	520056.821	5298472.753
BISH-70	520088	5298229	-	-	520084.768	5298225.152
BISH-29	520706	5298678	-	-	520707.807	5298671.502

Note: Coordinates are UTM, WGS 84, Zone 36N

12.2 Confirming Historic Casings

During the site visits, WGM also witnessed the existence of six historic drill casings on the Property. These six casings are listed in Table 12-2. Several of them were located close to Twin hole collar locations to which they are believed to correspond. All of these casings, except for one, were shown to WGM by GEORESOURCE. The one exception, labelled T-6 in the table, was spotted by WGM during a visit to Black Iron's Drill hole BISH-33, in progress at that time.

Table 12-2: WGM Check of Historical Casing Locations

ID	Hole ID (Assumed)	WGM Easting	WGM Northing	2005 DB Easting	2005 DB Northing
1	21708	520804	5298642	520807.84	5298635.91
2	21704	520213	5298840	520209.48	5298835.94
3	20287	520345	5298653	520339.73	5298645.71
4	13302	520537	5298540	520535.91	5298536.03
5	-	519988	5298377	-	-
6	T-6	520449	5298769	-	-

Note: Coordinates are UTM, WGS 84, Zone 36N

As mentioned in Section 9.4, seven other historic casings were subsequently identified on the Property and surveyed, but the six listed in Table 12-2 have not yet been surveyed by the Project surveyors. The locations of the first four listed in Table 12-2 appear to correspond reasonably well with historic drill holes, with differences of up to 11 m. The casing indexed as Number 5 corresponds with no known drill hole. This casing was at least 10 cm in diameter and stood 1 m above ground surface. Some pieces of un-split drill core were lying beside it.

The casing identified with an ID of Number 6 also corresponds to no known historic drill hole. However, its location does correspond to an indication marked in pencil on the 1989 Soviet Property Geology map as T-6. On this map, other T-holes are also marked. These marks were previously understood to be planned locations, rather than actual drill hole locations, but the identification of the casing at the T-6 location and the other casing labelled as 5 suggests that some additional undocumented drilling may have taken place on the Property.

12.3 Confirming Validity of GEORESOURCES Core Logging and Sampling

WGM “quick” logged a number of Black Iron Phase I and II cores at the GEORESOURCE core shed during its site visits. During this process, WGM confirmed that the GEORESOURCE logging was reasonably accurate with its lithostratigraphic coding that generally agreed with WGM’s observations. Some suggestions for improving the logging process were provided to GEORESOURCE to prompt improvements in future.

During this process, WGM also checked the locations of sample intervals and sample identifiers for agreement with locations recorded in the database, and found no errors.

12.4 Independent Sampling and Assaying

WGM completed independent sampling of Black Iron’s half-split drill core and assay pulps prepared by MCM during its second, third and fourth site visits to the Property. In total, WGM collected 23 samples of half-split core and 93 pulps (one pulp was lost in transit, providing 92 for assay at SGS-Lakefield). To this stream, WGM inserted instances of two Certified Reference Standards: CANMET’S FER-3 and the Ukrainian Standard P-010.

The pulps were collected from second pulps prepared by MCM. The laboratory protocol called for MCM to prepare a second 100 g pulp for every sample processed. MCM riffled this material out of the pulverized fraction. One pulp went to analysis at MCM; the second pulp was put aside for our use.

During its visits, WGM selected the pulps and sub-sampled each one, extracting 20 to 30 g and placed this material in small bags. The samples were selected by WGM to be representative of the entire assay/sample program, with samples taken from each of the sample shipment/MCM certificate batches. The samples were also selected to span the range of mineralization represented by a range of MCM assay results.

The drill core samples were sampled by WGM from the core boxes. For the most part, WGM’s samples represented the remainder of the half-split core left in the core trays after original sampling for MCM assaying. All but two of WGM’s samples correspond to GEORESOURCE’s samples.

These samples were assigned new sample identities, placed in sample bags with tamper-evident closures and shipped to SGS-Lakefield. It is important to note that the identity of the samples was not known to MCM, GEORESOURCE, Black Iron, or SGS-Lakefield. Upon arrival, SGS-Lakefield performed an inspection of the bags and reported that they were in good shape, showing no evidence of tampering.

At SGS-Lakefield, each sample was analyzed for major elements by lithium metaborate fusion Whole Rock–X-Ray Florescence (WR-XRF); FeO_T was determined by H_2SO_4/HF acid digest potassium dichromate titration; Fe_{mag} was determined by Satmagan: and S_T by LECO. Each sample also had SG determined on pulp, by gas comparison pycnometer. Bulk density was determined on each of the core samples (not the pulps) prior to crushing, using the weighing–in-water/weighing-in-air method.

The pulps required no sample preparation at SGS-Lakefield. The drill core samples were cone crushed to nominal ¼" and then a 1 kg sub-sample was riffled out. The sub-sample was stage-crushed to 10-mesh (2 mm), a 100 g was pulverized in a ring pulverizer to 200-mesh (75 µm), and then sent for analysis.

Each of the samples collected during WGM's fourth site visit was split into two portions, one portion going to SGS-Lakefield and the second portion going "blind" to MCM for re-assay, using the analytical package standard to the project.

Analysis of Initial Analytical Results

Samples collected during WGM's second and third site visits aggregated 53 pulps and 18 half-split drill core samples, including six Certified Reference Standards. Initial interpretation of analytical results for these samples showed that results for Fe_{tot}, SiO_2, FeO_T, and S_T were closely comparable between SGS-Lakefield and MCM. However, for Fe_{mag}, initial results showed that MCM values were lower than SGS-Lakefield values. An analysis of the Twin drill hole results was completed at the same time, by comparing assay results in Black Iron's Twin drill holes with its corresponding historic twin. Fe_{mag} values returned for Black Iron's samples were also generally lower than historic values. These two findings suggested that MCM's Fe_{mag} values were generally 2%-4% lower.

Figure 12-1 shows SGS-Lakefield assays of Fe_{mag} by Satmagan, plotted against original MCM assays.

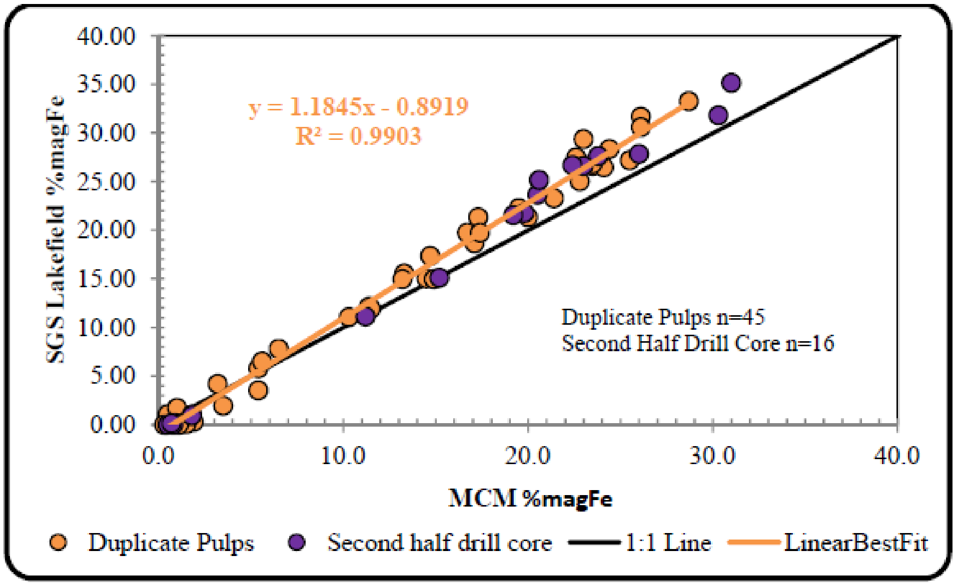


Figure 12-1: % Fe_{mag} at SGS-Lakefield vs. MCM on WGM Duplicate Pulps and Second half drill Core Samples

Table 12-3 and Table 12-4 report the SGS-Lakefield results for WGM control samples for comparison with MCM pre-saturation magnetizer recalibration assays and certified values.

Section 11.2 provides further description of this issue, for which the outcome was that MCM completed a recalibration of its saturation magnetization analyzer and re-issued revised Fe_{mag} values for all its samples done prior to this recalibration. All samples submitted and assayed after this recalibration were done using the “new” calibration.

Results after MCM Saturation Magnetizer Recalibration

After the recalibration at MCM was completed, WGM collected additional samples of pulps and half-core on subsequent visits to the site. Table 12-5, Table 12-6 and Table 12-7 list analytical results for the duplicate pulp and second half-core samples selected by WGM and assayed at MCM and SGS-Lakefield. Fe_{mag} values in these tables and in subsequent plots of analytical results use only the Fe_{mag} values from the “new” calibration.

Table 12-3: Assay Results for the FER-3 Standard at MCM and SGS-Lakefield

	$pctFe_{tot}$	$pctFe_{mag}$	$pctFeO_T$	$pctSiO_2$	pctP	$pctS_T$	SG
Assays at MCM - Pre-magnetization Saturation Analyser Recalibration							
Count	132	130	129	131	131	132	-
Avg	31.17	28.17	13.27	53.05	0.034	0.033	-
Median	31.20	28.15	13.30	53.04	0.035	0.030	-
Min	30.90	27.70	12.90	52.24	0.017	0.026	-
Max	31.40	28.70	13.80	53.50	0.040	0.300	-
Assays at MCM - Post-magnetization Saturation Analyser Recalibration							
Count	250	248	247	249	249	250	-
Avg	31.19	28.36	13.26	53.06	0.034	0.032	-
Median	31.20	28.40	13.30	53.04	0.034	0.030	-
Min	30.90	27.70	12.90	52.24	0.017	0.026	-
Max	31.40	30.40	13.80	53.50	0.040	0.300	-
WGM inserted FER-3 Duplicate Pulps - Assays at SGS-Lakefield							
Count	8	8	8	8	8	8	8
Avg	31.20	31.06	13.89	53.38	0.029	0.031	3.42
Median	31.15	31.19	13.80	53.40	0.031	0.030	3.40
Min	30.90	30.61	13.80	53.10	0.026	0.030	3.35
Max	31.50	31.48	14.10	53.60	0.031	0.040	3.57
Certified Values	**31.15**	**-**	**13.63**	**53.61**	**0.030**	**0.030**	

Table 12-4: Assay Results for the P-010 Standard at MCM Pre Mag Recalibration and SGS-Lakefield

	pctTFe	pctFe$_{mag}$	pctFeO$_T$	pctSiO$_2$	pctP	pctS$_T$	SG$_T$
MCM inserted P-010 - Assays at MCM - Pre-magnetization Saturation Analyser Recalibration							
Count	63	63	63	63	63	63	
Avg	36.85	26.82	15.18	39.35	0.050	0.137	
Median	36.90	26.80	15.20	39.30	0.05	0.14	
Min	36.70	26.50	15.00	39.16	0.040	0.124	
Max	37.10	27.00	15.40	39.70	0.056	0.149	
Assays at MCM - Post-magnetization Saturation Analyser Recalibration							
Count	216	216	216	216	216	216	
Avg	36.83	26.83	15.17	39.36	0.05	0.14	
Median	36.80	26.80	15.20	39.34	0.05	0.14	
Min	36.60	26.40	14.90	38.88	0.04	0.12	
Max	37.10	27.30	15.50	39.72	0.06	0.15	
WGM inserted P-010 Duplicate Pulps – Assays at SGS-Lakefield							
Count	7	7	7	7	7	7	7
Avg	36.87	28.54	15.71	39.57	0.04	0.14	3.62
Median	37.00	28.44	15.70	39.50	0.04	0.14	3.63
Min	36.50	27.93	15.50	39.50	0.04	0.12	3.51
Max	37.10	29.23	16.10	39.70	0.04	0.15	3.68
Certified Values	**36.82**	**26.9**		**39.4**			

Table 12-5: MCM and SGS-Lakefield Assay Results for WGM Duplicate Pulps

Original Sample ID	WGM Sample ID	MCM Fe_{tot}	SGS Fe_{tot}	MCM $pctFe_{mag}$	SGS Fe_{mag}	MCM FeO_T	SGS FeO_T	MCM SiO_2	SGS SiO_2	MCM P	SGS P	MCM S_T	SGS S_T	MCM BDensity	MCM PycSG	SGS PycSG
BI00022	BICH-01	31.30	31.1	18.70	18.67	22.80	23.4	40.66	43.1	0.11	0.09	0.28	0.24	3.3		3.45
BI00047	BICH-02	30.20	31.5	22.40	21.35	19.10	22.4	48.14	48.3	0.07	0.07	0.96	0.78			3.49
FER-3	BICH-03		31.2		30.68		13.8		53.5		0.03		0.03			3.40
BI00069	BICH-04	16.90	16.9	1.20	1.01	19.40	19.4	55.74	56.1	0.06	0.05	0.41	0.34			3.01
BI00082	BICH-05	31.50	31.1	21.20	22.00	20.30	20.8	48.66	47.2	0.08	0.08	0.09	0.08			3.42
BI00110	BICH-06	35.50	35.2	26.80	28.37	20.60	21.0	44.16	42.7	0.08	0.07	0.08	0.07			3.60
BI00141	BICH-07	25.60	25.3	5.80	5.79	21.00	26.0	52.12	51.4	0.08	0.07	0.15	0.14			3.29
BI00217	BICH-08	33.40	34.1	26.40	26.63	19.70	19.6	47.60	44.6	0.11	0.10	0.10	0.07			3.52
BI00267	BICH-09	30.40	30.1	16.10	15.05	24.50	25.0	49.14	47.8	0.11	0.10	0.12	0.11			3.43
BI00292	BICH-10	31.70	31.8	21.10	22.29	20.90	20.7	48.10	46.8	0.11	0.10	0.08	0.08	3.14		3.50
BI00398	BICH-11	35.50	36.2	28.50	31.69	19.50	18.9	46.90	41.7	0.10	0.07	0.03	0.05			3.58
BI00398	BICH-12	35.50	35.7	28.50	30.61	19.50	20.0	46.90	43.2	0.10	0.10	0.03	0.05			3.52
BI00418	BICH-13	15.90	15.8	0.90	1.09	17.50	17.9	57.94	56.2	0.06	0.06	0.40	0.41			3.00
BI00426	BICH-14	26.40	27.0	6.00	6.51	27.00	28.2	54.86	49.8	0.07	0.07	0.10	0.12	3.22		3.30
BI00468	BICH-15	36.50	36.0	31.10	33.29	18.20	18.4	46.18	42.4	0.10	0.10	0.05	0.06			3.59
BI00497	BICH-16	28.50	28.7	14.90	15.56	22.70	23.0	48.32	48.1	0.08	0.08	0.10	0.10			3.38
BI00523	BICH-17	26.90	26.4	6.90	7.81	26.60	26.1	51.94	51.6	0.08	0.07	0.07	0.08	3.16		3.27
BI00537	BICH-18	30.20	30.0	16.30	17.37	23.20	23.3	48.00	47.6	0.09	0.07	0.11	0.12	2.95		3.40
BI00547	BICH-19	10.10	10.1	1.40	1.74	11.10	10.2	56.64	54.6	0.04	0.02	1.69	1.66			2.86
BI00553	BICH-20	23.10	23.6	3.60	4.20	25.90	25.8	55.66	54.6	0.13	0.09	0.16	0.18			3.20
BI00584	BICH-21	36.30	36.5	25.00	27.50	23.50	23.7	45.34	41.7	0.08	0.08	0.09	0.08			3.57

Original Sample ID	WGM Sample ID	MCM Fe_{tot}	SGS Fe_{tot}	MCM $pctFe_{mag}$	SGS Fe_{mag}	MCM FeO_T	SGS FeO_T	MCM SiO_2	SGS SiO_2	MCM P	SGS P	MCM S_T	SGS S_T	MCM BDensity	MCM PycSG	SGS PycSG
FER-3	BICH-22		30.9		30.61		13.8		53.2		0.03		0.03			3.35
BI00635	BICH-23	33.40	33.2	18.90	21.35	23.70	23.7	45.80	45.1	0.11	0.10	0.13	0.13			3.58
BI00656	BICH-24	32.90	32.5	18.30	19.75	23.50	23.5	46.20	46.1	0.10	0.09	0.07	0.07			3.47
BI00710	BICH-25	36.20	35.5	25.40	29.38	20.30	20.8	46.72	44.3	0.10	0.09	0.06	0.06			3.47
P-010	BICH-26		36.5		27.93		15.7		39.5		0.04		0.12			3.66
BI00778	BICH-27	64.10	64.3	5.80	3.55	2.60	2.5	4.04	4.0	0.02	0.01	0.00	0.02			4.79
BI00794	BICH-28	34.20	34.3	1.30	0.14	1.60	1.5	49.16	50.0	0.02	0.01	0.01	0.01			3.55
BI00863	BICH-29	33.60	33.9	25.20	25.04	20.90	20.6	44.96	44.5	0.09	0.07	0.14	0.13			3.51
BI00958	BICH-30	29.20	29.4	16.50	14.98	22.70	23.5	54.56	50.9	0.10	0.10	0.15	0.13			3.38
BI01002	BICH-31	29.10	29.2	13.00	12.16	19.60	25.4	48.80	49.0	0.11	0.10	0.15	0.14			3.40
FER-3	BICH-32		31.1		30.75		13.8		53.6		0.03		0.03			3.40
BI01013	BICH-33	21.60	21.5	2.20	1.01	24.40	23.8	49.62	54.7	0.07	0.07	0.14	0.14			3.13
BI01072	BICH-34	12.10	11.8	1.50	0.07	12.40	12.7	57.28	56.9	0.05	0.04	0.31	0.33			2.97
BI01107	BICH-35	31.70	31.6	13.10	11.94	26.70	26.8	45.50	45.5	0.04	0.03	0.13	0.12			3.42
BI01132	BICH-36	35.70	35.5	25.50	27.21	20.30	20.7	40.00	42.5	0.09	0.09	0.06	0.06	3.34	3.46	3.57
BI01157	BICH-37	21.20	21.1	2.20	1.01	7.60	8.9	54.52	54.4	0.07	0.07	0.02	0.02			3.04
BI01180	BICH-38	28.40		11.30		23.70		46.18		0.07		0.78				
BI01307	BICH-39	35.70	35.4	26.50	26.48	21.70	22.0	43.90	43.0	0.08	0.07	0.06	0.06			3.57
FER-3	BICH-40		31.1		31.33		14.0		53.3		0.03		0.03			3.42
BI01352	BICH-41	15.80	15.8	1.50	0.07	17.90	18.1	57.12	56.8	0.06	0.05	0.33	0.33			3.03
P-010	BICH-42		36.5		28.15		15.6		39.7		0.04		0.14			3.68
BI01364	BICH-43	31.70	31.6	14.80	14.98	24.80	25.8	46.20	46.3	0.09	0.09	0.10	0.09			3.46
BI01366	BICH-44	35.20	34.9	23.80	23.30	21.20	23.1	44.00	44.4	0.10	0.10	0.05	0.06			3.57

Original Sample ID	WGM Sample ID	MCM Fe_{tot}	SGS Fe_{tot}	MCM $pctFe_{mag}$	SGS Fe_{mag}	MCM FeO_T	SGS FeO_T	MCM SiO_2	SGS SiO_2	MCM P	SGS P	MCM S_T	SGS S_T	MCM BDensity	MCM PycSG	SGS PycSG
BI01373	BICH-45	18.80	18.8	2.30	0.29	17.30	21.3	56.66	57.0	0.07	0.07	0.19	0.21			3.10
BI01463	BICH-46	17.00	17.0	1.90	0.07	18.40	19.7	55.92	56.2	0.07	0.05	0.99	0.93			3.01
BI01470	BICH-47	28.00	28.5	10.70	11.07	22.40	24.0	49.88	50.3	0.07	0.06	0.55	0.56			3.36
BI01485	BICH-48	35.30	35.0	25.90	26.85	21.40	22.4	44.80	44.5	0.10	0.09	0.06	0.05			3.64
BI01499	BICH-49	23.20	23.2	3.90	1.95	24.30	26.2	53.28	53.6	0.08	0.07	0.34	0.29			3.23
BI01504	BICH-50	31.20	31.3	19.00	19.75	19.90	21.6	47.72	48.2	0.12	0.12	0.09	0.07			3.47
BI01538	BICH-51	12.90	12.9	1.50	0.00	13.70	15.0	58.54	59.0	0.05	0.05	0.39	0.40			2.97
I01566	BICH-52	7.40	7.6	0.70	0.00	8.60	9.1	42.68	42.6	0.02	0.01	0.25	0.21			2.95
BI01950	BICH-53	9.20	9.3	1.10	1.16	8.90	10.8	45.32	44.5	0.01	0.00	0.01	0.02			3.06
BI01952	BICH-54	33.40	33.4	20.80	24.75	19.30	20.5	41.00	41.5	0.11	0.09	0.17	0.14			3.43
BI02002	BICH-55	25.50	25.7	4.40	5.93	25.80	25.5	51.46	51.8	0.06	0.06	0.38	0.33			3.26
BI02142	BICH-56	33.50	33.9	18.10	17.80	26.10	27.4	44.40	44.8	0.06	0.06	0.56	0.50			3.48
BI02149	BICH-57	35.20	35.3	26.00	26.05	21.20	22.5	43.66	43.8	0.08	0.07	0.15	0.13			3.51
P-010	BICH-58		37.1		29.23		16.1		39.5		0.04		0.14			3.57
BI02254	BICH-59	31.20	31.3	15.30	13.68	26.80	9.5	47.60	47.7	0.11	0.10	0.08	0.08			3.41
BI02278	BICH-60	27.60	27.4	2.40	2.89	31.10	31.4	49.84	49.8	0.08	0.07	0.14	0.14			3.35
BI02321	BICH-61	27.20	27.5	9.70	0.94	21.70	21.1	44.48	44.8	0.08	0.07	0.18	0.16			3.28
BI02330	BICH-62	18.80	18.9	1.10	0.94	21.20	22.5	55.96	56.2	0.07	0.07	0.31	0.30			3.03
BI02389	BICH-63	29.20	29.4	12.80	14.47	23.70	24.8	48.02	49.5	0.08	0.07	0.10	0.10			3.36
FER-3	BICH-64		31.1		31.26		14.1		53.1		0.03		0.03			3.41
BI02410	BICH-65	33.90	32.9	22.80	25.47	13.30	14.0	49.94	49.3	0.02	0.02	0.03	0.02			3.46
BI02412	BICH-66	34.40	34.3	20.10	19.68	17.20	18.2	43.98	44.2	0.02	0.02	0.04	0.05			3.45
BI02530	BICH-67	26.90	27.1	10.40	10.56	23.90	25.2	52.52	52.5	0.08	0.08	0.20	0.19			3.24

Original Sample ID	WGM Sample ID	MCM Fe_{tot}	SGS Fe_{tot}	MCM $pctFe_{mag}$	SGS Fe_{mag}	MCM FeO_T	SGS FeO_T	MCM SiO_2	SGS SiO_2	MCM P	SGS P	MCM S_T	SGS S_T	MCM BDensity	MCM PycSG	SGS PycSG
BI02538	BICH-68	30.50	30.6	17.70	17.00	23.10	24.5	48.40	48.5	0.08	0.08	0.06	0.05			3.43
BI02547	BICH-69	35.20	35.3	28.10	26.27	20.00	21.5	42.88	43.3	0.10	0.09	0.07	0.06			3.62
P-010	BICH-70		36.9		28.80		15.9		39.7		0.04		0.14			3.58
BI02555	BICH-71	25.50	25.9	6.30	6.51	25.70	26.9	50.40	52.4	0.08	0.08	0.23	0.22		3.28	3.24
BI02691	BICH-72	33.90	34.1	18.40	20.04	23.70	25.6	44.52	45.6	0.11	0.10	0.22	0.18			3.74
BI02693	BICH-73	27.20	27.4	10.80	11.94	20.90	22.7	49.50	51.8	0.09	0.08	0.19	0.16			3.25
BI02713	BICH-74	26.60	26.4	4.00	4.41	28.10	29.1	51.12	51.3	0.08	0.08	0.16	0.16			3.30
BI02762	BICH-75	22.50	22.5	0.60	0.87	25.70	26.9	53.24	54.4	0.08	0.08	0.16	0.16			3.13
FER-3	BICH-76		31.3		31.11		14.0		53.2		0.03		0.03			3.38
BI02773	BICH-77	15.30	15.5	0.60	0.94	17.30	18.5	59.58	59.7	0.05	0.05	0.97	0.88			2.92
BI02790	BICH-78	34.70	34.8	18.80	20.62	25.50	26.7	42.08	42.3	0.05	0.04	0.21	0.16			3.59
BI02853	BICH-79	32.20	32.2	22.00	23.30	20.80	21.5	46.80	46.8	0.10	0.10	0.08	0.07			3.41
BI02863	BICH-80	15.20	15.1	1.30	2.03	15.00	16.6	56.74	57.2	0.05	0.05	0.42	0.38			2.99
BI02927	BICH-81	31.20	31.3	12.10	13.02	27.50	28.5	47.58	47.9	0.08	0.07	0.20	0.17			3.44
BI02933	BICH-82	37.30	37.7	27.00	28.44	23.20	23.5	41.54	41.6	0.08	0.07	0.06	0.05			3.58
P-010	BICH-83		37.0		28.37		15.5		39.5		0.04		0.14			3.63
BI02977	BICH-84	23.70	23.5	5.00	5.07	24.10	25.2	56.56	56.9	0.05	0.07	0.21	0.18			3.20
BI03022	BICH-85	24.60	25.0	5.60	5.93	24.00	25.5	51.58	52.0	0.07	0.07	0.24	0.22			3.30
BI03028	BICH-86	30.80	31.0	12.90	14.33	25.90	27.0	46.82	46.4	0.08	0.07	0.17	0.16			3.45
BI03075	BICH-87	36.20	36.6	22.20	22.58	18.30	19.0	41.98	42.8	0.08	0.08	0.05	0.05		3.55	3.53
BI03097	BICH-88	14.00	14.1	0.80	0.72	14.80	14.8	58.18	58.4	0.05	0.03	0.55	0.52			2.97
BI03278	BICH-89	35.20	35.6	25.80	27.50	20.80	21.8	42.78	43.3	0.05	0.06	0.10	0.08			3.55
BI03287	BICH-90	31.30	31.6	18.30	19.32	23.00	23.5	47.82	48.1	0.10	0.09	0.11	0.10			3.56

Original Sample ID	WGM Sample ID	MCM Fe_{tot}	SGS Fe_{tot}	MCM $pctFe_{mag}$	SGS Fe_{mag}	MCM FeO_T	SGS FeO_T	MCM SiO_2	SGS SiO_2	MCM P	SGS P	MCM S_T	SGS S_T	MCM BDensity	MCM PycSG	SGS PycSG
FER-3	BICH-91		31.5		31.26		13.8		53.6		0.03		0.03			3.57
BI03472	BICH-92	20.10	22.1	2.90	3.18	23.90	24.4	55.32	55.6	0.08	0.07	0.21	0.19			3.13
BI03491	BICH-93	30.40	30.6	17.10	17.73	9.30	9.1	51.56	51.9	0.05	0.05	0.04	0.04			3.37
BI03587	BICH-94	32.00	32.0	18.00	19.18	18.40	18.9	46.82	47.2	0.04	0.04	0.01	0.02			3.32
BI03592	BICH-95	35.30	35.5	20.40	21.42	25.30	26.0	42.46	42.6	0.08	0.07	0.06	0.06			3.59
BI03754	BICH-96	38.20	38.0	5.00	5.43	2.50	3.1	44.88	45.2	0.01	0.02	0.00	0.01			3.74
BI03765	BICH-97	27.20	26.6	14.70	15.05	18.60	18.7	51.68	51.5	0.04	0.03	0.11	0.09	3	3.26	3.21
P-010	BICH-98		37.0		28.44		15.7		39.6		0.04		0.15			3.68
BI03817	BICH-99	14.30	14.2	0.60	0.80	15.60	15.7	59.58	59.7	0.06	0.07	0.52	0.44			2.93
BI03989	BICH-100	33.50	33.5	18.90	19.90	21.40	22.4	45.30	45.3	0.08	0.07	0.27	0.23			3.43
BI03996	BICH-101	29.40	29.7	12.70	13.46	23.60	24.1	46.90	47.6	0.10	0.09	0.17	0.16			3.26
BI04011	BICH-102	36.40	36.2	28.80	30.39	19.60	20.5	42.34	41.8	0.09	0.07	0.08	0.06			3.56
BI04192	BICH-103	38.80	38.7	29.40	30.03	21.90	21.6	41.56	42.0	0.02	0.01	0.05	0.05			3.60
FER-3	BICH-104		31.4		31.48		13.8		53.5		0.03		0.04			3.39
BI04204	BICH-105	39.40	39.2	24.90	31.11	23.10	23.1	40.16	40.3	0.02	0.01	0.14	0.14			3.61
BI04232	BICH-106	33.60	34.0	20.90	22.07	24.40	24.4	43.88	44.7	0.07	0.05	0.46	0.38			3.54
P-010	BICH-107		37.1		28.87		15.5		39.5		0.04		0.15			3.51
BI04243	BICH-108	31.30	32.0	21.00	21.93	21.40	21.2	45.78	46.3	0.10	0.08	0.21	0.18			3.40

Note: Sample BICH-38 was not received by SGS-Lakefield.

Table 12-6: MCM and SGS-Lakefield Assay Results for WGM Second-half Drill Core Samples

Original Sample ID	WGM Sample ID	MCM Fe_{tot}	SGS Fe_{tot}	MCM Fe_{mag}	SGS Fe_{mag}_Sat	MCM FeO_T	SGS FeO_T	MCM SiO_2	SGS SiO_2	MCM P	SGS P	MCM S_T	SGS S_T	MCM BD	MCM PycSG	SGS BD	SGS PycSG
BI00925	BIWGM-01	34.60	35.3	26.20	27.64	20.20	21.4	47.40	44.9	0.06	0.05	0.11	0.09			3.50	3.60
BI00986	BIWGM-02	29.80	29.8	11.60	11.14	24.10	27.1	48.44	48.0	0.09	0.08	0.09	0.04	3.33		3.36	3.42
BI01015	BIWGM-03	20.10	19.7	2.20	0.94	22.60	23.0	55.34	56.6	0.08	0.08	0.30	0.29			3.00	3.09
BI00116	BIWGM-04	32.10	32.5	21.90	21.78	20.30	22.2	48.60	47.3	0.09	0.09	0.10	0.04			3.47	3.58
BI00137	BIWGM-05	10.30	9.5	0.90	0.00	10.40	11.3	55.80	58.5	0.03	0.03	0.09	0.04			2.89	2.95
BI00049	BIWGM-06	34.70	35.2	28.40	27.86	18.20	20.5	44.00	45.2	0.08	0.08	0.18	0.04			3.53	3.56
BI00090	BIWGM-07	31.10	30.4	16.80	15.12	22.30	25.1	46.34	47.4	0.09	0.10	0.12	0.03			3.35	3.44
BI00478	BIWGM-08	34.80	35.1	25.40	26.63	20.60	21.3	44.16	44.8	0.10	0.10	0.15	0.07			3.50	3.59
BI00242	BIWGM-09	38.60	37.7	31.30	31.84	20.60	21.2	38.92	39.0	0.12	0.10	0.05	0.01			3.49	3.68
BI00836	BIWGM-10	38.20	36.7	24.80	26.70	16.10	17.9	41.58	43.9	0.06	0.05	0.07	0.01			3.42	3.56
BI00791	BIWGM-11	34.80	35.5	1.20	0.00	1.30	0.6	48.56	49.7	0.02	0.00	0.01	0.01		3.68	3.32	3.59
BI00388	BIWGM-12	34.50	34.3	22.90	23.66	23.00	22.8	44.44	44.5	0.08	0.07	0.08	0.06			3.52	3.58
BI00888	BIWGM-13	32.60	32.2	20.80	21.56	19.20	22.0	44.00	43.6	0.10	0.10	0.16	0.06			3.46	3.62
	BIWGM-14		4.3		0.29		3.8		68.8		0.02		1.24			2.59	2.84
BI01664	BIWGM-15	37.40	37.2	33.30	35.17	16.80	18.0	39.46	39.5	0.05	0.04	0.24	0.20			3.53	3.59
	BIWGM-16		7.4		0.00		9.2		40.2		0.01		0.19			2.84	2.89
BI01527	BIWGM-17	34.30	35.1	23.00	25.18	23.10	23.2	45.30	45.0	0.09	0.09	0.06	0.05		3.45	3.40	3.57
BI01330	BIWGM-18	13.90	13.4	1.10	0.14	14.20	16.1	56.50	57.8	0.05	0.04	0.24	0.23			2.92	2.97
BI04664	BIWGM-19	32.60	32.9	18.50	18.31	25.20	25.5	43.48	43.7	0.08	0.09	0.31	0.20			3.37	3.53
BI04782	BIWGM-20	18.50	17.8	0.90	1.01	21.90	21.1	58.40	59.2	0.09	0.08	0.50	0.39			2.94	3.08
BI04431	BIWGM-21	35.00	35.0	26.40	28.58	18.30	17.9	41.10	41.9	0.04	0.03	0.06	0.03			3.43	3.57
BI04258	BIWGM-22	35.70	35.9	29.90	31.84	19.10	18.7	43.42	44.3	0.09	0.08	0.10	0.08			3.56	3.62
BI04425	BIWGM-23	37.10	36.6	0.80	0.58	0.60	0.6	46.10	47.9	0.01	0.01	0.00	0.01	3.41	3.61	3.49	3.68

Table 12-7: Comparison of Assays Completed on WGM Pulps December 2011

WGMSample ID	tblSample SampleID	MCM1 Fe_{tot} (%)	MCM2 Fe_{tot} (%)	MCM1 Fe_{mag} (%)	MCM2 Fe_{mag} (%)	MCM1 FeO_T (%)	MCM2 FeO_T (%)	MCM1 P (%)	MCM2 P (%)	MCM1 S_T (%)	MCM2 S_T (%)	MCM1 SiO_2 (%)	MCM2 SiO_2 (%)
BICH-53	BI01950	9.20	9.0	1.10	0.9	8.90	10.2	0.01	0.011	0.01	0.021	45.32	43.91
BICH-54	BI01952	33.40	33.5	20.80	24.6	19.30	19.8	0.11	0.099	0.17	0.162	41.00	40.86
BICH-55	BI02002	25.50	25.5	4.40	5.5	25.80	25.5	0.06	0.060	0.38	0.365	51.46	51.50
BICH-56	BI02142	33.50	33.6	18.10	17.1	26.10	27.2	0.06	0.055	0.56	0.526	44.40	44.51
BICH-57	BI02149	35.20	35.0	26.00	25.2	21.20	22.4	0.08	0.074	0.15	0.146	43.66	43.32
BICH-59	BI02254	31.20	31.3	15.30	13.8	26.80	25.7	0.11	0.104	0.08	0.078	47.60	47.46
BICH-60	BI02278	27.60	27.4	2.40	2.5	31.10	31.0	0.08	0.078	0.14	0.135	49.84	49.93
BICH-61	BI02321	27.20	27.4	9.70	12.0	21.70	20.2	0.08	0.075	0.18	0.178	44.48	44.19
BICH-62	BI02330	18.80	18.9	1.10	0.8	21.20	22.0	0.07	0.067	0.31	0.324	55.96	56.33
BICH-63	BI02389	29.20	29.4	12.80	14.1	23.70	24.2	0.08	0.072	0.10	0.102	48.02	49.24
BICH-65	BI02410	33.90	33.9	22.80	26.1	13.30	13.8	0.02	0.022	0.03	0.029	49.94	49.22
BICH-66	BI02412	34.40	34.5	20.10	18.9	17.20	18.1	0.02	0.024	0.04	0.045	43.98	43.66
BICH-67	BI02530	26.90	27.2	10.40	10.0	23.90	25.2	0.08	0.076	0.20	0.187	52.52	52.05
BICH-68	BI02538	30.50	30.7	17.70	16.5	23.10	24.0	0.08	0.080	0.06	0.056	48.40	48.10
BICH-69	BI02547	35.20	35.3	28.10	25.8	20.00	21.0	0.10	0.088	0.07	0.067	42.88	43.01
BICH-71	BI02555	25.50	25.9	6.30	6.0	25.70	26.5	0.08	0.084	0.23	0.216	50.40	51.89
BICH-72	BI02691	33.90	33.9	18.40	18.9	23.70	25.0	0.11	0.112	0.22	0.196	44.52	45.08
BICH-73	BI02693	27.20	27.3	10.80	11.4	20.90	22.5	0.09	0.089	0.19	0.157	49.50	51.24
BICH-74	BI02713	26.60	26.5	4.00	4.2	28.10	29.2	0.08	0.086	0.16	0.146	51.12	50.85
BICH-75	BI02762	22.50	22.4	0.60	0.8	25.70	26.7	0.08	0.085	0.16	0.153	53.24	53.89
BICH-77	BI02773	15.30	15.6	0.60	0.8	17.30	18.2	0.05	0.045	0.97	0.848	59.58	59.48
BICH-78	BI02790	34.70	34.6	18.80	19.8	25.50	26.6	0.05	0.049	0.21	0.180	42.08	41.85
BICH-79	BI02853	32.20	32.4	22.00	22.5	20.80	21.1	0.10	0.099	0.08	0.074	46.80	46.66

WGMSample ID	tblSample SampleID	MCM1 Fe_{tot} (%)	MCM2 Fe_{tot} (%)	MCM1 Fe_{mag} (%)	MCM2 Fe_{mag} (%)	MCM1 FeO_T (%)	MCM2 FeO_T (%)	MCM1 P (%)	MCM2 P (%)	MCM1 S_T (%)	MCM2 S_T (%)	MCM1 SiO_2 (%)	MCM2 SiO_2 (%)
BICH-80	BI02863	15.20	15.2	1.30	1.7	15.00	16.4	0.05	0.052	0.42	0.376	56.74	56.80
BICH-81	BI02927	31.20	31.2	12.10	12.6	27.50	28.2	0.08	0.076	0.20	0.196	47.58	47.58
BICH-82	BI02933	37.30	37.5	27.00	27.3	23.20	23.1	0.08	0.078	0.06	0.058	41.54	41.26
BICH-84	BI02977	23.70	23.4	5.00	4.9	24.10	24.9	0.05	0.071	0.21	0.203	56.56	56.56
BICH-85	BI03022	24.60	24.6	5.60	5.6	24.00	25.1	0.07	0.076	0.24	0.239	51.58	51.62
BICH-86	BI03028	30.80	31.0	12.90	13.5	25.90	26.6	0.08	0.088	0.17	0.163	46.82	46.27
BICH-87	BI03075	36.20	36.6	22.20	21.6	18.30	19.2	0.08	0.085	0.05	0.056	41.98	42.20
BICH-88	BI03097	14.00	13.9	0.80	0.7	14.80	15.0	0.05	0.040	0.55	0.502	58.18	58.20
BICH-89	BI03278	35.20	35.5	25.80	26.4	20.80	21.6	0.05	0.062	0.10	0.090	42.78	42.88
BICH-90	BI03287	31.30	31.5	18.30	18.9	23.00	22.6	0.10	0.092	0.11	0.099	47.82	47.34
BICH-92	BI03472	20.10	22.4	2.90	2.9	23.90	24.2	0.08	0.074	0.21	0.192	55.32	55.34
BICH-93	BI03491	30.40	30.5	17.10	18.3	9.30	9.3	0.05	0.050	0.04	0.029	51.56	51.68
BICH-94	BI03587	32.00	32.2	18.00	18.3	18.40	18.7	0.04	0.037	0.01	0.015	46.82	47.20
BICH-95	BI03592	35.30	35.6	20.40	21.0	25.30	25.8	0.08	0.055	0.06	0.063	42.46	42.74
BICH-96	BI03754	38.20	38.1	5.00	5.2	2.50	3.4	0.01	0.022	0.00	0.004	44.88	44.76
BICH-97	BI03765	27.20	26.8	14.70	14.4	18.60	18.5	0.04	0.029	0.11	0.106	51.68	51.90
BICH-99	BI03817	14.30	14.4	0.60	0.6	15.60	14.8	0.06	0.063	0.52	0.435	59.58	59.00
BICH-100	BI03989	33.50	33.6	18.90	19.2	21.40	22.2	0.08	0.074	0.27	0.231	45.30	45.00
BICH-101	BI03996	29.40	29.7	12.70	12.9	23.60	24.0	0.10	0.090	0.17	0.159	46.90	47.00
BICH-102	BI04011	36.40	36.1	28.80	29.1	19.60	20.0	0.09	0.078	0.08	0.067	42.34	41.50
BICH-103	BI04192	38.80	39.0	29.40	30.5	21.90	21.4	0.02	0.013	0.05	0.045	41.56	41.50
BICH-105	BI04204	39.40	39.2	24.90	30.6	23.10	23.0	0.02	0.011	0.14	0.125	40.16	40.00
BICH-106	BI04232	33.60	33.9	20.90	21.0	24.40	24.2	0.07	0.047	0.46	0.370	43.88	44.16
BICH-108	BI04243	31.30	32.0	21.00	21.6	21.40	21.2	0.10	0.086	0.21	0.204	45.78	46.00

Figure 12-2 to Figure 12-7 show the results of assaying at SGS-Lakefield compared to the assays at MCM on duplicate pulps and second half-drill core samples selected by WGM during its site visits.

Figure 12-2 is for Fe_{mag} and shows that SGS-Lakefield and MCM Fe_{mag} assays, following the recalibration, are quite similar, revealing no evidence of significant bias. One sample looks like it is an error due to mix-up, or cross-contamination.

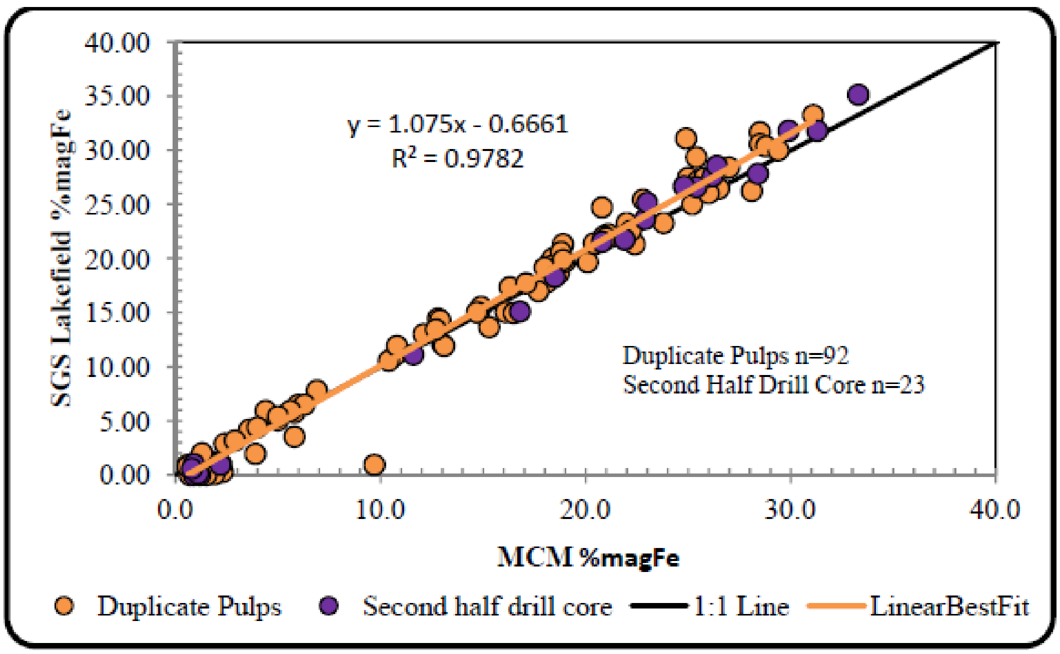


Figure 12-2: Comparison of % Fe_{mag} at SGS-Lakefield vs. MCM for WGM's Independent Samples

Figure 12-3 shows results for Fe_{tot}. Similar to Black Iron's results for the 100 samples assayed at MCM and SGS-Lakefield, (Figure 11-14) and for the 35 samples assayed at ALS (Figure 11-20), Fe_{tot} is unbiased between MCM and SGS-Lakefield.

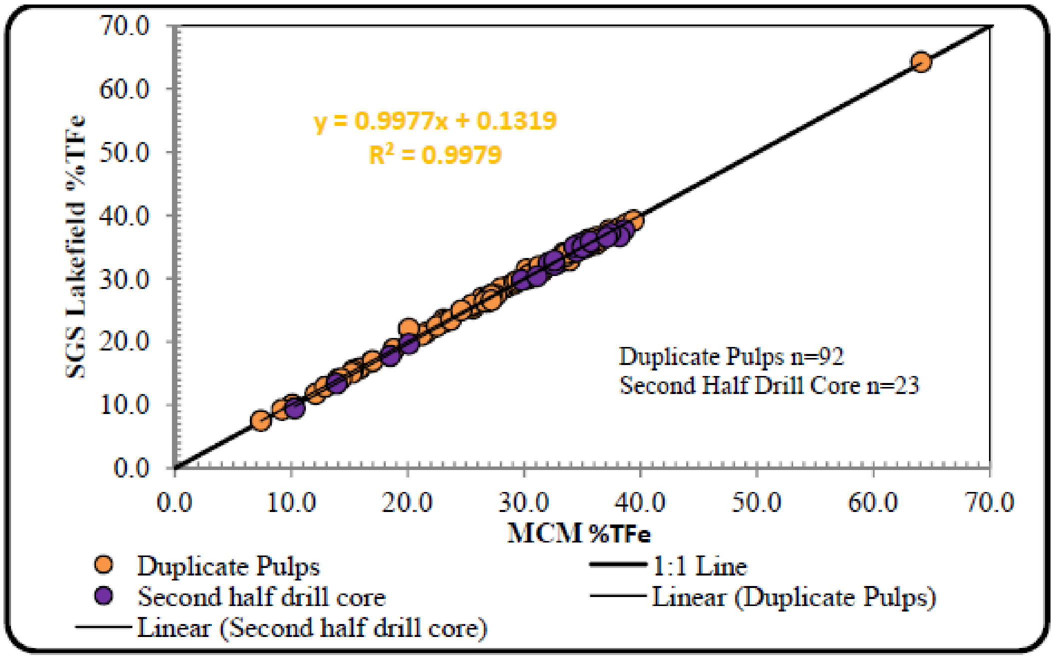


Figure 12-3: Comparison of % Fe_{tot} at SGS-Lakefield vs. MCM for WGM's Independent Samples

Figure 12-4 shows results for FeO_T. Results are strongly positively correlated between the two labs. FeOT at SGS-Lakefield appears to be slightly higher. One sample shows some unknown error.

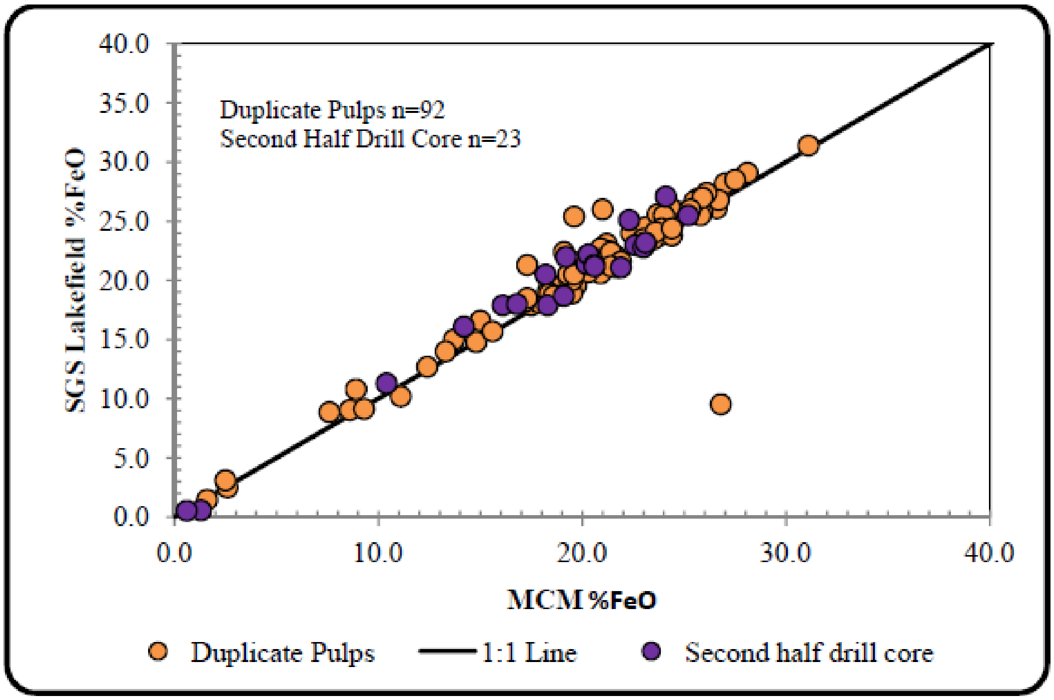


Figure 12-4: Comparison of % FeO_T at SGS-Lakefield vs. MCM for WGM's Independent Samples

Figure 12-5 shows results for SiO_2. Black Iron's check analysis with MCM and SGS-Lakefield (Figure 11-17) showed a slight bias with MCM's being very slightly higher than SGS-Lakefield, but this pattern is not shown here.

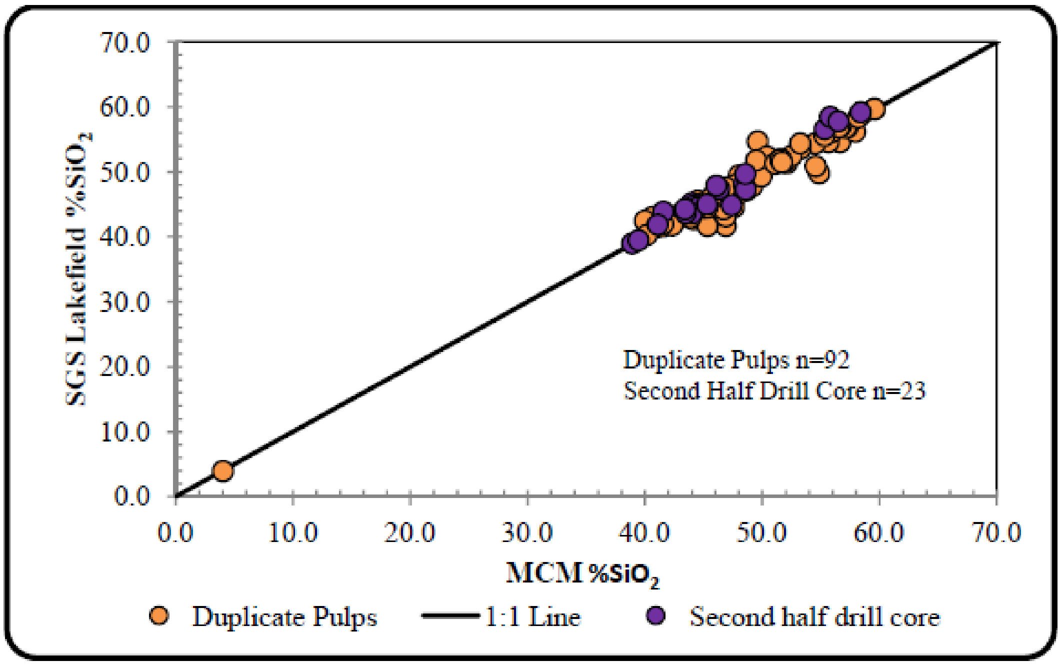


Figure 12-5: Comparison of % SiO_2 at SGS-Lakefield vs. MCM for WGM's Independent Samples

Figure 12-6 shows results for P at MCM and SGS-Lakefield. Similar to results shown for Black Iron's check analysis (Figure 11-18, Figure 11-24 and Figure 11-25) phosphorous at MCM is a little too high.

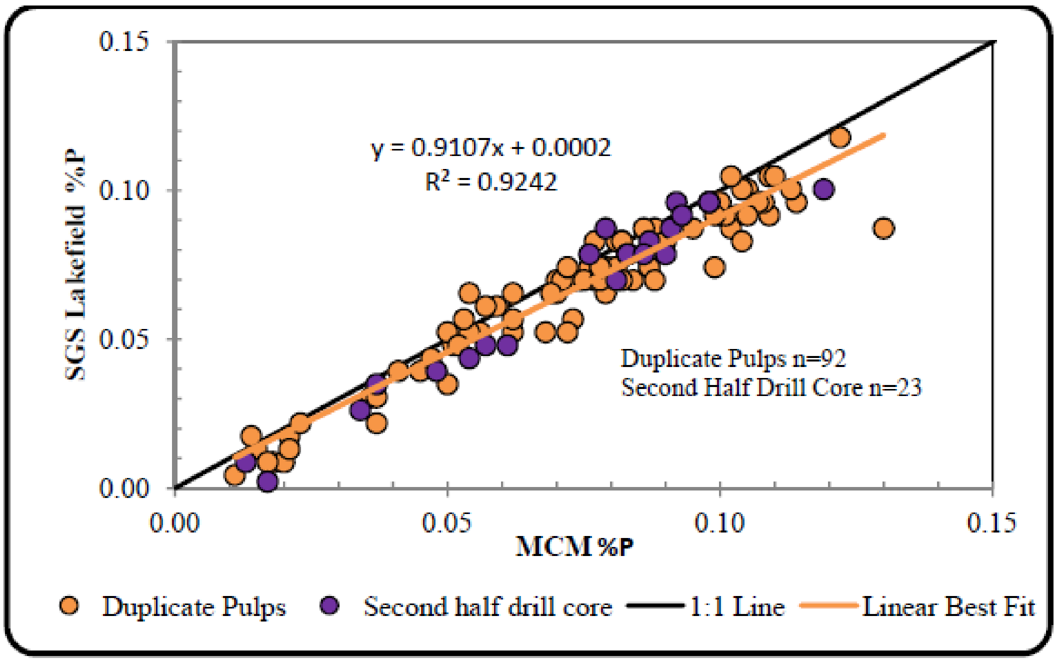


Figure 12-6: Comparison of % P at SGS-Lakefield vs. MCM for WGM's Independent Samples

Figure 12-7 shows results for S_T at MCM and SGS-Lakefield. Results are highly correlated with a slight bias in favour of MCM.

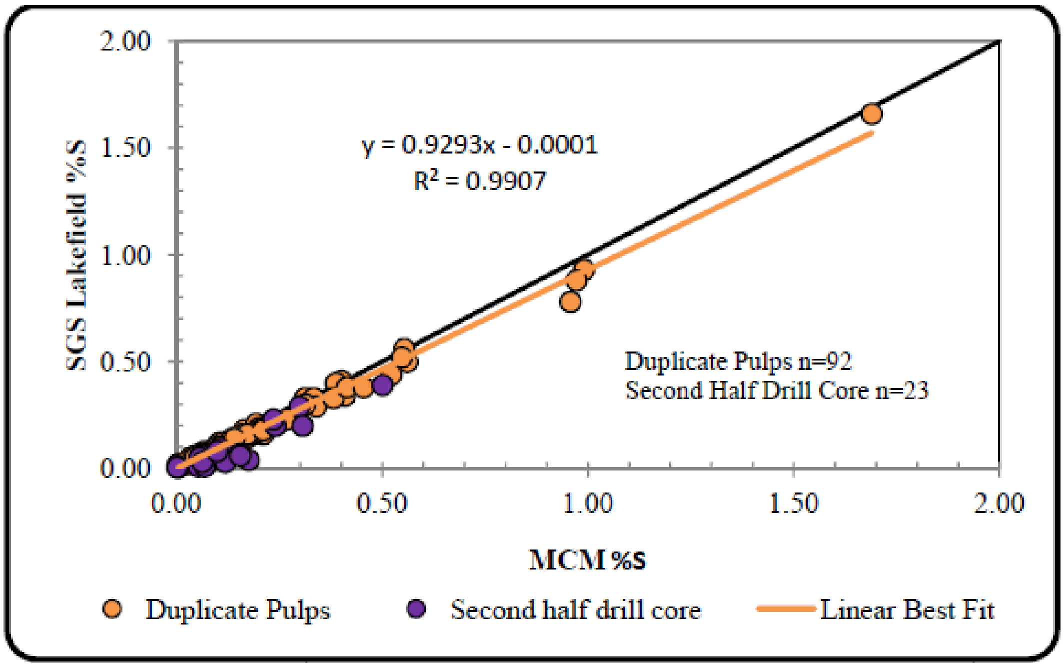


Figure 12-7: Comparison of % S_T at SGS-Lakefield vs. MCM for WGM's Independent Samples

WGM's pulp samples had SG determined by gas comparison pycnometer at SGS-Lakefield, while the split core pre-crushing had bulk density determinations and, after crushing, pycnometer SG. A direct comparison of density/SG between MCM and SGS-Lakefield cannot be made for most of these samples because only a few of these original samples had density and/or SG determined at MCM.

Figure 12-8 shows a comparison of bulk density and pycnometer SG completed on the half-core samples at SGS-Lakefield. The bulk densities are all a little higher than the pycnometer SG. Patterns like this are possible for rock samples that have inherent porosity because they lose porosity when they are crushed or pulverized. Subsequent pycnometer SG determinations on such samples can generate SGs that are too high because any porosity originally present is removed and not measured. However, for these samples, WGM believes the likely reason the pycnometer densities are a little higher is because of calibration errors.

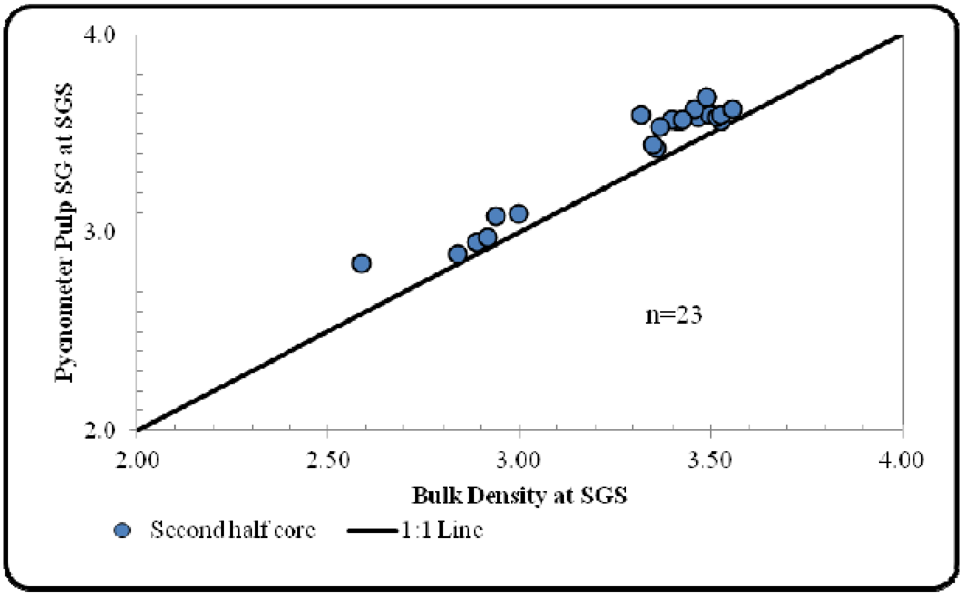


Figure 12-8: Comparison of SG vs. Bulk Density for WGM's Independent Samples – Determinations at SGS-Lakefield

Figure 12-9 shows bulk density versus % Fe_{mag}. A polynomial trend line has been best fit through the data points, excluding two samples of martite mineralization. Figure 12-10 similarly shows bulk density versus % Fe_{tot}.

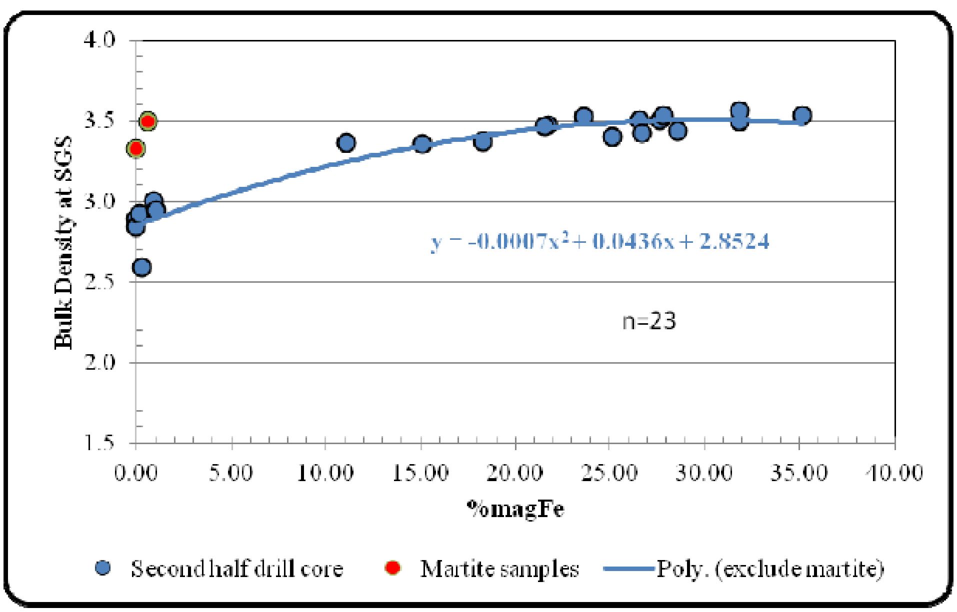


Figure 12-9: Bulk Density vs. % Fe_{mag} for WGM's Independent Samples – Determinations at SGS-Lakefield

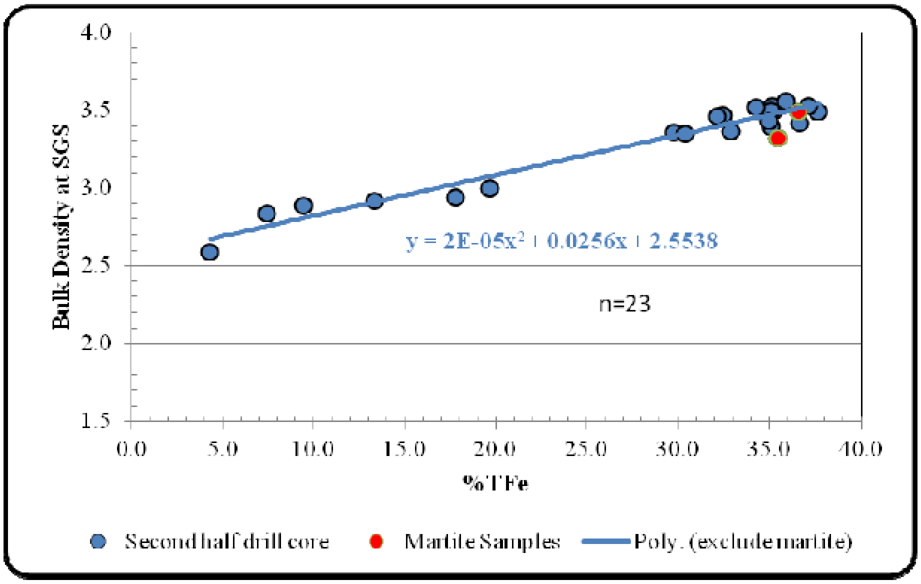


Figure 12-10: Bulk Density vs. % Fe_{tot} for WGM's Independent Samples – Determinations at SGS-Lakefield

Figure 12-11 shows results for pycnometer SG versus % Fe_{mag} for the MCM pulps and split-core samples collected by WGM. The pattern on Figure 11-17 is similar to that on Figure 11-16, except that the trend line is at a slightly higher value of SG.

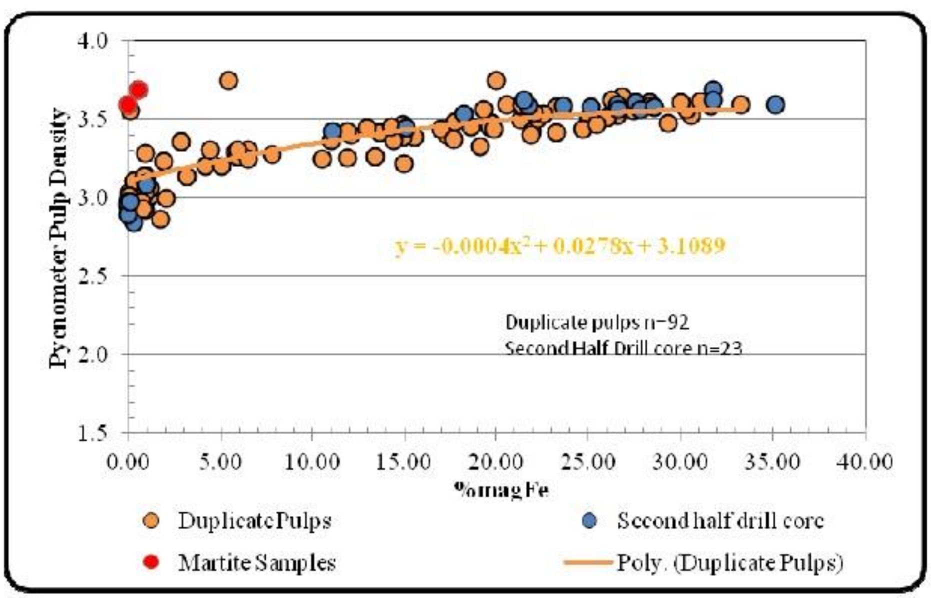


Figure 12-11: SG vs. % Fe_{mag} for WGM's Independent Samples – Determinations at SGS-Lakefield

Figure 12-12 shows results for pycnometer SG versus % Fe_{tot} for the MCM pulps and split-core samples collected by WGM. Again, results for pycnometer SG are similar to the results for bulk density (see Figure 12-10).

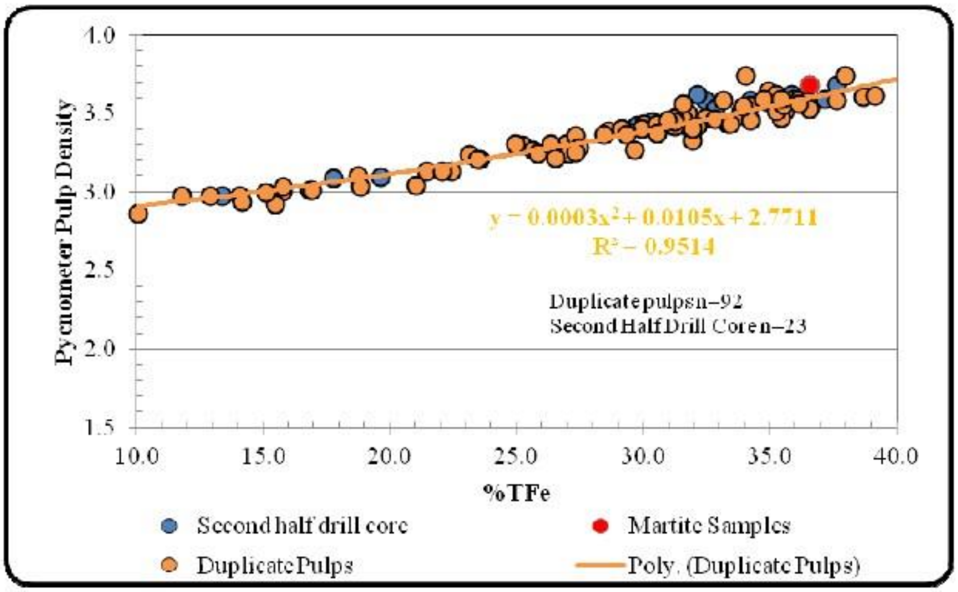


Figure 12-12: SG vs. % Fe_{tot} for WGM's Independent Samples – Determinations at SGS-Lakefield

12.5 Checking Historical Documents

WGM completed a drill hole-by-drill hole review of the drill hole attitude information in the 2005 database vs. collar azimuth, collar dip, end-of-drill hole azimuth and dip information from the 1989 Soviet report. For a number of the drill holes, there are discrepancies between the two sets of data. Where there was a discrepancy, WGM also reviewed the Soviet cross-sections and the drill logs, where available. The discrepancies are often minor and immaterial. More significant differences are often not resolvable with certainty because there is insufficient information detailing the data and its quality. WGM provided Black Iron with comments for each drill hole, making recommendations for revisions of drill hole attitude for several drill holes. Black Iron used this information to adjust the attitudes for some of the historic drill holes.

WGM performed a random check of a small selection of the sample intervals and assays in the logs and in volumes VI and VII of the 1989 Soviet FS report. When the company checked the samples against the database, it found substantial agreement and occasional differences. For a few cases, the 2005 database agrees with the data in volume VII of the 1989 Soviet report, but differs from the log. The core logs contain assays for FeO_T that are not in the Soviet volume or the 2005 database. Lithology intervals in the logs agree approximately with the database, which is reasonable if the 2005 database data was determined from the Soviet cross-sections. The sample tables in volumes VI and VII of the Soviet report also tabulate lithology codes for samples, but these were apparently not compiled by GIC.

12.6 Comments on Data Verification

After completing its verification in the field in Ukraine, its review of the Twin hole drilling program results, and its review of historical documents, including checking various documents against each other, WGM is satisfied that Soviet drilling locations, assay and lithology results are substantially and generally reliable, with a few caveats. The review, documented in Section 10.2 of the Twin hole drilling results and compared with Soviet results, showed that Black Iron's Twin drill holes returned very similar lithology and Fe_{mag} assay intercepts that are similar to those in the corresponding, historic drill holes.

WGM believes that minor errors and uncertainties are associated with many of the Soviet data items, but the extent of these errors has not proven to be significant. These data items include accuracy of drill hole collar locations, collar azimuths and inclinations, and down hole attitude surveys. WGM's review of Appendix 38 in the 1989 Soviet report, Soviet plans and cross-sections, and GIC's database showed a number of discrepancies with respect to historic drill hole azimuth, dip and down hole attitude and for many of these issues resolution was not possible. Inspection of historic casings in the field showed several metres of difference between coordinates for historic drill holes and the located historic casings, but these differences are of little significance to the current Study and they may be the result of data transformations or other minor errors. However, WGM did observe two historic casings that are not documented as drill holes in the information made available. The fact of the existence of these casings suggests that perhaps more drill holes exist on the Property than are documented. But other explanations for the unidentified casings, such as their being abandoned holes, may be possible.

It can be a challenge to secure high-quality, completely and properly documented exploration data from Ukraine. WGM was provided sets of drill hole coordinates that were slightly different, at different times. The differences are small, but no explanation to rationalize the differences was forthcoming. WGM repeatedly requested a copy of a historic map showing historic drill holes that it had witnessed briefly in Ukraine, but this map was not provided.

WGM found the lithological rock-composition coding documented in the historic reports, drill logs and database to be generally reasonable. However, the company believes some of the stratigraphic assignments lack basis. The Soviet lithological codes incorporate stratigraphic assignment, as well as rock-composition. The issue is the stratigraphic component, particularly concerning SX5F and adjacent members. WGM believes that the Soviet geologists were too presumptive in assigning any strongly oxidized–martinized iron formation to the fifth member of the Saksagan sequence, (SX5F) and believes that this assignment affects the coding for adjacent iron formation members and influences the geological interpretation of the Shymanivske deposit itself.

Review of drill logs and comparison with data tables in the Soviet reports shows minor differences for some assays. However, these differences appear to be minor and perhaps could be due to normal re-assaying with records not completely updated by the Soviet authors. One of the significant findings is the historic drill hole assays for Fe_{tot}. As concluded in Section 10.2.3 of this report, it appears that Fe_{tot} assays for individual holes or for certain Soviet drilling campaigns are not always accurate and cannot be relied upon. It is likely that some historic Fe_{mag} sample assays are also a little too high, while others are a little too low. However, the Twin hole drilling program shows that Fe_{mag} results are substantially correct.

On the basis of Check assay comparisons with SGS-Lakefield and ALS — in which much of the Check assaying is based on samples “blind” to all parties, except WGM — WGM is satisfied that MCM assay results for Black Iron’s drilling are generally reliable. Some inaccuracy appears to be present for bulk density results, and phosphorus assays at MCM are evidently too high. However, WGM also believes that some assay irregularities have occurred and bases this belief on the assay results for the Certified Reference Standards by MCM and SGS-Lakefield for WGM’s independent samples and inspection and comparison of Fe_{mag} results on a sample-by-sample basis with post-recalibration results (see Chapter 11). These assay irregularities may relate to MCM’s assigning Fe_{mag} values on the basis of sample identity, rather than on actual assay values. This issue has affected WGM’s faith in the assay results, especially for Fe_{mag}, for MCM inserted Standards, and for Blanks and Duplicates. Despite this caveat, the Check assaying done on MCM-prepared pulps and non-MCM processed second half-split core samples, using secondary labs and “blind” samples, suggests that any possible assay inaccuracies are not very significant for evaluating the Shymanivske deposit.

However, to increase confidence in MCM’s Fe_{mag} determinations on drill hole samples and SG/density, WGM recommends more sample aliquots from archived pulps be re-assayed/tested at an accredited Western lab. Alternately more twinning of both the 2011 program and Soviet drill holes be completed to investigate relationships between geology and assays for multiple generations of exploration programs.

13. MINERAL PROCESSING AND METALLURGICAL TESTING

A significant amount of test work was completed over a number of years, including work done by WorleyParsons during the 2012 FS. As was recommended, additional tests were conducted in order to confirm assumptions and to potentially introduce new technologies to the proposed process flowsheet.

The additional tests, which were completed during the 2014 FS, included pilot scale comminution and beneficiation. The tests were carried out at various laboratories including SGA (Studiengesellschaft für Eisenerzaufbereitung) in Germany, HPGR (High Pressure Grinding Rolls) manufacturers in Germany, COREM in Québec City, Metso's facility in the USA as well as additional tests at SGS Canada, SGS Australia, MCM Ukraine and ALS Ammtec Australia.

The main conclusion drawn from the 2012 FS testwork was that the mineralization from the Shymanivske deposit can be processed and upgraded to the targeted specifications with crushing, stage grinding, low intensity magnetic separation and sulphide flotation. A final grind size of P_{80} = 32 µm was required to achieve a concentrate grade of 68% Fe and 4.5% SiO_2 with a sulphur content of 0.05%. The additional testwork completed during the present 2014 FS allowed the flowsheet to be refined with the following important modifications:

- The crushing circuit capacity was increased and optimized in order to optimize the downstream HPGR stage;
- The cobbing stage was modified for a wet cobbing instead of dry cobbing;
- The power on the primary grinding ball mill was reduced and the secondary ball mill grinding stage was replaced by grinding with tower mills.

Brief summaries of the testwork results from the 2011 PEA, and both the 2012 FS and 2014 FS, are presented in this Chapter. Testwork that is not pertinent to the flowsheet and metallurgical performance supporting this current Study is not discussed in detail. A more complete discussion of the past testwork can be found in the filed NI 43-101 Reports on the System for Electronic Document Analysis and Retrieval (SEDAR). No new testwork was performed for this current Study.

13.1 Testwork Prior to the 2011 PEA

Historical testwork information was taken from a technical report entitled "Detailed Elaboration of Ferriferous Quartzites of Shymanivske Deposit of Kryvyi Rih Iron Ore Basin of Dnepropetrovsk Region, 1989." This testwork was also summarized in the NI 43-101 Technical Report "Resource Estimate Shymanivske Deposit in Ukraine", dated January 27, 2011.

Magnetic separation testing was carried out at the MekhanobrCherMet Institute (MCM) on oxidized quartzite material obtained from diamond drill core of the Shymanivske deposit. Several samples were ground to 98% passing 0.074 mm and then in a second pass to 95% passing 0.045 mm. The results provided preliminary indications that an iron rich concentrate could be produced using magnetic separation methods.

13.2 2011 PEA Study Testwork

A metallurgical testwork program was developed by BBA in the early stages of the PEA study, designed to characterize the Black Iron Shymanivske ore body. The objective of the testwork was to evaluate the ore's amenability to processing by gravity separation and/or by magnetic separation, in order to produce a commercially acceptable, high-quality product that would allow for the economic development of the Shymanivske Project. An important part of the testwork consisted of evaluating whether using a gravity separation circuit before a magnetic separation circuit could contribute to an increase in iron and weight recovery. The testwork results were then used in defining a conceptual process flowsheet for the 2011 PEA study. The main metallurgical testwork was carried out at MCM in Kryvyi Rih, Ukraine.

In addition to the testwork carried out at MCM, grindability testing and mineralogical study by QEMSCAN™ analysis were carried out at SGS Lakefield on sub-samples of the selected composite samples. After a round of preliminary testing, further laboratory tests were carried out to assess several flowsheet configurations. The results from this testwork were used to develop the preliminary process flowsheet as well as preliminary mass and water balance, forming the basis of process design for the study.

For the test work, two 300 kg composite samples were prepared from drill cores from the Twin Drilling Program. Approximately 30 kg of pieces over 25 mm from each composite sample were sent to SGS Lakefield for grindability characterization. The remainder was ground to 10 mm and used for metallurgical testing. The main results of the 2011 PEA test work can be summarized as follows:

- Mineralogical analyses of the head of the two composite samples indicated a content of 25-28% magnetite, 5-7% hematite-martite, 2-4% carbonates and 33-40% silicates. The silicates contained 20-30% of the total iron. The iron in the silicates is not recoverable either by gravity or by magnetic methods.
- Gravity separation tests using shaking tables were carried out at particle sizes of -0.8 mm and 0.5 mm. The heavy fraction (concentrate) contained about 65% iron or greater, but represented only about 10% or less of the feed by weight. This weight recovery was found to be too low for gravity separation to be viable on its own. About 70% of the feed reported to the middling, which contained about 30% Fe. The Fe content of the middling was too low to be recombined with the heavy fraction in order to produce an acceptable concentrate grade.
- Magnetic separation tests, using Davis Tube, were performed at grind sizes ranging from 80% passing 0.074 mm to 95% passing 0.044 mm. The results showed that the Shymanivske mineralised material would require a grind size of at least 95% passing 0.044 mm, which was consistent with historical results.
- Combined middling and tails fractions from the shaking table tests were subjected to further upgrading by magnetic separation. It was concluded that gravity separation provided no additional benefit.

- Magnetic separation tests were performed using an Eriez wet magnetic separator (LIMS type) to determine if an effective cobbing step could be carried out at coarser grind sizes. The results showed that an effective cobbing step with at least 95% magnetite recovery can be carried out at -0.841 mm, eliminating at least 30% feed weight.
- Grindability characterization tests were performed in the form of SAG Mill Comminution (SMC) and Bond Rod and Ball Mill Grindability Tests. The results of the tests were used to size the grinding circuit for the 2011 PEA.

13.3 2012 FS Metallurgical Testwork

A comprehensive metallurgical test program was conducted by WorleyParsons as part of the 2012 Feasibility Study. Testing involved comminution, magnetite recovery and sulphur removal characterization sufficient to provide a process flowsheet and criteria required for detailed plant design. Several samples of diamond drill core were selected from drill hole intervals located throughout the Shymanivske mineralization zone and tested at ALS AMMTEC in Perth, Australia. The testwork program consisted of the following:

- Log and sort samples to provide the following composites:
  - SAGDesign composite samples (x10), SDT01 to SDT10;
  - CWi composite samples (x30), CWi01 to CWi30;
  - BWi composite samples (x30), BWi01 to BWi30;
  - Beneficiation composite samples (x5), BC1 to BC5;
  - Three composite samples were produced for flotation testwork.
- Comminution testwork on SAGDesign, CWi and BWi composites (x70) samples:
  - Crushing Work index (CWi) determination;
  - Apparent relative density (SG) determination;
  - SMC test;
  - Abrasion Index (Ai) determination;
  - SAGDesign test;
  - Fibrous analysis;
  - Bond rod mill work index determination;
  - Bond ball mill work index determination;
  - Head assay;
  - Davis Tube Recovery (DTR) on BWi composite samples at P_{80} of 38 µm;
  - LIMS separation on BWi composite samples at P_{80} of 38 µm.

- Grind liberation and magnetic separation testwork on beneficiation composites (x5):
  - Control crush to four sizes: -5.0, -3.35, -2.0 and -1.0 mm;
  - Particle size distribution on ground samples;
  - Davis Tube Wash (DTW) on 13 ground / crushed sizes;
  - LIMS separation on beneficiation composite samples at 13 ground/crushed sizes;
  - DTR at a P_{80} of 38 µm on LIMS non-magnetics;
  - Dry LIMS separation at four crushed sizes;
  - DTR at a P_{80} of 38 µm on DMS non-magnetic;
  - Bulk magnetic separation on composites 1, 2 and 3 and reverse flotation optimization on composite 3;
  - Grind three composites to a P_{80} of 45 and 32 µm;
  - Bulk LIMS separation at 900 Gauss and a P_{80} of 45 µm;
  - Flotation optimization on composite 3;
  - Additional tests on samples generated from the testwork.

13.3.1 Sample Selection and Preparation

Based on the geological studies of the Shymanivske deposit, there are three main rock types designated as F1, F2 and F4. Historical mineralogical studies and metallurgical testwork have shown that rock types F2 and F4 have the same mineralogical structure and the same response to the beneficiation and can be counted as one geo-metallurgical unit. These rocks form about 84% of the mineralization in the Shymanivske deposit. Given this assemblage of the deposit, a total of 2,300 kg of samples from drill cores were selected from 16 drill holes (from the Twin Drilling Program) and sent to ALS AMMTEC in Perth, Australia. Sample preparation for the various composites and the metallurgical test plan are illustrated in the flowsheets shown in Figure 13-1 to Figure 13-4.

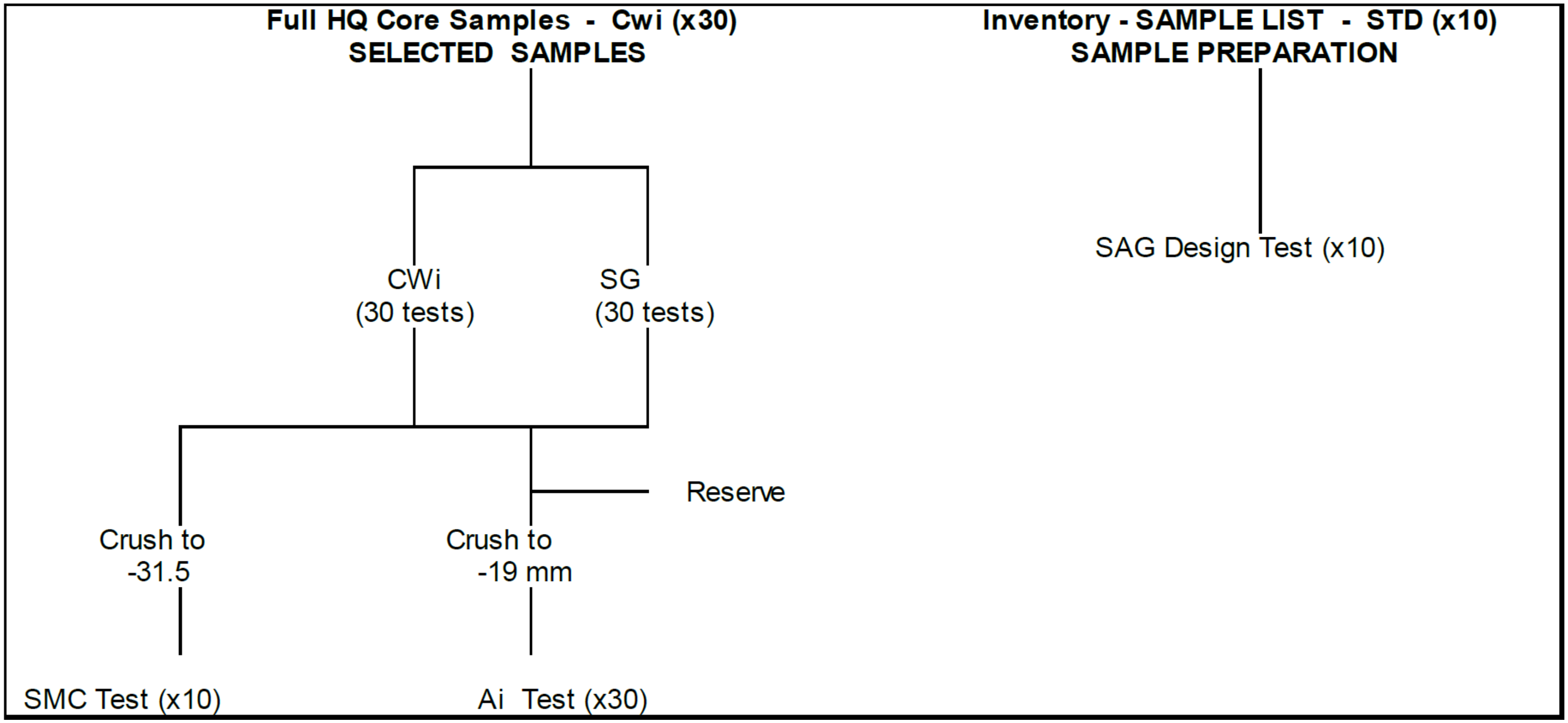


Figure 13-1: Sample Preparation for CWi, Ai and SAGDesign Tests

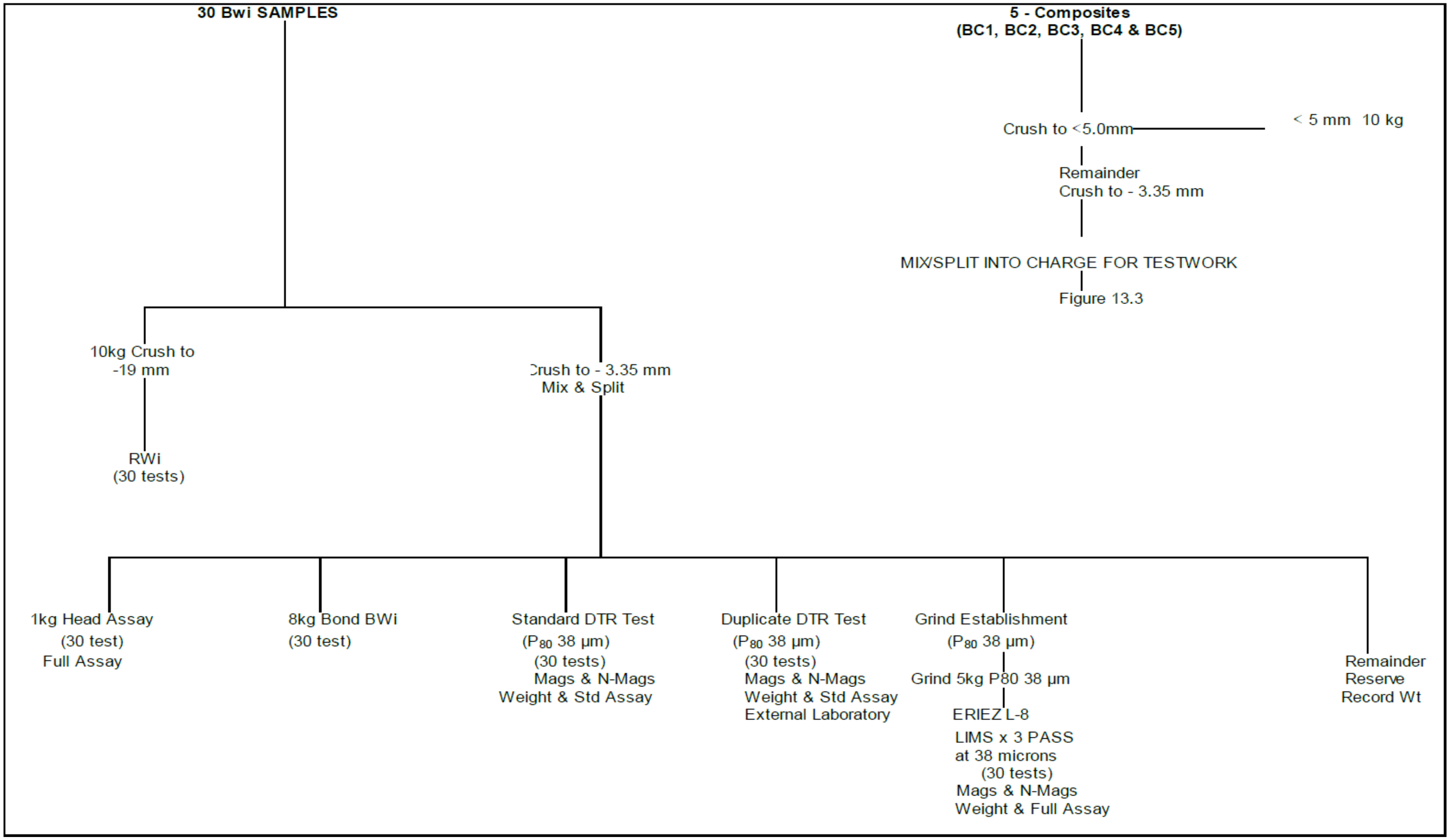


Figure 13-2: Sample Preparation and Metallurgical Test Plan for Beneficiation and Bond Grindability Tests

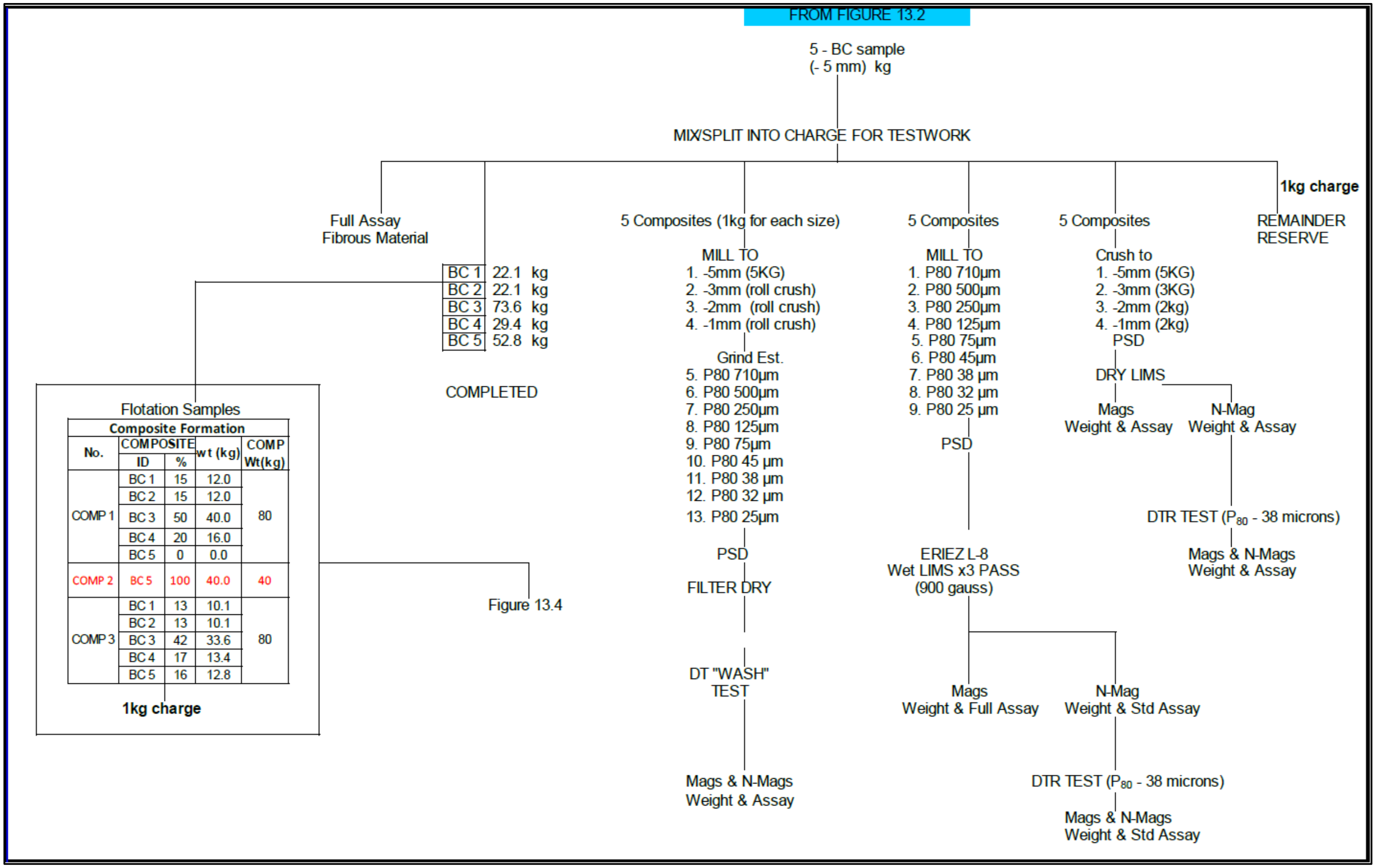


Figure 13-3: Sample Preparation and Metallurgical Test Plan for Beneficiation Tests

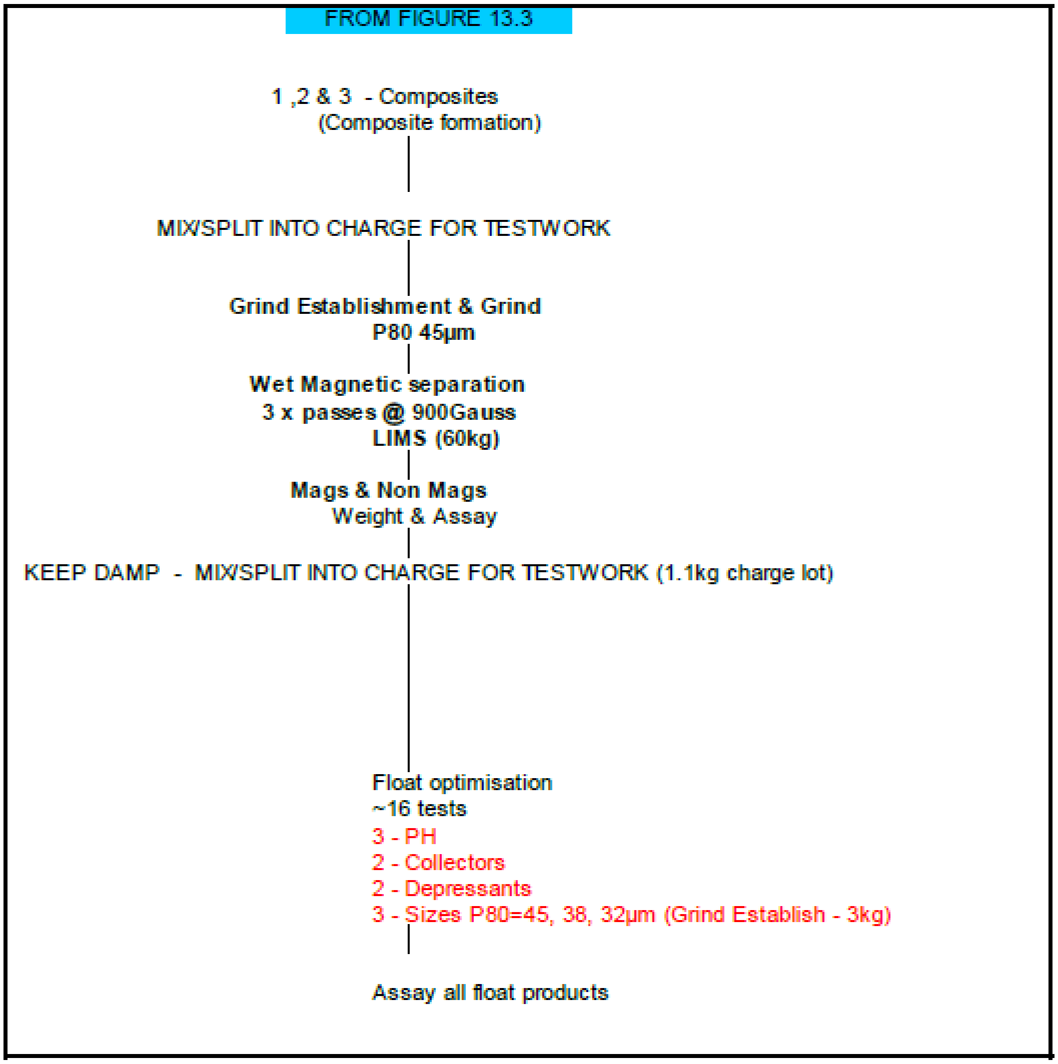


Figure 13-4: Sample Preparation and Metallurgical Test Plan for Flotation Tests

13.3.2 Head Assay Analysis

All chemical analyses were carried out at ALS analytical laboratories in Western Australia. The analysis was conducted by XRF, with the exception of magnetite, which was measured by Satmagan, and sulphur, which was measured by LECO. For the samples used in the beneficiation tests (BC1 to BC5), iron content in the head varied from 29.7% to 35.2% and sulphur content varied from 0.05% to 0.12%. The iron associated with magnetite (i.e., Fe_{mag}) calculated from the Satmagan varied from 23.0% to 35.0%.

13.3.3 Comminution Tests

13.3.3.1 Bond Ball and Rod Mill Grindability Tests

A total of 30 samples (BWi 1 to BWi 30) were submitted for grindability tests using the Bond ball and rod mill grindability tests. A summary of the results of the Bond ball mill grindability tests is shown in Table 13-1 and the results of Bond rod mill grindability tests are shown in Table 13-2.

Table 13-1: Bond Ball Mill Grindability Tests Results

	F_{80} (µm)	P_{80} (µm)	Grp (g/rev)	Bond Ball Mill Work Index (kWh/t)	Test Aperture (µm)
Average	2600	37	0.70	18.9	45
80th Percentile	2643	39	0.73	19.4	
Average	2597	111	1.37	16.02	150
80th Percentile	2611	116	1.46	16.60	
Average	2618	663	2.59	24.87	850
80th Percentile	2667	681	2.61	26.10	

Table 13-2: Bond Rod Mill Grindability Tests Results

	F_{80} (µm)	P_{80} (µm)	Grp (g/rev)	Bond Rod Mill Work Index (kWh/t)	Test Aperture (µm)
Average	9497.3	875	4.67	21.8	1180
80th Percentile	9737	897	4.91	22.8	

From the results, the average Bond ball and rod mill work index values indicate the material is in the hard category. Since there was a significant difference between the Bond ball mill grindability test results as compared to the results reported in the 2011 PEA study, four duplicate samples were submitted to the SGS lab in Australia. The SGS Bond ball mill grindability tests were conducted at a closing screen site of 150 mm. The average BWi of the four tests was 18.06 kWh/t and confirmed that the mineralization is in the hard category. Based on the results of the test work, and comparison with the experience of two adjacent operating iron mines, a Bond ball mill work index of 15.9 kWh/t was used for the 2012 FS.

13.3.3.2 Bond Crushing and Abrasion Index Tests

The crushing-work index determination was carried out on specimens selected from the full HQ core samples. A set of more than ten suitable specimens from each core was selected and the crushing index was determined with an impact crushability test unit. The twin-pendulum impact crushability test unit used at ALS Ammtec was built by Nordberg, USA, and is designed to copy the traditional Bond impact crushability test unit. The results determined that the material can be categorized as hard in the crushing process. Based on the results of the test work, the crushing work index used for the 2012 FS was 23 kWh/t.

For the abrasion index, a sub-sample of each composite in the size fraction of -19/+12.5 mm was sorted and subjected to the abrasion index test, using the standard procedure developed by F.C. Bond. Abrasion test results determined that the material is in the medium abrasive category (0.4 – 0.6). An average of 0.43 for the abrasion index is used the 2012 FS.

13.3.3.3 SMC Testwork

SMC testing was conducted on 10 CWi Composites crushed to -31.5 mm. Results indicate A*b (which is a measure of resistance to impact breakage) values ranging between 32.3 and 36.7, classifying the Shymanivske mineral in the hard category.

13.3.3.4 General Conclusion from 2012 FS Comminution Tests

The conclusion on comminution tests is that the Shymanivske material is competent and hard in both macro and micro grinding. To determine the optimum flowsheet, a trade-off study between SAG mill and HPGR was completed. This study reviewed the comminution and recovery data and compared alternative comminution flowsheets incorporating HPGR, Autogenous Grinding (AG) or Semi-Autogenous Grinding (SAG) circuits. Each of the alternatives was reviewed in terms of total energy requirements and capital and operating costs, with preliminary flowsheets developed for each. On the basis of the trade-off study, it was decided to substitute HPGR's in the 2012 FS for the SAG mills that had been selected for the 2011 PEA design.

13.3.4 Beneficiation Testing

The standard processing route for magnetite beneficiation is Low Intensity Magnetic Separation (LIMS). The Shymanivske flowsheet also includes a sulphur reduction step in the form of reverse sulphide flotation. The 2012 FS test program investigated the following:

- Magnetic separation tests by Davis Tube and wet LIMS to establish the liberation size of magnetite and determine the recovery and yield;
- Flotation tests to establish the parameters for sulphide removal and determine the recovery and yield;

- Verification of the effectiveness of the selected flowsheet in upgrading the material and establishing the overall mass balance;
- Dry Coarse cobbing to investigate early coarse gangue rejection and minimize grinding energy requirements. A sub-sample of each of the five BC Composite samples was submitted for dry magnetic separation (DMS) at 100% passing -5.0, 3.35, 2.0, and 1.0 mm, and was tested with a small pilot dry magnetic separator (Eriez 350 mm).

13.3.4.1 Dry Coarse Cobbing Tests

Coarse cobbing reduces downstream grinding costs and equipment requirements and also allows for a more consistent feed composition to the beneficiation plant and the control of mining dilution.

Test results were mixed. For all samples, with the exception of BC3 and BC4, gangue rejection was higher than 10% with a weighted average of 15.3%. The target particle size for dry cobbing is 80% passing 3.35 mm, with a 10% gangue rejection for the 2012 FS. This size was selected on the basis of benchmarking with existing operations and after discussions with vendors.

13.3.4.2 Davis Tube Testing

The Davis Tube test was used to evaluate the effect of grind size on concentrate quality, and to establish grinding requirements for the confirmatory wet LIMS testing. All composites, BC1 to BC5, were submitted to the Davis Tube test.

Each composite was crushed or crushed/ground (in the case of finer sizes) to 13 different sizes, with 100% passing 5.0, 3.0, 2.0, 1.0 mm, and 80% passing 710, 500, 250, 125, 75, 45, 38, 32 and 25 µm. Particle size analysis was performed on a split of each sample. A 20 g sub-sample of each composite was pulverized and submitted for the Davis Tube test. The variations in SiO_2 content by size are presented in Figure 13-5.

The SiO_2 content of the concentrates sharply decreased with finer grinds and at sizes of a P_{80} of 45 µm and a P_{80} of 32 µm, 5.7% and 4.1% SiO_2 were achieved respectively.

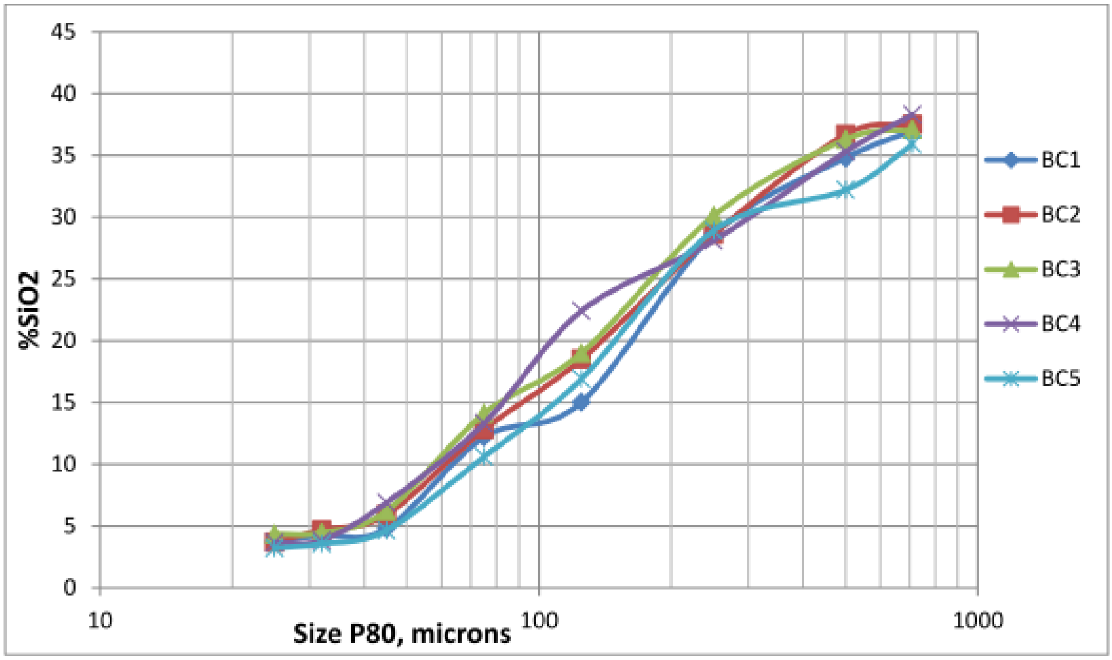


Figure 13-5: Size-by-Size SiO_2 Analyses on Davis Tube Concentrates

13.3.4.3 Wet Low Intensity Magnetic Separation Tests (LIMS)

A sub-sample of each ground BC Composite was submitted for the LIMS test, using an Eriez L8 separator set at 900 Gauss (operated concurrently) and at the following P_{80} grind sizes: 710, 500, 250, 125, 75, 45, 38, 32 and 25 µm. The variations in silica content by size are presented in Figure 13-6. Similar to the Davis Tube results, silica sharply decreased with finer grind sizes, while at a P_{80} of 45 µm and a P_{80} of 32 µm, 6.4% and 4.8% silica were achieved respectively.

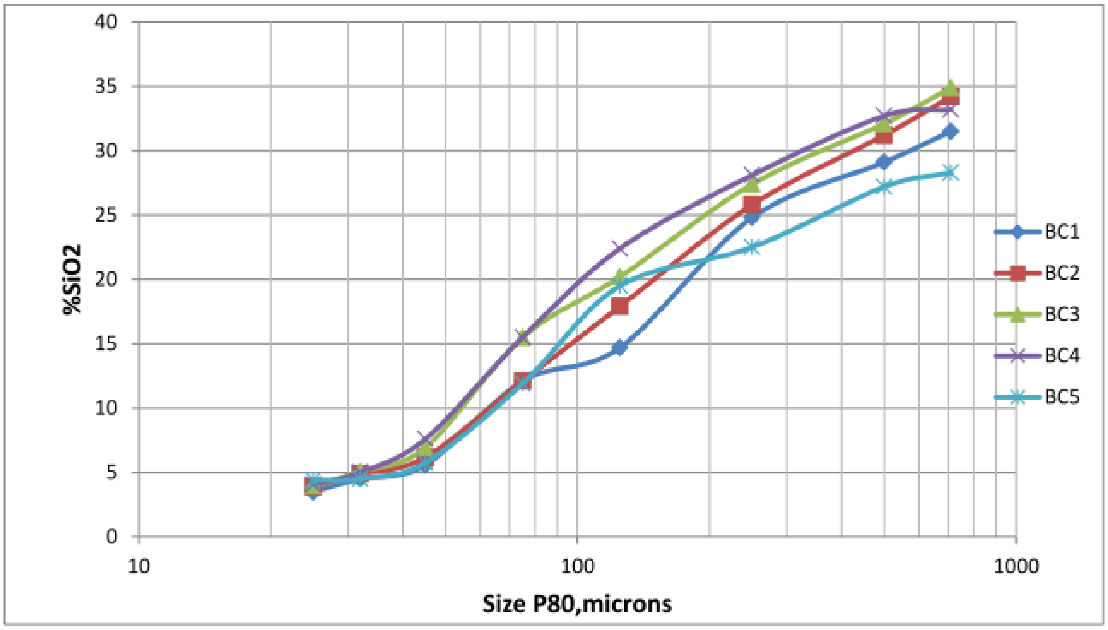


Figure 13-6: Size-by-Size SiO_2 Analyses on LIMS Concentrates

Specifications of the concentrate produced by Davis Tube and LIMS are compared in Table 13-3.

Table 13-3: Comparison between Davis Tube and LIMS Results

Passing Size (P_{80})	Yield %		Fe Grade		SiO_2 Grade	
	LIMS	DT	LIMS	DT	LIMS	DT
µm	%	%	%	%	%	%
710	57.27	69.4	44.49	40.27	32.63	37.22
500	55.25	64.31	46.09	41.94	30.62	35.20
250	48.92	52.98	50.04	47.21	25.88	28.86
125	42.20	42.34	55.95	56.03	18.91	18.43
75	38.37	37.95	60.43	61.48	13.50	12.70
45	34.22	34.32	66.42	67.48	6.43	5.74
38	33.80	33.70	67.34	68.39	5.15	4.68
32	33.54	33.03	67.82	68.86	4.81	4.18
25	32.87	32.24	68.66	69.24	3.93	3.74

On the basis of the predicted results of magnetic separation, the size of P_{80} of 32 µm was selected as the final grind size to reach the silica content of less than 4.5% in the final concentrate. However, the associated weight recovery from the 2012 FS tests cannot be used directly as the feed tested contained a higher average magnetite grade as compared to the mine plan.

13.3.4.4 Flotation Tests

Testwork determined that the sulphur content in the Shymanivske magnetite ore, after magnetic separation stages, exceeded the target of 0.05%. A mineralogical analysis suggested that sulphur in the material is primarily iron sulphides, pyrite and pyrrhotite. As pyrrhotite is ferromagnetic, it will primarily be recovered to concentrate during low intensity magnetic separation. As a result, it was decided to remove the sulphides via froth flotation, and reduce the sulphur content to the target value of 0.05% in the final concentrate.

Reverse sulphide flotation testwork was completed on a master composite (composite No. 3) at different particle sizes. This sample had been upgraded by LIMS at a P_{80} of 45 µm prior to the flotation tests.

In addition to sulphide flotation, some of the tests were designed and carried out on both sulphide and silica flotation in order to understand the efficiency of flotation on the reduction of silica content in the final concentrate. In total, 16 flotation tests were completed. Each test was carried out on a 1,000 g sample in a laboratory Agitair LA500 flotation machine (2.2-litre cell), where local tap water of Perth, Australia, was added to achieve a pulp density of approximately 30% solids by weight. Flotation test results indicated that it was possible to reduce the sulphur content under some circumstances while maintaining a weight and iron recovery in the 98% range. Confirmatory flotation tests were recommended before proceeding with the final EPCM sizing.

13.4 2013 Feasibility Study Testwork

An additional test program was undertaken during the 2014 FS. Soutex Inc. was mandated to organize and supervise this test program. The original objectives of this testwork were to confirm the feasibility study process flowsheet and modify where appropriate. More precisely:

- Validate the equipment selection;
- Determine the equipment sizing;
- Quantify the magnetic recovery at each concentration step;
- Quantify the energy consumption at each grinding step.

This section describes the material characterisation, lab scale and pilot scale tests and data analysis performed during the 2013 testing program.

13.4.1 Sample Selection

For the 2013 testwork, no new drilling or bulk sampling program was undertaken because of anticipated delays related to sampling permit issues. It was decided to use the available drill cores of a previous exploration phase to obtain sufficient material for comminution and beneficiation pilot testwork.

Drill cores were used for the grinding energy validation and beneficiation testwork. They had not been previously crushed or ground. This testwork was performed in order to quantify the grinding energy and circulating loads for the grinding circuits, and also to define the magnetic separation behavior of the material. A total of 9,735 kg of drill core material was sent to SGA laboratory in Germany for testing.

13.4.2 Sample Preparation

The drill core samples were prepared as follows:

- Pre-crushing to -31.5 mm and homogenization of the material;
- Split-out portions for head assay, size analysis, Bond Ball Work Index determination, HPGR crushing for Dry and Wet cobbing, mineralogical characterization, DTR and DTW;
- Shipping of the material to HPGR vendors for HPGR testing and HPGR grinding to -3 mm:
  - 2.22 tonnes were sent to KHD;
  - 4.7 tonnes were sent to Köppern.
- Preparation of the material to -3 mm at the HPGR testing facilities.

After the material was ground in HPGRs, it was shipped back to SGA to perform grinding and beneficiation testing. Approximately 5.5 tons of material was received following HPGR processing at Köppern and KHD facilities. This material was prepared as follows:

- Reception and homogenization of the HPGR ground material;
- Split-out portions for head assay and Bond Ball Mill Work Index determination;
- Piloting of cobbing;
- Homogenization and split-out portions of cobbing concentrate for assaying and Bond Ball Mill Work Index;
- Shipping of Cobber Concentrate sample for stirred media mill tests;
- Piloting of primary grinding and magnetic separation;
- Homogenization and split-out portions of the primary grinding concentrate for assaying and fine grinding tests;
- Shipping of primary grinding product samples for fine grinding testwork (stirred media mill tests);

- Piloting of secondary grinding and magnetic separation;
- Shipping of concentrate samples for dewatering testwork. Figure 13-7 recalls the testwork steps performed with HQ cores.

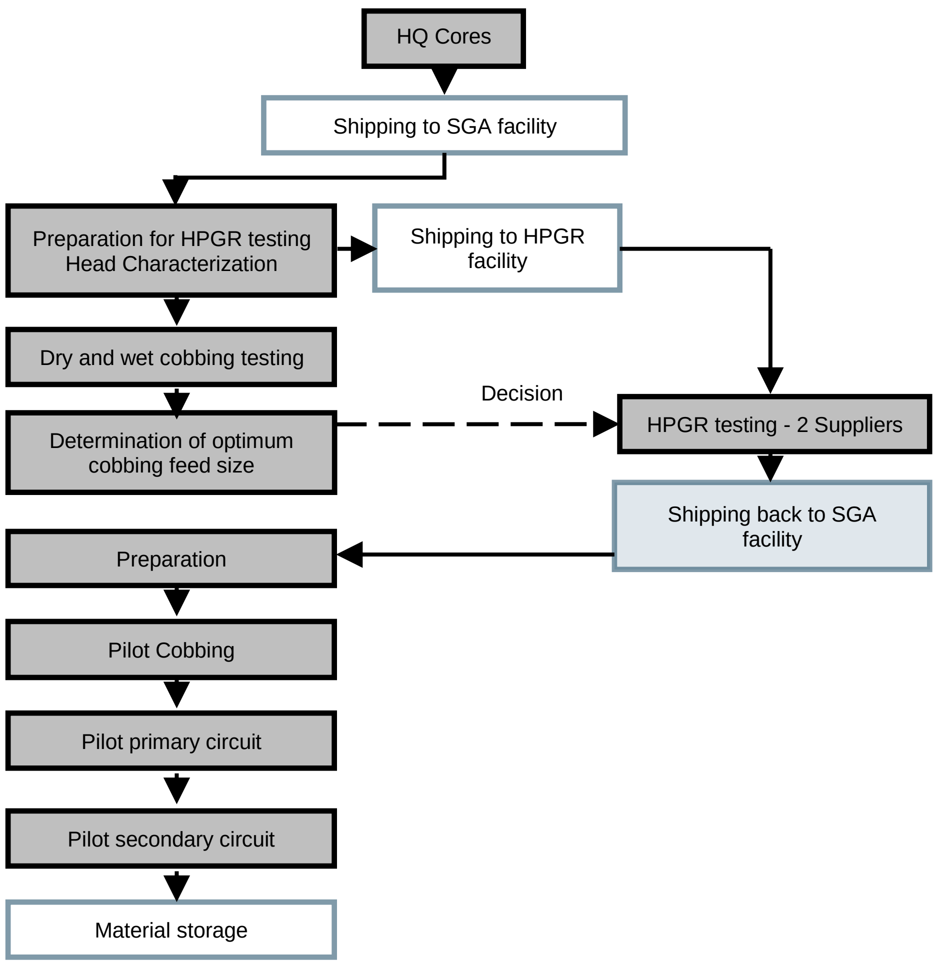


Figure 13-7: Testwork Steps

13.4.3 Head Assay Analysis

The head sample was characterized for chemistry to establish the sample's representativeness with regards to the historical testwork data and the Mine Plan. In addition to SGA, laboratories that performed chemical assays in the previous phases were mandated to repeat the same methodology using the drill cores head sample for comparison purposes. COREM was used for additional mineralogical characterization/assays for this phase only. The main results of the head assay analyses are presented in Table 13-4.

Table 13-4: Head Assay Analyses Summary

Laboratory	ID	Fe_{tot} (%)	Fe_{mag} (%)	SiO_2 (%)	AL_2O_3 (%)	P (%)	S (%)	Magnetite (%)	LOI (%)
SGA	Head	33.2	22.0	45.1	2.05	0.086	0.14	30.4	1.51
	Cobber Feed 1	32.7	22.2	45.9	1.92	n/a	n/a	30.7	n/a
	Cobber Feed 2	32.9	22.9	46.3	1.84	n/a	n/a	31.7	n/a
MCM	Head, 1	33.9	21.2	45.9	n/a	0.095	0.16	29.3	n/a
	Head, 2	33.4	21.2	44.74	n/a	0.091	0.14	29.3	n/a
	Head, 3	33.1	21.0	45.0	n/a	0.100	0.14	29.0	n/a
	Head, 4	33.2	20.4	45.18	n/a	0.088	0.14	28.2	n/a
	Head, 5	32.8	20.6	45.34	n/a	0.093	0.14	28.5	n/a
SGS Canada	Head	32.1	20.8	47.2	1.8	0.087	0.14	28.8	0.13
ALS Ammtec	Head	33.2	24.0	45.2	1.91	0.09	0.13	33.1	0.06
COREM	Head	32.7	21.7	46.6	2	0.08	0.17	30.0	n/a

13.4.4 Comminution Tests

The bench scale Bond Ball Mill Work Index from 2012 FS testing is a good indication of the grinding energy needs, but does not reflect the impact on hardness changes through the various stages of the process: HPGR, cobbing, LIMS in the grinding loop, etc. For this reason, the 2014 FS test work covered, in more detail, the complete comminution flowsheet, stage by stage, including both laboratory scale and pilot scale primary and secondary grinding, as well as pilot scale HPGR tests.

13.4.4.1 HPGR Testing

Two technology vendors performed HPGR grinding tests on pre-crushed drill cores provided by SGA: Köppern and KHD, both located in Germany and both submitted a report outlining their findings. The testwork objectives were to validate the advantages of HPGR, obtain an adequate equipment sizing and develop the most efficient flowsheet possible. The following elements were determined:

- A wear test was conducted to evaluate the wear rate of the roll surface;
- Ball mill grindability tests were completed to characterize the influence on the grinding energy demand of material pre-treated with HPGR;
- Flake characterization.

The test work consisted of single pass and locked cycle HPGR grinding tests. KHD performed a total of 16 tests and Köppern performed a total of 20 tests. The following observations were made from the test results:

- Regarding specific roll pressure:
  - KHD tested a specific roll pressure range from 2.3 to 4.9 N/mm^2 while Köppern tested a range from 2.6 to 4.7 N/mm^2;
  - KHS found that specific throughput reduced with pressure increase while Köppern found that it remained nearly constant with specific pressure variations;
  - KHD found that specific energy showed a linear relationship with pressure whereas Köppern found that specific energy increased almost linearly with increasing pressure;
  - Both found that product fineness improved with increasing specific pressure.
- Regarding roll speed:
  - KHD tested roll speeds between 0.32 and 1.01 m/s while Köppern tested only a constant roll speed of 0.56 m/s;
  - KHD found that:
    - Specific throughput decreased as roll speed increased;
    - Specific energy decreased as roll speed increased;
    - Product fineness did not appear to be affected.
- Regarding moisture:
  - Both tested similar ranges of moisture (from 1.0 % to 3.5%);
  - Specific throughput, energy and product fineness were compared and, although there seemed to be differences between KHD and Köppern, these did not seem to be significant or conclusive.
- Regarding full feed versus truncated feed, no significant difference was observed although Köppern seemed to show a slightly coarser product for truncated feed;
- Regarding roll surface wear rate:
  - KHD observed that the crushed mineralized material filled the stud on the roll's surface providing a strong autogenous wear layer. The internal wear rate index gave a result of 0.0176 g/min;
  - Köppern stated that wear results are specific to the lab test only and these are not to be expected from an industrial size operation. The wear rates observed are in the order of 9.7 µm per 1000 revolutions.
- Regarding ball mill energy demand:
  - KHD test results show an average decrease of 10% in the Ball Mill Work Index for the HPGR product;
  - Köppern test results show a ball mill energy demand decrease of 11% for 500 µm particles and a decrease of 8.5% for 100 µm particles;
  - Both vendors agree that HPGR product decreases energy requirements for subsequent ball milling.

13.4.4.2 Primary Grinding

Bond Ball mill Work Index Determination

During the 2013 testing, lab scale Bond Work Index (BWi) tests were carried out in order to estimate the grinding energy prior to piloting and in order to validate the BWi measured at SGA in comparison to measurements made at other facilities. Standard BWi evaluations carried out at SGA are presented in Table 13-5.

Table 13-5: SGA's Standard Bond Work Index Tests Results

Sample	BWi (kWh/t)
Head (crushed ore)	14.2
Cobber Feed	12.8
Cobber Concentrate	11.7

The difference between the crushed mineralized material (HPGR feed) and the cobber feed is a result of the loss of material competency created by the HPGR. It is believed that the loss of competency occurs because micro-cracks are induced in the material due to the high pressure applied by the HPGR. The difference between the cobber feed and concentrate was also expected because of the quartz removal in the cobber low intensity magnetic separators (LIMS). Quartz is considered harder than magnetite at that size.

Due to the fact that the hardness measured at SGA was lower than the 2012 FS value of 15.9 kWh/t, it was decided to validate the sample hardness at the testing facilities used in the previous phases. This additional testing led to the results presented in Table 13-6.

Table 13-6: Standard Bond Work Index Tests Results

Laboratory	Sample	BWi (kWh/t)
ALS Ammtec	Head	16.2
	Head	16.1
SGS Australia	Head	15.6
	Head	15.4
Metso	Cobber Concentrate	12.94
	Cobber Concentrate	13.35

The average of the four tests performed on the head sample (15.82 kWh/t) is very close to the 2012 FS value of 15.9 kWh/t, which was the average measured hardness at ALS Ammtec. Following this verification, it was determined that the tested material's grinding characteristics were in line with what is considered the average for the deposit.

Pilot Scale Testing

Three pilot plant test runs were performed for the primary grinding circuit, using cobber concentrate. The basic equipment set-up was identical for all three tests: Screen overflow from a Derrick screen was fed to a ball mill. The ball mill discharge was processed via wet rougher LIMS (1-stage Eriez type, 1000 Gauss); the magnetic concentrate was recirculated to the Derrick screen. The Derrick screen underflow was the final product of the primary grinding circuit, to be fed to the secondary grinding circuit. The primary grinding pilot flowsheet is presented in Figure 13-8.

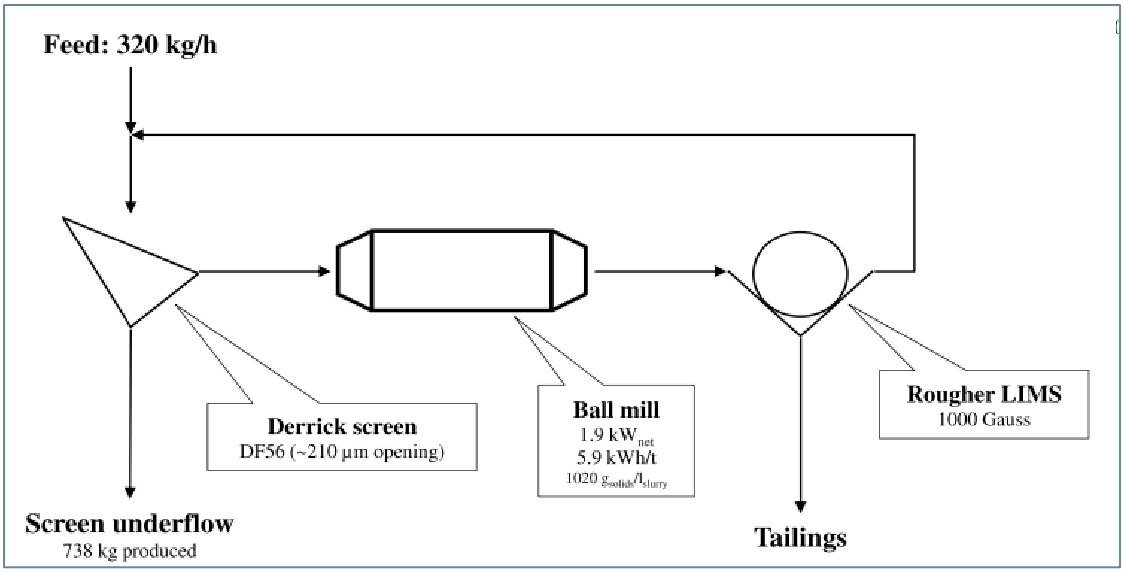


Figure 13-8: Primary Grinding Pilot Flowsheet

In order to estimate the grinding energy of an industrial scale ball mill, a scale-up from the SGA pilot scale ball mill is made. SGA demonstrated that the net grinding energy (BWo) provided by their mill was 1.9 kW [SGA, 2013-09].

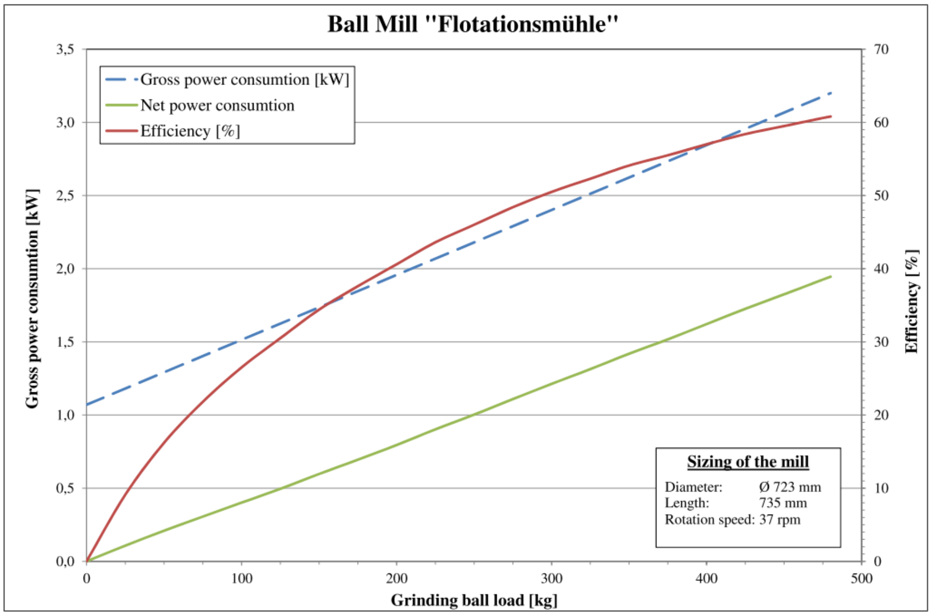


Figure 13-9: Net and Gross Energy from the Pilot Mill

From this energy, the feed flowrate, the F_{80} and the P_{80}, it is possible to evaluate an equivalent work index for the grinding loop including the LIMS.

The following methodology was used:

1. Compute the BWo of the grinding loop for each test run;
2. Back calculate the equivalent BWi for the grinding loop that includes a LIMS;
3. Use the obtained BWi to scale a Ball Mill with any desired feed rate, P_{80} and F_{80}.

Table 13-7 shows the results from the three primary grinding test runs. All tests were conducted with a DF 56 Derrick screen.

Table 13-7: Primary Grinding Results

Parameter	Value			
	Run 1	Run 2	Run 3	units
Feed rate	320	415	415	kg/h
F80	1 703	1 703	2 506	µm
P80	138	160	170	µm
Circulating load	53	62	64	%
Net unitary power (BWo)	5.94	4.58	4.58	kWh/t
Equivalent BMWi	9.75	8.35	8.07	kWh/t
Concentrate produced	738	965	518	kg

*Circulating load is defined as the recycled LIMS concentrate over the fresh feed ratio

13.4.4.3 Secondary Grinding

Tower Mills Grinding Results

Concentrates from the first two runs of primary grinding piloting at SGA were shipped to Metso to perform a lab scale test to assess the grinding energy required to grind the magnetite pre-concentrate down to P_{80} = 32 µm. Table 13-8 shows the results from Metso Jar Mill tests.

Table 13-8: Metso's Jar Mill Grinding Results [Metso 2013-08]

Test	Sample ID	F_{80} (µm)	P_{80} (µm)	Specific Energy (kWh/mt)
Jar Mill 1	Sample A	140.4	32	8.10
Jar Mill 2	Sample A	139.6	32	7.96
Jar Mill 3	Sample B	160.7	32	8.74
Jar Mill 4	Sample B	161.3	32	8.70

The specific energy values corresponding to the BMWo and the Bond equation cannot be used for tower mills. The sizing relies on Metso's proposed design.

Secondary Grinding Pilot

For the first and second secondary grinding pilot plant runs, the upper half of the process was similar to the primary grinding circuit set-up. The feed was charged to a Derrick screen with DF280 panels (opening of ~37 µm), the oversize was fed to the ball mill, the mill discharge was fed to a cleaner LIMS (2-stage SALA-type, 600 Gauss) and the magnetic concentrate was recirculated to the Derrick screen. The screen underflow was sent to finisher magnetic separation (2-stage Thune-type, 500 Gauss). The concentrate was then processed through flotation cells in order to reduce the sulphur content. As sulphur bearing minerals (pyrite and pyrrhotite) were expected to still be present, flotation with a new recipe was tested.

For the second run, the Derrick screen panel was replaced with a DF325 (opening of ~33 µm) in order to achieve the final liberation target.

For the third run, the flowsheet was modified in order to evaluate the impact of having a LIMS in the circulating loop. The LIMS was removed, and the feed rate reduced to account for the increased circulating load. Because the material was crushed and ground in stages, with extended periods of time between the stages, the oxidation of the pyrrhotite led to poor pilot flotation results. The flotation step was then skipped in the third run.

The three secondary grinding runs were conducted on the combined products of the primary grinding runs. The secondary grinding pilot flowsheet is presented in Figure 13-10 (Runs 1 and 2). Run 3 did not include a LIMS in the grinding loop nor flotation. This was done in order to evaluate the impact of the LIMS on the grinding energy. Table 13-9 shows the results from the three secondary grinding test runs.

Run 1 had a completely different recirculating load and finer tailings P_{80} and a finer ball mill discharge P_{80}. This test was therefore not taken into account in the results analysis.

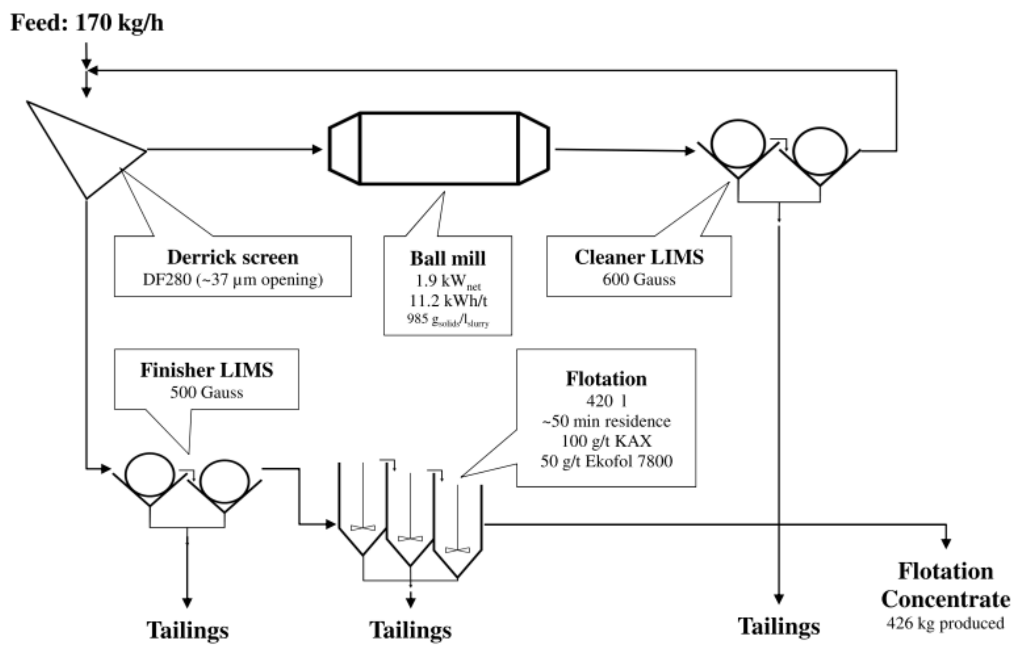


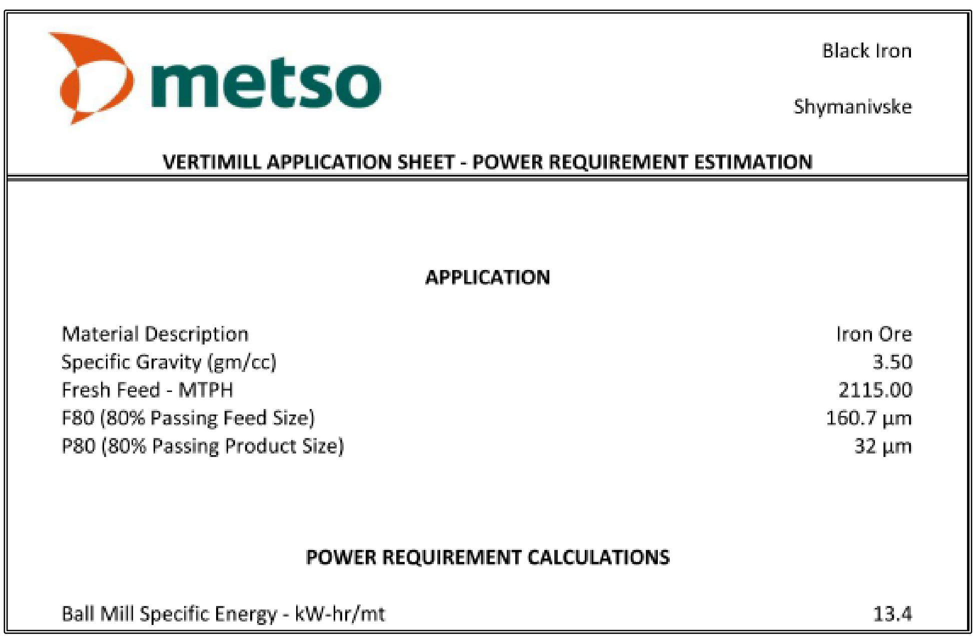
Figure 13-10: Secondary Grinding Pilot Flowsheet

Table 13-9: Secondary Grinding Results

Parameter	Value			
	Run 1	Run 2	Run 3	units
Feed rate	170	147	110	kg/h
F80	150	158	158	µm
P80	38	29	23	µm
Circulating load	85	176	282	%
Net unitary power (BWo)	11.18	12.90	17.27	kWh/t
Equivalent BMWi	13.85	12.16	13.40	kWh/t
Total Feed	850	589	732	kg

Validation of SGA's measurements by Metso's ball mill sizing tests allowed the error margin to be reduced. Jar Mill tests run by Metso indicate a specific energy (BMWo) of 13.4 kWh/t starting with a F_{80} of 160 µm, as shown in Figure 13-11.

Using the estimated BMWi of Run 3 (similar flowsheet to Metso's tests, without LIMS), a specific energy of 13.1 kWh/t is calculated for the equivalent F_{80} and P_{80}. The fact that the two measurements are very close increases the confidence in the power estimations based on SGA's tests. The safety margin on SGA's power estimation could therefore be reduced.



metso

Black Iron

Shymanivske

VERTIMILL APPLICATION SHEET - POWER REQUIREMENT ESTIMATION

APPLICATION

Material Description	Iron Ore
Specific Gravity (gm/cc)	3.50
Fresh Feed - MTPH	2115.00
F80 (80% Passing Feed Size)	160.7 µm
P80 (80% Passing Product Size)	32 µm

POWER REQUIREMENT CALCULATIONS

Ball Mill Specific Energy - kW-hr/mt	13.4

Figure 13-11: Metso's Ball Mill Sizing Report

13.4.4.4 Grinding Energy Requirement Determination

The following sections detail the methodology for estimating the specific energy at the primary and the secondary grinding stages.

Primary Grinding

Figure 13-12 shows the estimated grinding energy for Runs 2 and 3 of the secondary grinding pilot. It is observed that the equivalent ball mill work index is higher for finer grinds. For the ball mill sizing, a logarithmic fit (black line) was conducted in order to predict the hardness at different P_{80}.

In Figure 13-12, the blue line shows the equivalent BMWi in the case where LIMS are included in the circulating loop. In comparison, the red line shows the tendency when no LIMS is included in the regrind loop (computed from Run 3 of the secondary grinding as well as Bond tests on the Cobber concentrate). The addition of a LIMS in the loop decreases the grinding energy needed by about 10% for secondary grinding.

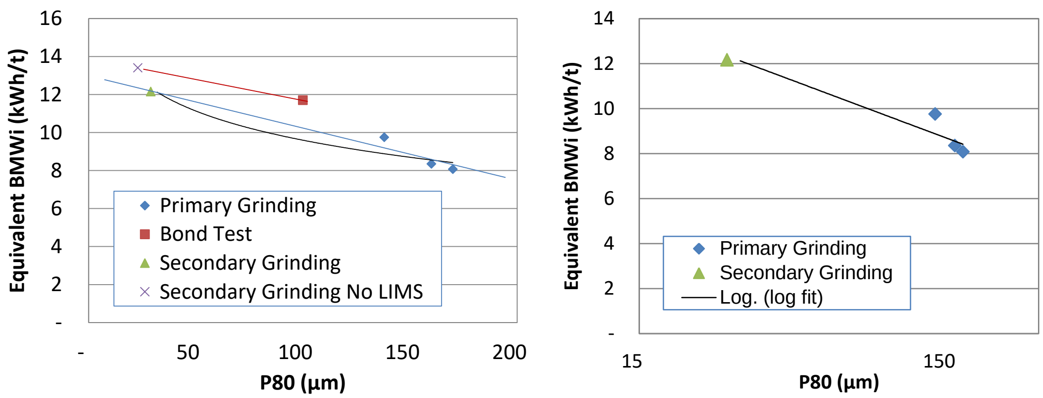


Figure 13-12: Equivalent Ball Mill Work Indices at Various P_{80} (Normal and Log Scale)

Secondary Grinding

For secondary grinding, the Bond equation is not used. Specific energy is directly used from the Jar Mill test results. Depending on the F_{80}, a different specific energy was used, as shown in Figure 13-13. Considering the fact that the Jar Mill tests were not performed in closed loop with a LIMS, it is assumed that the necessary grinding energy will be reduced by the same factor as what was observed during the ball mill pilot test (10% less energy illustrated in Figure 13-12).

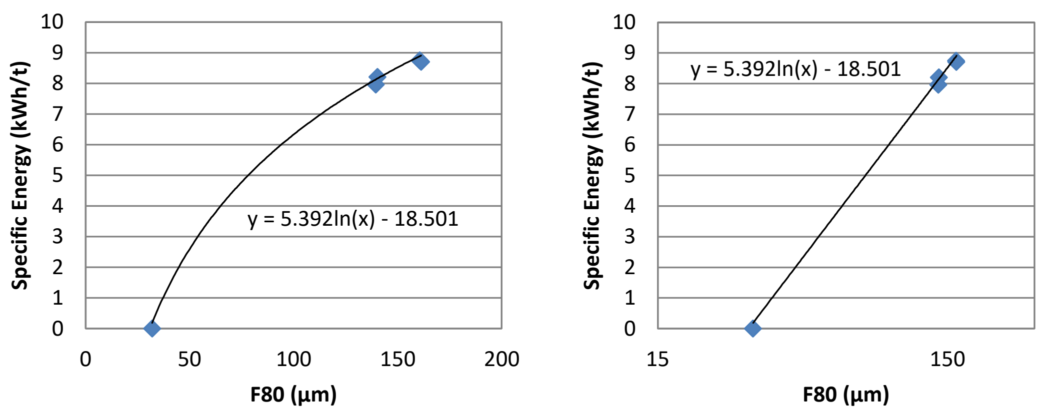


Figure 13-13: Specific Energy at Various F_{80} (Normal and log Scale)

13.4.5 Beneficiation Tests

The low intensity magnetic separation behaviour of the material was characterized during the 2014 FS program at various grind sizes, both at laboratory and pilot scales. From these results, a mass recovery model was developed and is also presented.

13.4.5.1 Davis Tube Testing

Representative samples from the Drill Cores head sample generated at SGA were sent for magnetic separation characterization at SGS Canada and ALS Ammtec, who had performed the Davis Tube testing during the 2012 FS. SGS Canada's results are shown in Figure 13-14. ALS performed a Davis Tube Recovery test with the sample pulverized and screened at 63 µm (Table 13-10), and a Davis Tube Wash test with a sample at P_{80}=32 µm (Table 13-11). Every test performed confirms that the target grinding size P_{80} of 32 µm is appropriate to obtain a silica content of 4.5% in the concentrate and that the material tested has the same liberation characteristics observed as in the previous phases.

Feed Sample:	19.6	grams
Preparation:	Pulverized	
K_{95}:	49	Microns (Head)
Amp setting:	1.5	Amps
Stroke Rate:	100	Stroke/min
Water Rate:	1	L/min

Stream	Weight		Assays, %																
	g	%	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	MnO	Cr_2O_3	V_2O_5	LOI	Sum	Fe	Sat	S
DT Conc	6.09	31.1	5.36	0.39	96.9	0.36	0.18	0.05	0.04	0.04	0.05	0.03	0.03	< 0.01	-2.75	100.7	67.8	89.1	0.19
DT Tails	13.5	68.9	66.3	2.49	22.6	4.56	1.81	0.18	0.25	0.05	0.26	0.14	< 0.01	< 0.01	1.72	100.4	15.8	0.90	0.14
Calc. Head	19.6	100.0	47.3	1.84	45.7	3.25	1.30	0.14	0.18	0.05	0.19	0.11	-	-	-	-	32.0	28.4	0.16
Direct Head	-	-	47.2	1.80	45.9	3.35	1.31	0.14	0.25	0.06	0.20	0.10	0.02	< 0.01	0.13	100.4	32.1	28.8	0.14

Figure 13-14: DTR Results at SGS

Table 13-10: DTR Results at ALS Ammtec

DTR @3000 GAUSS	PRODUCT WEIGHT (g)	Wt. DISTn. (%)	Fe Grade (%)	Fe DISTn. (%)	SiO_2 Grade (%)	SiO_2 DISTn. (%)	Mag Sus Grade (%)	Mag Sus DISTn. (%)
DT MAGS	6.5	32.4	68.1	67.8	4.73	3.3	76.0	N/A
DT N-MAGS	13.5	67.6	15.5	32.2	65.50	96.7	N/A	N/A
Calc' Head	20.0	100.0	32.5	100.0	45.8	100.0	N/A	N/A
ASSAY HEAD			33.2		45.2		33.1	

Table 13-11: DTW Results at ALS Ammtec

DTW @3000 GAUSS	PRODUCT WEIGHT (g)	Wt. DISTn. (%)	Fe Grade (%)	Fe DISTn. (%)	SiO_2 Grade (%)	SiO_2 DISTn. (%)	Mag Sus Grade (%)	Mag Sus DISTn. (%)
DT MAGS	6.4	31.9	68.6	67.4	4.09	2.8	83.1	N/A
DT N-MAGS	13.6	68.1	15.5	32.6	66.30	97.2	N/A	N/A
Calc' Head	20.0	100.0	32.5	100.0	46.4	100.0	N/A	N/A
ASSAY HEAD			33.2		45.2		33.1	

13.4.5.2 Cobbing Tests

Preliminary cobbing tests

Dry cobbing and wet cobbing were tested for comparison. About 400 kg of raw mineralized material was crushed and then processed in the HPGR. The material was ground to four different sizes with a P_{80} of 3.9 mm, 2.8 mm, 2.1 mm and 1.3 mm. Each grind size was then processed through pilot scale wet and dry cobbing units. Table 13-12 recalls the separation results at different grind sizes for the dry and wet cobbing.

Table 13-12: Preliminary Cobbing Tests

	Analysis								Recoveries		
Size (P80, mm)	Sat	Fe tot.	SiO_2	Al_2O_3	CaO	MgO	Na_2O	K_2O	WR	Fe Rec	Mag Rec
	%	%	%	%	%	%	%	%	%	%	%
head	30.40	33.20	45.10	2.05	1.22	3.35	0.11	0.27	n/a	n/a	n/a
Dry Cobbing Concentrate											
3.9	50.20	43.40	34.30	1.02	1.07	2.25	0.08	0.13	48.3	63.6	78.8
2.8	51.70	45.30	31.90	1.12	1.04	2.25	0.08	0.14	47.9	65.3	81.4
2.1	52.90	45.80	30.95	1.17	0.99	2.23	0.09	0.15	49.4	68	85.6
1.3	53.10	45.70	31.20	1.12	1.00	2.20	0.08	0.13	50.9	70.3	89
Wet Cobbing Concentrate											
3.9	41.60	38.60	40.30	1.31	0.99	2.64	0.11	0.17	63.9	74.5	87.4
2.8	42.10	38.90	39.60	1.28	1.06	2.62	0.08	0.16	68.9	80.9	94.7
2.1	43.40	39.80	38.70	1.33	1.02	2.60	0.11	0.16	68.5	82.3	97.1
1.3	45.20	41.20	36.50	1.25	1.12	2.53	0.08	0.15	65.7	81.5	97.4

Based on recovery and tails rejection, wet cobbing was selected as the path forward that would allow the downstream grinding circuit size to be reduced as well as the energy demand for processing. This is a significant change from the 2012 FS in which dry cobbing with 10% weight rejection was used.

Pilot scale cobbing

The pilot scale wet cobbing test was performed using a Krupp type LIMS (1000 Gauss). The feed rate was at 1000 kg/h. Two cobbing runs were performed on -3 mm material ground in HPGRs. Different HPGR processed material shipments were received. They were not homogenized to provide some variability and validate the response of the proposed cobbing flowsheet to it. The reconciled results are presented in Table 13-13.

Table 13-13: Reconciled Pilot Scale Cobbing Results

Stream	Fe (%)	Mag (%)	SiO_2 (%)	Weight Rec (%)	Fe Rec. (%)	Mag Rec. (%)	SiO_2 Rec. (%)	P_{80} (μm)
Cobbing, First Run								
Fresh Feed	32.7	30.6	45.9	100.0	100.0	100.0	100.0	1 581
Cobber Tails	17.6	2.6	63.1	36.5	19.6	3.1	50.2	1 272
Cobber Con	41.4	46.7	36.0	63.5	80.4	96.9	49.8	1 803
Cobbing, Second Run								
Fresh Feed	32.9	31.5	46.1	100.0	100.0	100.0	100.0	2 338
Cobber Tails	17.4	2.6	64.4	34.6	18.3	2.9	48.3	983
Cobber Con	41.2	46.8	36.4	65.4	81.7	97.1	51.7	2 582

13.4.5.3 Primary Grinding and Magnetic Separation Pilot

The obtained reconciled metallurgical balances for each of the three test runs are presented in Table 13-14.

Table 13-14: Reconciled Primary Grinding Pilot Results

Stream	Fe (%)	Mag (%)	SiO_2 (%)	Weight Rec (%)	Fe Rec. (%)	Mag Rec. (%)	SiO_2 Rec. (%)	P_{80} (µm)
Primary Grinding 1st run								
Fresh Feed	40.5	45.5	37.4	100.0	100.0	100.0	100.0	-
Derrick Screen Undersize	52.6	66.6	22.5	67.7	87.9	99.1	40.7	138
Magnetic Separation Tailings	15.2	1.3	68.6	32.3	12.1	0.92	59.3	93
Primary Grinding 2nd run								
Fresh Feed (cobber Con)	41.6	45.4	37.1	100.0	100.0	100.0	100.0	-
Derrick Screen Undersize	51.4	65.9	22.8	68.4	84.5	99.2	42.1	160
Magnetic Separation Tailings	20.4	1.1	67.9	31.6	15.5	0.77	57.9	130
Primary Grinding 3rd run								
Fresh Feed (cobber Con)	40.7	45.8	37.1	100.0	100.0	100.0	100.0	-
Derrick Screen Undersize	52.0	65.8	23.7	69.1	88.2	99.3	44.0	170
Magnetic Separation Tailings	15.5	1.1	67.1	30.9	11.8	0.7	56.0	118

13.4.5.4 Secondary Grinding and Magnetic Separation

The obtained reconciled metallurgical balances for each of the three test runs are presented in Table 13-15.

Table 13-15: Reconciled Secondary Grinding Pilot Results

Stream	Fe (%)	Mag (%)	SiO_2 (%)	Weight Rec (%)	Fe Rec. (%)	Mag Rec. (%)	SiO_2 Rec. (%)	P_{80} (µm)
Secondary Grinding 1st run								
Fresh Feed	52.9	65.6	22.3	100.0	100.0	100.0	100.0	
Derrick Screen Undersize	65.5	86.8	7.2	75.0	92.9	99.2	24.1	38
Mag Scavenger Tails	15.1	2.1	67.7	25.0	7.1	0.8	75.9	39
Mag Finisher Con	67.4	90.1	5.2	71.9	91.6	98.8	16.8	38
Mag Finisher Tails	21.1	8.3	53.2	3.1	1.2	0.4	7.3	34
Secondary Grinding 2nd run								
Fresh Feed	52.7	66.2	22.6	100.0	100.0	100.0	100.0	
Derrick Screen Undersize	67.4	91.9	4.9	70.8	90.5	98.3	15.4	29
Mag Scavenger Tails	17.1	3.9	65.5	29.2	9.5	1.7	84.6	77
Mag Finisher Con	68.8	94.4	3.5	68.7	89.7	98.0	10.5	31
Mag Finisher Tails	21.7	8.8	52.2	2.1	0.9	0.3	4.8	
Secondary Grinding 3rd run								
Fresh Feed	52.7	66.5	22.7	100.0	100.0	100.0	100.0	
Derrick Screen Undersize	52.7	66.5	22.7	100.0	100.0	100.0	100.0	23
Mag Finisher Con	69.4	94.3	3.0	69.3	91.2	98.2	9.3	28
Mag Finisher Tails	15.1	3.8	66.9	30.7	8.8	1.8	90.7	21

13.4.5.5 Mass Recovery Model

Magnetic Iron Liberation

The beneficiation testwork performed by ALS Ammtec during the 2012 FS study provided grade and recovery values for total iron in magnetic separation concentrates at various grind sizes, based on five composite samples tested. The magnetic iron grades were not quantified. For the purposes of the 2014 FS study, magnetite grades for the ALS samples were estimated based on a relationship between total iron and magnetite grade developed from the results at SGA. Figure 13-15 presents the total iron grades in the magnetic concentrates for the tests performed at ALS Ammtec and SGA.

A relation between magnetic iron (Mag Fe) grade and P_{80} was developed and used to evaluate the magnetite (mag) grade of the pre-concentrates at each grinding stage. The final concentrate mag grade was calculated based on a correlation between the silica grade and the mag grades in the different concentrates generated at SGA (see Figure 13-17).

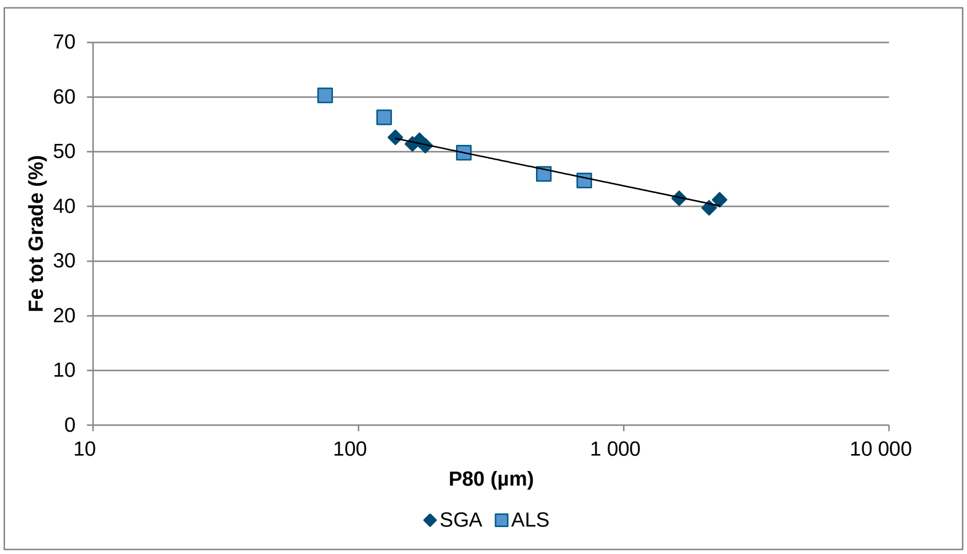


Figure 13-15: Total Iron Grade in Mag Pre-Concentrate Versus P_{80}

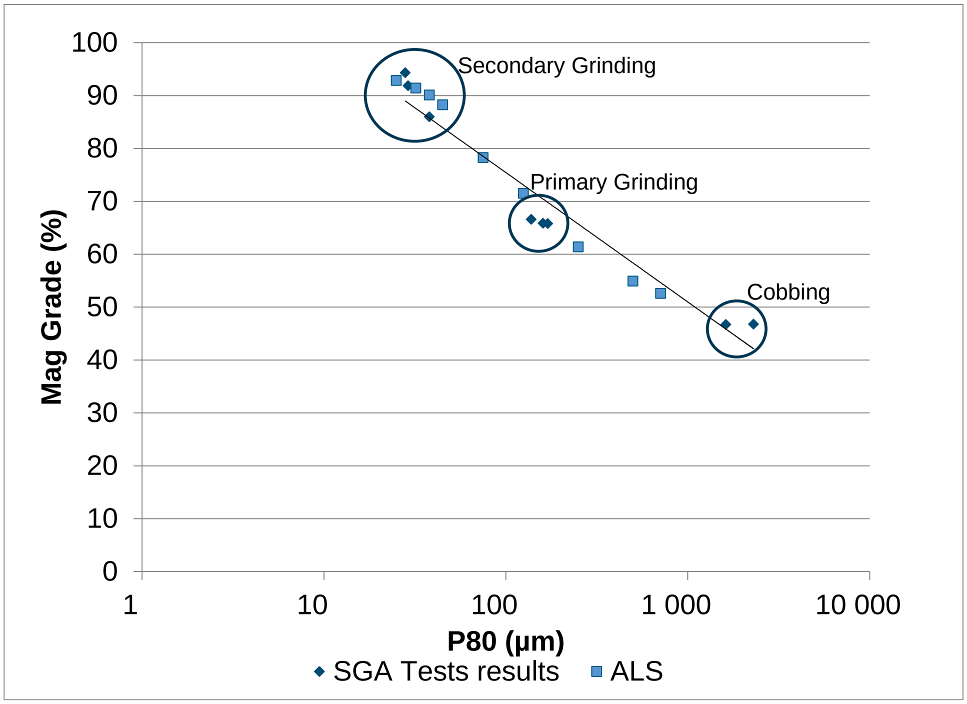


Figure 13-16: Mag Grade in Magnetic Separation Concentrate Versus P_{80}

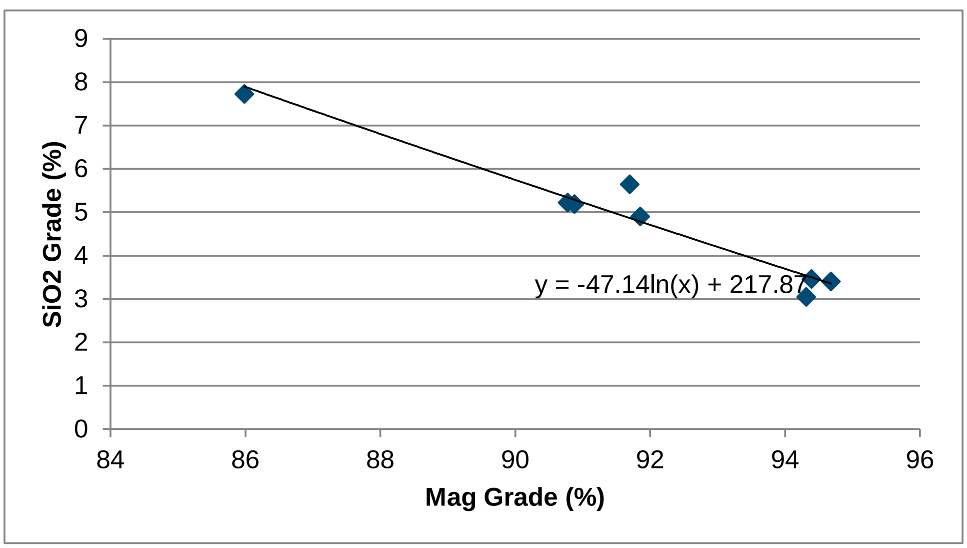


Figure 13-17: Mag Grade vs. Silica Grade in Concentrate

Figure 13-18 presents the total iron grades versus the mag grades for all the pilot samples measured at SGA. The obtained correlation is used to calculate the total iron grade at each grinding stage in the mass recovery model.

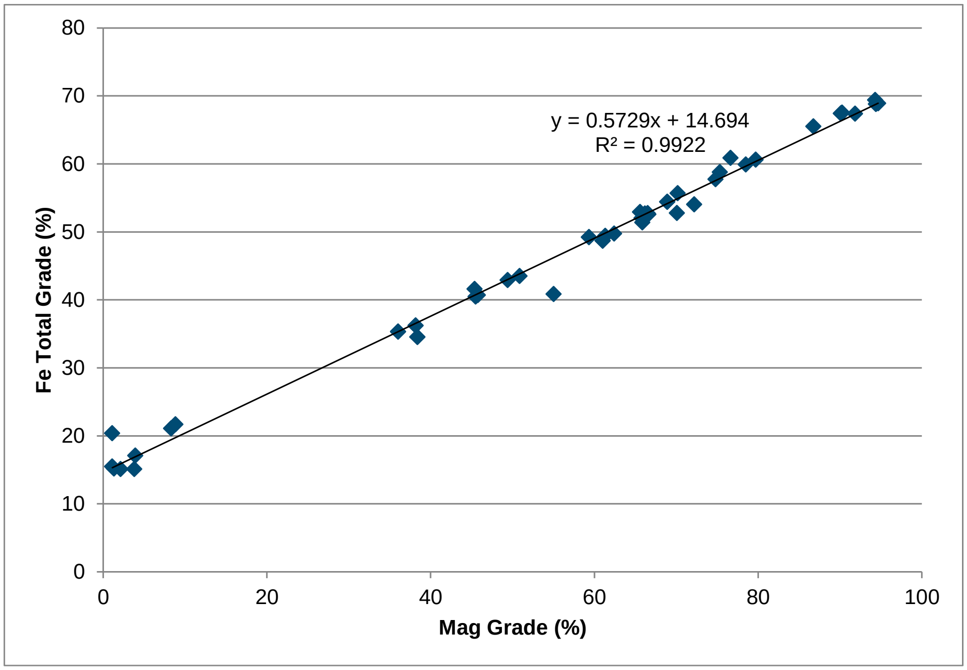


Figure 13-18: Piloting Samples Total Iron Grade versus Mag Grade

13.4.5.5.1 Magnetite Recovery

Table 13-16 summarizes the results for magnetite grade and magnetite recovery measured during each pilot test run. The mass balance basis compared to the average of the tests results is then presented in Table 13-17 for each beneficiation stage.

Table 13-16: Magnetite Grade and Recovery at each Stage

Description	Mag Grade	Mag Recovery	Mag Recovery (global)
Feed	30.4		
Cobbing			
Cobbing 1st run	46.7	96.90	96.90
Cobbing 2nd run	46.8	97.14	97.14
Primary Grinding			
Prim grinding 1st run	66.6	99.08	96.00
Prim grinding 2nd run	65.9	99.23	96.16
Prim grinding 3rd run	65.8	99.26	96.18
Secondary Grinding			
Sec Grinding 1st run	86.0	99.21	95.25
Sec Grinding 2nd run	91.9	98.27	94.50
Sec Grinding 3rd run	94.3	98.25	94.49
Finishing			
Finishing, 38 µm	90.8	99.44	94.71
Finishing, 29 µm	94.4	99.72	94.08
Final Concentrate			
Flotation, 38 µm	90.9	99.55	94.28
Flotation, 29 µm	94.7	98.71	93.28

Table 13-17: Average Test Result and Selected Nominal Mag Grades and Recoveries at each Stage

Description	Mag Grade	Mag Recovery	Mag Recovery (global)
Feed			
Averrage test result	30.4		
Nominal mass balance	28.1		
Cobbing			
Averrage test result	46.8	97.0	97.0
Nominal mass balance	45.4	97.1	97.1
Primary Grinding			
Averrage test result	66.1	99.2	96.1
Nominal mass balance	63.5	99.0	96.1
Secondary Grinding			
Averrage test result	88.9	98.7	94.9
Nominal mass balance	90.7	99.0	95.2
Finishing			
Averrage test result	92.6	99.6	94.4
Nominal mass balance	92.3	99.5	94.7
Final concentrate			
Averrage test result	93.3	98.8	94.0
Nominal mass balance	92.4	98.2	93.0

14. MINERAL RESOURCE ESTIMATES

14.1 Mineral Resource Estimate Statement

Following the completion of additional drilling in December 2011, Farshid Ghazanfari, P. Geo., BKI Chief Geologist at the time, prepared an updated Mineral Resource estimate for the Shymanivske deposit. WGM was retained by Black Iron to audit this in-house estimate. The most recent Mineral Resource estimate for the Shymanivske deposit was completed in May, 2011, for a PEA by Black Iron and then verified and audited by Hugh De Corta, P. Geo., an independent consulting geologist. Additional confirmation and infill drilling by Black Iron, which commenced in April, 2011, led to the compilation of this data, and the subsequent drilling density allowed for the upgrading of the Mineral Resource estimates for the Project. Information used for this update included historical drill hole data, in addition to Black Iron twin drilling and definition drilling programs.

Although WGM cannot verify the quality assurance and quality control processes and methods used in compiling the historical technical data, WGM believes that the historical technical data is relevant to the overall potential of the Shymanivske Project and to the establishment of updated Mineral Resources. The accuracy and validity of the historical data used was verified to the best of Black Iron's abilities and is explained in detail by WGM in Chapter 12 of this Report.

The current Mineral Resources are categorized as Measured, Indicated and Inferred and the categories are based on drill hole spacing, data quality (and confidence) and search ellipse distances. Resources are interpolated out to a maximum of 675 m (approx.) on the ends/edges and at depth, when supporting information from adjacent cross-sections was available. The resources are reported above -440 m elevation level (about 500 m from surface), which is the same pit shell depth used in the previous PEA.

A summary of the Mineral Resources is provided in Table 14-1

Table 14-1: Mineral Resource Estimate for the Shymanivske Iron Ore Deposit (Cut-off Grade of 10% Fe_{mag})

Category	Tonnes (Million)*	Fe_{tot} %	Fe_{mag} %
Measured	355.1	32.0	19.5
Indicated	290.7	31.1	17.9
Total M&I	645.8	31.6	18.8
Inferred	188.3	30.1	18.4

* Tonnage and grade numbers rounded to the first decimal

The classification of Mineral Resources used in this Report conforms to the definitions provided in the final version of NI 43-101, which came into effect on February 1, 2001, and was revised on June 30, 2011. WGM further confirms that, in arriving at the classification, it has followed the guidelines adopted by the Council of the Canadian Institute of Mining Metallurgy and Petroleum (CIM) Standards. The relevant definitions for the CIM Standards/NI 43-101 are as follows:

- A Mineral Resource is a concentration or occurrence of diamonds, natural, solid, inorganic or fossilized organic material including base and precious metals, coal, and industrial minerals in or on the Earth's crust in such form and quantity and of such a grade or quality that it has reasonable prospects for economic extraction. The location, quantity, grade, geological characteristics and continuity of a Mineral Resource are known, estimated or interpreted from specific geological evidence and knowledge.
- An Inferred Mineral Resource is that part of a Mineral Resource for which quantity and grade or quality can be estimated on the basis of geological evidence and limited sampling and reasonably assumed, but not verified, geological and grade continuity. The estimate is based on limited information and sampling gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes.
- An Indicated Mineral Resource is that part of a Mineral Resource for which quantity, grade or quality, densities, shape and physical characteristics can be estimated with a level of confidence sufficient to allow the appropriate application of technical and economic parameters, to support mine planning and evaluation of the economic viability of the deposit. The estimate is based on detailed and reliable exploration and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes that are spaced closely enough for geological and grade continuity to be reasonably assumed.
- A Measured Mineral Resource is that part of a Mineral Resource for which quantity, grade or quality, densities, shape, physical characteristics are so well established that they can be estimated with confidence sufficient to allow the appropriate application of technical and economic parameters, to support production planning and evaluation of the economic viability of the deposit. The estimate is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes that are spaced closely enough to confirm both geological and grade continuity.
- A Mineral Reserve is the economically mineable part of a Measured or Indicated Mineral Resource demonstrated by at least a Preliminary Feasibility Study. This Study must include adequate information on mining, processing, metallurgical, economic and other relevant factors that demonstrate, at the time of reporting, that economic extraction can be justified. A Mineral Reserve includes diluting materials and allowances for losses that may occur when the material is mined.

- A Probable Mineral Reserve is the economically mineable part of an Indicated, and in some circumstances a Measured Mineral Resource, demonstrated by at least a Preliminary Feasibility Study. This Study must include adequate information on mining, processing, metallurgical, economic, and other relevant factors that demonstrate, at the time of reporting, that economic extraction can be justified.
- A Proven Mineral Reserve is the economically mineable part of a Measured Mineral Resource demonstrated by at least a Preliminary Feasibility Study. This Study must include adequate information on mining, processing, metallurgical, economic, and other relevant factors that demonstrate, at the time of reporting, that economic extraction is justified.

Mineral Resource classification is based on certainty and continuity of geology and grades. In most deposits, there are areas where the uncertainty is greater than in others. The majority of the time, this is directly related to the drilling density. Areas more densely drilled are usually better known and understood than areas with sparser drilling. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.

14.2 General Mineral Resource Estimation Procedures

Black Iron's block model Mineral Resource estimate procedure included:

- Validation of digital data in the geological software package of Gemcom Software International Inc. (Gemcom™).The data was transferred to WGM from Black Iron in Gemcom™ format for the WGM audit and it was validated both within MS Access and Gemcom™;
- Generation of cross-sections to be used for geological interpretations;
- Basic statistical analyses to assess cut-off grades, compositing and cutting (capping) factors, if required;
- Development of 3D wireframe models for the different ore horizons within the Shymanivske Property that had sufficient continuity of geology/mineralization, using available geochemical assays for each drill hole sample interval; and
- Generation of block models for the Mineral Resource estimates and categorization of the results, according to NI 43-101 and CIM definitions.

14.3 Database

14.3.1 Drill hole Data

Data used to update the Mineral Resource estimates for Shymanivske originated from a dataset generated by Black Iron technical personnel and supplied to WGM for an audit. Gemcom™ Software (GEMS Version 6.2) was utilized to hold all the requisite data to be used for any manipulations necessary and for completion of the geological and grade modelling for the Mineral Resource estimate.

The database, which was created for previous Mineral Resource estimates and utilized in the PEA (May 2011), has been used for the purpose of updating the current estimate. This database was originally created by Genivar (January 2011), by incorporating all historical data from tables including ASSAY, LITHO, COLLAR, SURVEY, COORD, BULK ASSAY, GEOTECH and Summary_Ore_Characteristics, which were extracted from the 2005 database. The 2005 database was compiled by GIC (see Section 6.1 for more details). The original Gemcom™ drill hole database consisted of 215 historical diamond drill holes. The database was updated with the results from the recent twin hole program (totalling 6,041.8 m in 22 holes) and the definition-drilling program (totalling 10,740 m in 41 holes). The raw-sample intervals totalled 5,669 within the mineralized zones (including internal waste) and ranged from 0.3 m to 22.1 m, averaging 3.9 m.

Black Iron's drilling programs are summarized in Section 10.2 of this Report. The drill holes are dispersed along the Banded Iron Formation (BIF) horizons for approximately 2,150 m of strike length and 900 m of width of the Shymanivske deposit.

The current database has adequate drill hole density to better understand the structure, geology and mineralization in these areas. Therefore, the categorization of the Mineral Resources could be upgraded from the previous resource estimates.

Additional information, which included copies of the geological logs, summary reports and internal geological interpretations, was supplied to WGM digitally or as hard copies.

14.3.2 Data Validation

Upon receipt of the data, WGM performed the following validation steps:

1. Checking for location and elevation discrepancies by comparing collar coordinates with the copies of the original drill logs received from the site;
2. Checking minimum and maximum values for each quality value field and confirming/modifying those outside of expected ranges;
3. Checking for inconsistency in lithological unit terminology and/or gaps in the lithological code;
4. Spot-checking original assay certificates against information entered in the database; and
5. Checking gaps, overlaps and out-of-sequence intervals for both assays and lithology tables.

The database tables, as originally supplied, contained some minor errors that were corrected and confirmed by Black Iron before proceeding with the audit of the Mineral Resource estimate. WGM was kept up to date on the database revisions and geological interpretation that Black Iron was generating.

The database was also validated by Black Iron with the internal validation tools of Gemcom^{TM}. In general, WGM found the database to be in good order and no database issues were identified that would have a material impact on the Mineral Resource estimate.

14.3.3 Database Management

The drill hole data was stored in a Gemcom^{TM} multi-tabled workspace, specifically designed to manage collar and interval data. The line work for the geological interpretations and the resultant 3D wireframes were also stored within the Gemcom^{TM} Project. The Project database stored cross-section and level plan definitions along with the block models, so that all data pertaining to the Project is contained within the same Project database.

14.4 Geological Modelling Procedures

14.4.1 Cross-section and Level Plan Definition

Two geology level (plan) maps and a surface topographic map as DXFs (Drawing Exchange Format) were directly imported into the Gemcom^{TM} Project. Furthermore, the two geology level maps were scanned and digitized, along with 13 cross-sections with drill hole locations and the original Soviet geological interpretations. Figure 7-2 (shown previously in Chapter 7) illustrates the geological interpretation at surface. The position and the name of the cross-sections are also presented in this figure. The sections are unevenly spaced and perpendicular to the general strike of the iron formations and are oriented at 111.5°N. Some cross-sections have geological interpretations down to the -600 m level, while others stop at the -250 m level. Typical cross-sections illustrating the geology and mineralization are presented in Figure 7-5 and Figure 7-6, in Chapter 7 of this Report.

Drill holes on cross-sections were variably spaced with vertical or near vertical dips for historical drill holes and twin drill holes and flatter dips (~70°) for Black Iron definition drill holes. The drilling was done on sections perpendicular to the strike of the formations with spacing varying from 30 m to 130 m along sections, and from 80 m to 300 m along strike with vertical depths of 250 m to 550 m. The mineralized zones in the central and south parts of the Shymanivske Property are drilled with tighter spacing (denser drilling pattern) to allow better definition of the Mineral Resources; however, the northern part of the Property (north of Cross-section 6) has wider spaced drilling of up to 300 m. This is due to the interruption in the Black Iron definition drilling program of 2011; therefore all planned holes were not completed.

Because of the variable drilling pattern, most cross-sections contained at least three holes, and some had as many as 20 holes, passing through the mineralized zones. However, there are two cross-sections (6A and 7A) in the northern extremity of the Property with no drill holes. See Figure 7-2 in Chapter 7 for the locations of the drill holes in the Mineral Resource area and the cross-section orientations.

14.4.2 Geological Interpretation and 3D Wireframe Creation

The initial, interpreted mineralized units were first hand-drawn on paper cross-sections by WGM, based on lithological characteristics and head assay grades. The modeling cut-off grade for the domains was set at 10% Fe_{mag}, which is essentially a natural cut-off grade for the mineralization. These outlines were then digitized on each section as closed polygons in Gemcom™ and appropriately labeled. The digitized lines were "snapped" to drill hole intervals to ensure that the resulting wireframes honoured the 3D position of the drill hole interval.

Simplification of some of the outlines needed to be done for ease of 3D modeling. WGM's and Black Iron's final geological interpretations were slightly different when compared, but the differences would have minimal material effect on the overall tonnage or grade of the deposit. Discussions were held in order to approve any changes, and some revisions were made over the course of the work.

Although the lithological domains are somewhat similar to the ones used in the 1989 interpretation and were related to each of the previously identified BIF horizons, they were unified and/or separated to show the regional and deposit scale folded structures (Table 14-2). The 3D zone solids/wireframes (Figure 14-1) were built by extruding the polygons at mid-section, which were drawn on the cross-sections for each lithological domain.

The overburden surface was extracted from the previous Mineral Resource estimate (BBA, December 2011) and adopted for the overburden contact for the current estimate. In most cases, the recent drilling validates the overburden surface and small errors occur only in one of the interpreted sections, which is between the existing overburden surface and recent drill hole collars. An updated topography wireframe, derived from a gridded digital elevation model from the 2011 ground gravity survey, replaced the previous topography surface. These surfaces were used to limit the upper boundary of the geological block model (i.e., the Mineral Resources were defined up to the surface representing the bottom of the overburden). Black Iron ensured that the Mineral Resource estimate stayed below this overburden surface.

Table 14-2: Lithological Domains

Domains	DB Rock Code	Waste/Ore	Density from 2005 Database (g/sm^3)	Lithology
FOX	121	o	3.00	Altered Ore
OX	21	w	2.50	Altered Waste
NKA	2	w	2.80	Amphibolite
NKM	1	w	2.70	Migmatite
GD1_2S	20	w	2.52	Sandstone
SK2	4	w	2.85	Schist
SK3	3	w	2.85	Conglomerate
SX1F	8	o	3.40	Magnetite-Quartzite
SX1S	6	w	3.07	Quartzite Schist
SX1T	5	w	3.07	Talc-Chlorite Schist
SX2F	11	o	3.42	Magnetite Quartzite
SX2S	9	w	3.08	Quartzite Schist
SX4F	14	o	3.39	Magnetite Quartzite
SX4S	12	w	3.13	Quartzite Schist
SX5F	18	w	3.31	Martite-Magnetite-Qz
SX5S	15	w	3.17	Quartzite Schist

Note: Densities for FOX, OX, NKM and NKA are from geological knowledge since no data were provided.

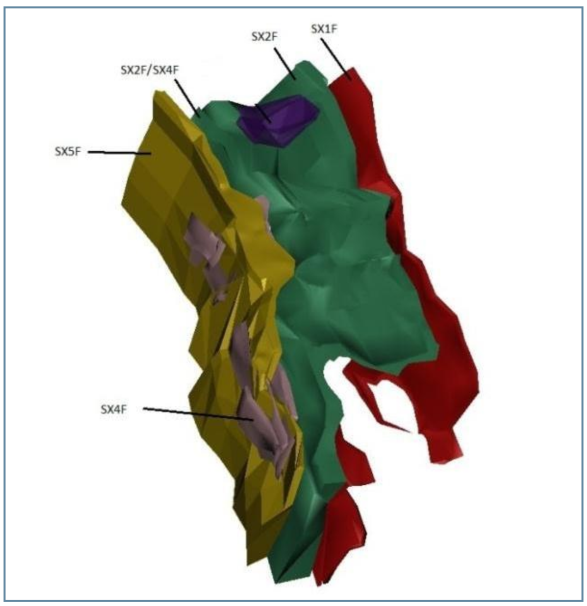


Figure 14-1: 3D Solid Models (as Viewed from the Upper Southwest)

The upper elevations of the models were limited to the bedrock-overburden contact, while maximum depths were limited to 45 m relative to sea level (RSL) based on maximum depths of drilling. Mineralized boundaries extended to a maximum of 600 m (approx.) on the ends of the zones and at a depth where there was no/little drill hole information, but only if the interpretation was supported by drill hole information on adjacent cross-sections or solid geological inference.

Alteration products in the form of martite, hematite, limonite and goethite are dominant features in the Oxide Zone (SX5F), which developed along the sheared limb of the anticline (thrust fault zones) on the west side of the Property. This zone was modeled on 120 m-spaced sections; it shows a similar strike with other mineralized zones (N22°E) and it dips about -70°SW. There is also an Oxide/altered blanket zone which covers only the SX2F and SX4F horizons and appears underneath the overburden with a thickness of up to 12 m. The latter zone is considered to be a result of weathering and is not related to any specific fault zones. This Oxide Zone was interpolated with grades, but was excluded from the Mineral Resource estimate at this time because of the lack of drilling and metallurgical information.

According to the results of the recent drilling, the continuity of the mineralization as a whole appeared to be quite good, giving WGM the confidence to extend the interpretation beyond the 300 m distance in some cases. As long as there was drill hole information and supporting data from adjacent sections, Black Iron continued at depth with the 3D model for the Shymanivske deposit mineralized domains and the Oxide/Waste Domain (SX5F). Since the drilling density was lower in the deeper parts of the deposits, the drill hole spacing was taken into consideration when classifying the Mineral Resources, and these areas were given a lower confidence category. Even though the wireframe continued to a maximum depth of -600 m (approximately 675 m vertically below surface and extending 200 m past the deepest drilling), no Mineral Resources were defined/considered, at this time, that were below -440 m elevation in the Shymanivske deposit.

Figure 14-2 to Figure 14-4 show two representative cross-sections through the deposit and a level plan, illustrating the zone/unit boundaries and % Fe_{mag} block model.

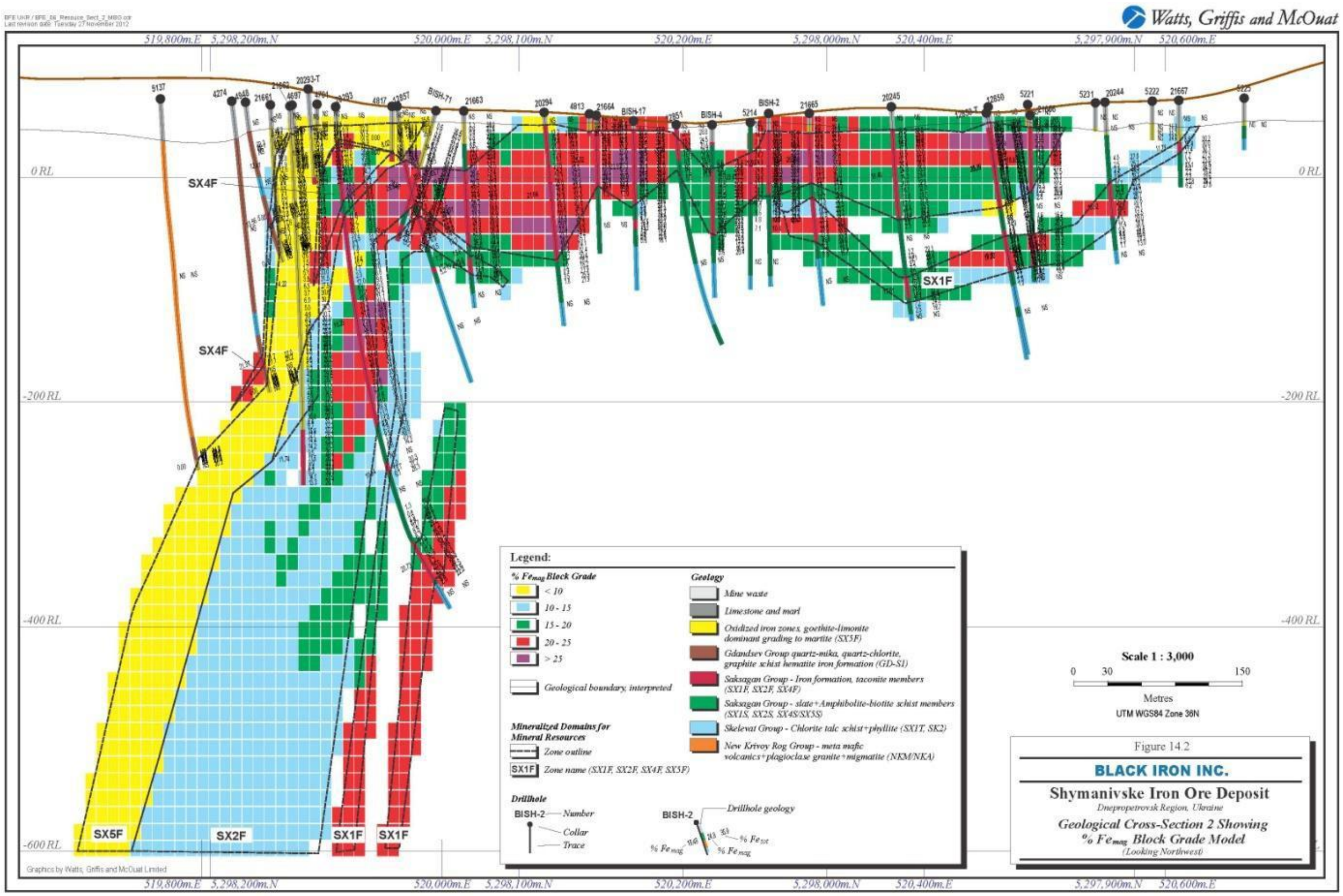


Figure 14-2: Cross-section 2 Showing % Fe_{mag} Block Model

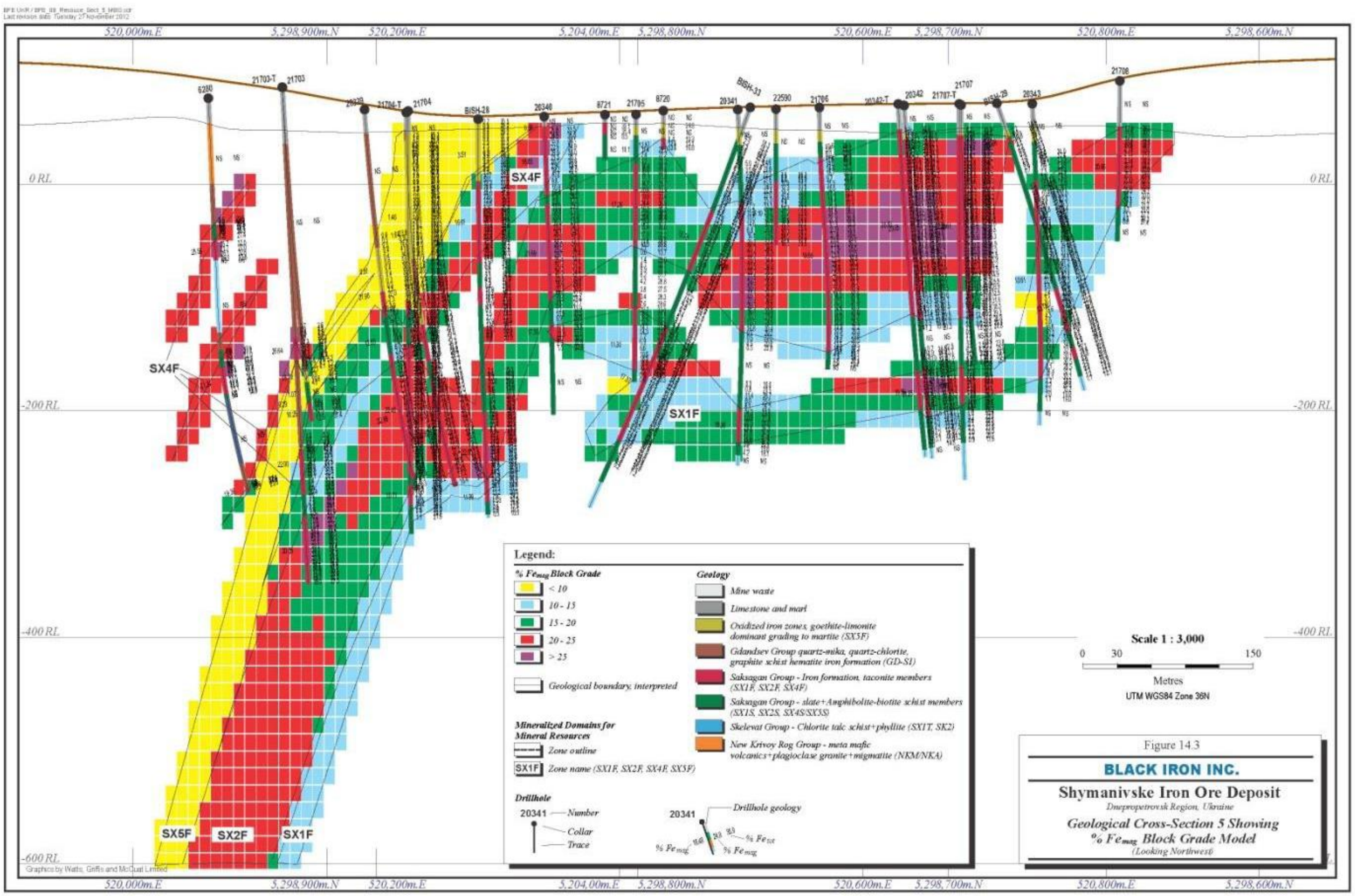


Figure 14-3: Cross-section 5 Showing % Fe_{mag} Block Model

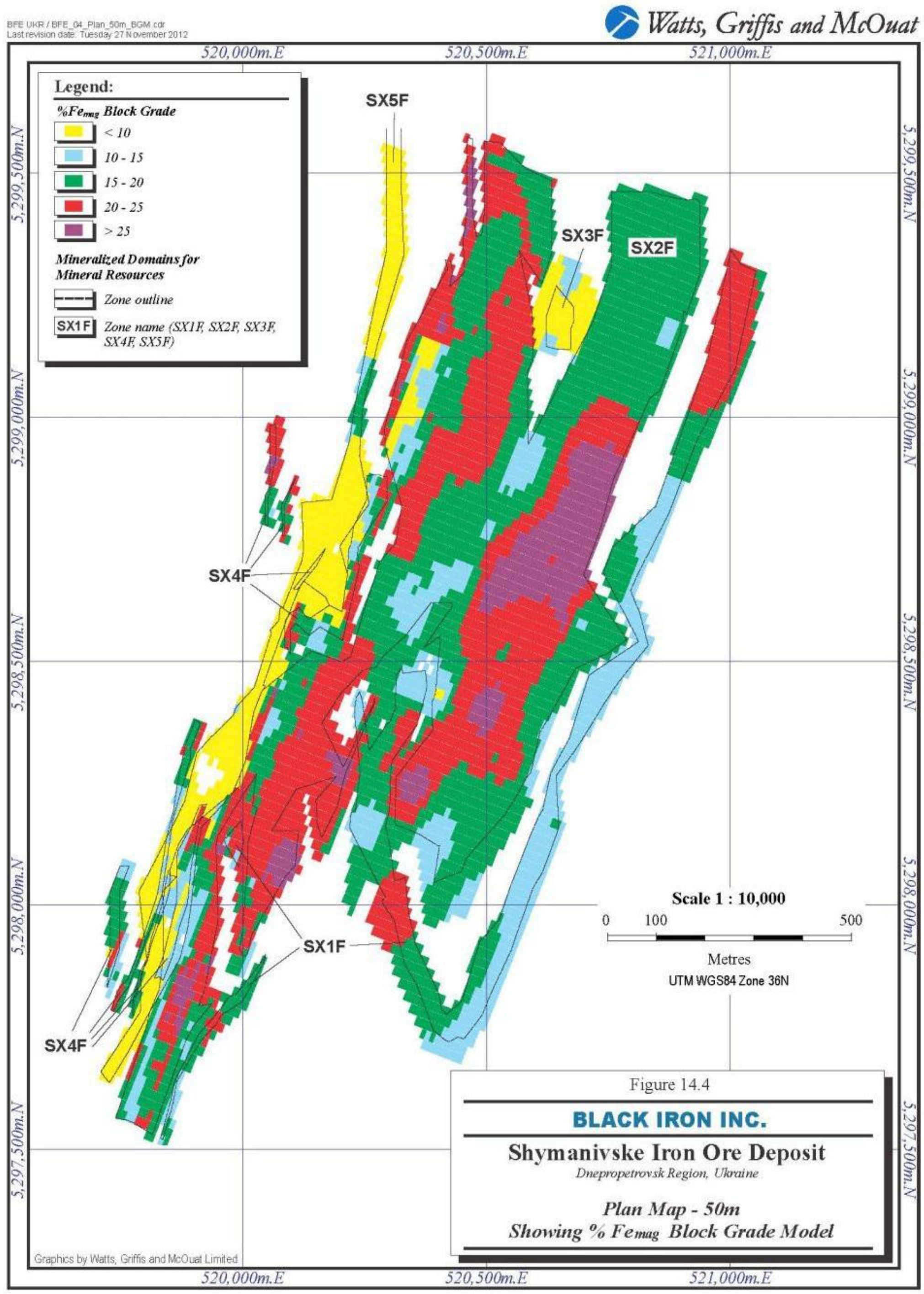


Figure 14-4: Level Plan -50 m Showing % Fe_{mag} Block Model

14.5 Statistical Analysis, Compositing, Capping and Specific Gravity

14.5.1 Back-coding of Rock-Code Field

The 3D wireframes/solids that represented the interpreted mineralized zones were used to back-code a rock code field into the drill hole workspace, and these were checked against the logs and the final geological interpretation. Each interval in the original assay table and the composite table was assigned a rock-code value based on the rock-type wireframe that the interval midpoint fell within.

14.5.2 Statistical Analysis and Compositing

Univariate statistical analysis was performed, using Snowden's Supervisor™ software. The % Fe_{tot} and % Fe_{mag} values were extracted from the Gemcom™ database for all three major mineralized domains (SX1F, SX2F and SX4F) and the Oxide Domain (SX5F), which is considered waste in the current Mineral Resource estimate. The histograms are shown in Figure 14-5 through Figure 14-8 with univariate statistical data for the raw assays. These values are representative of the uncut and non-composited assay data in the SX1F, SX2F, SX4F and SX5F domains and are weighted on the basis of the length of the representative intervals.

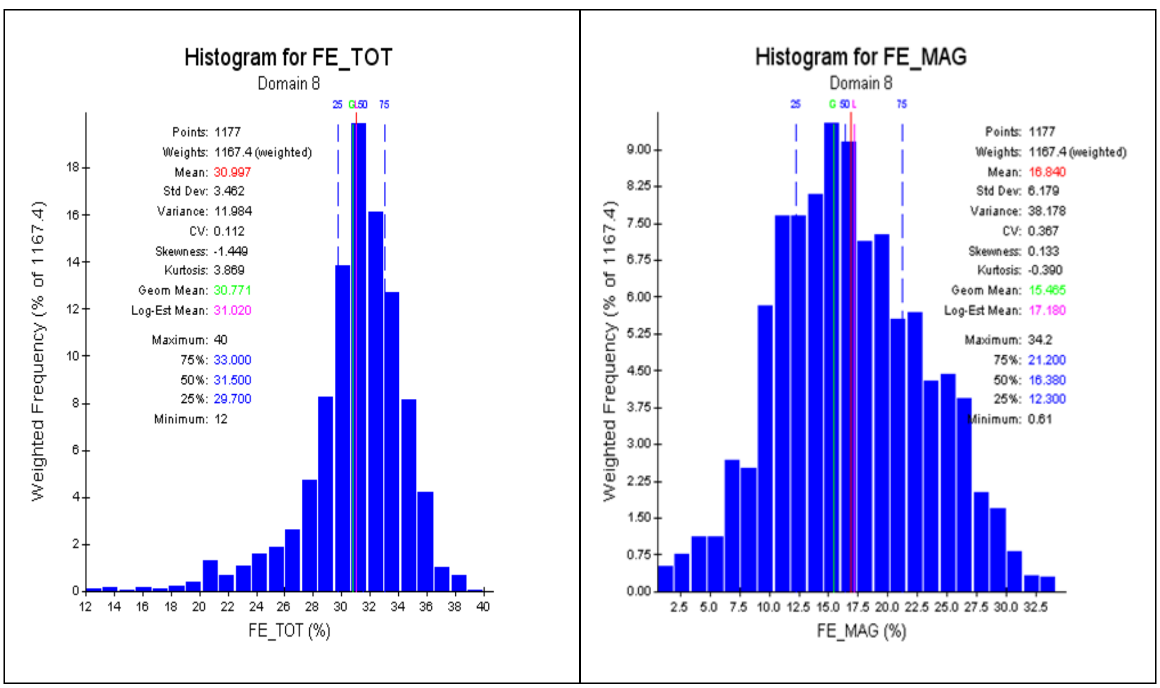


Figure 14-5: Histogram for Assays in SX1F Domain

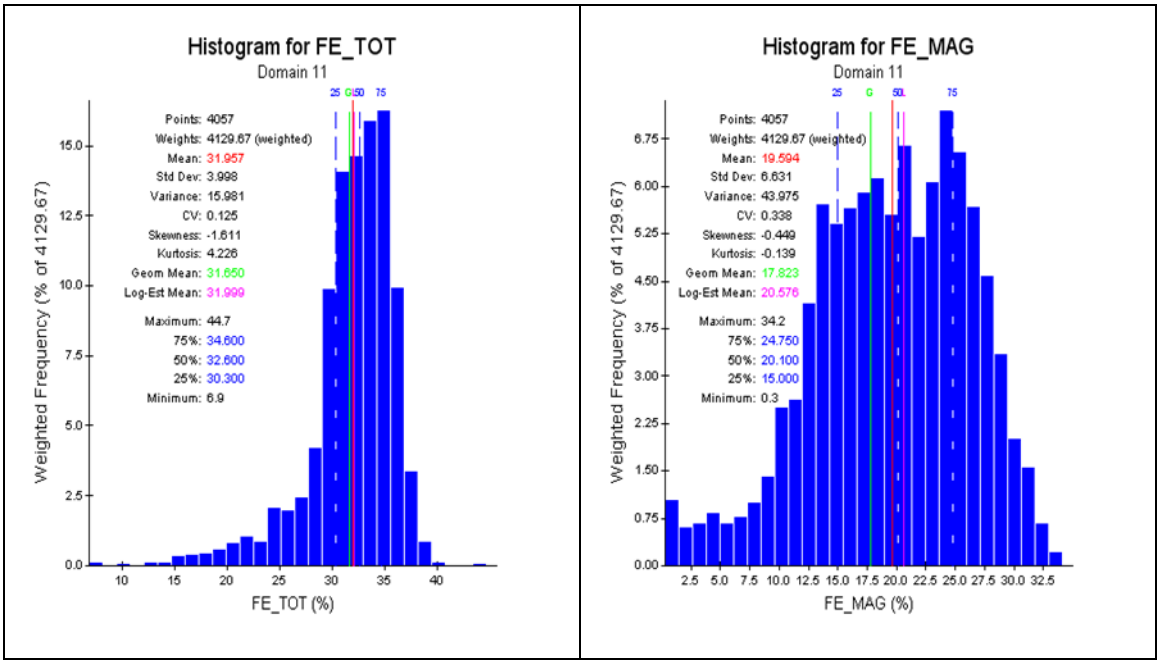


Figure 14-6: Histogram for Assays in SX2F Domain

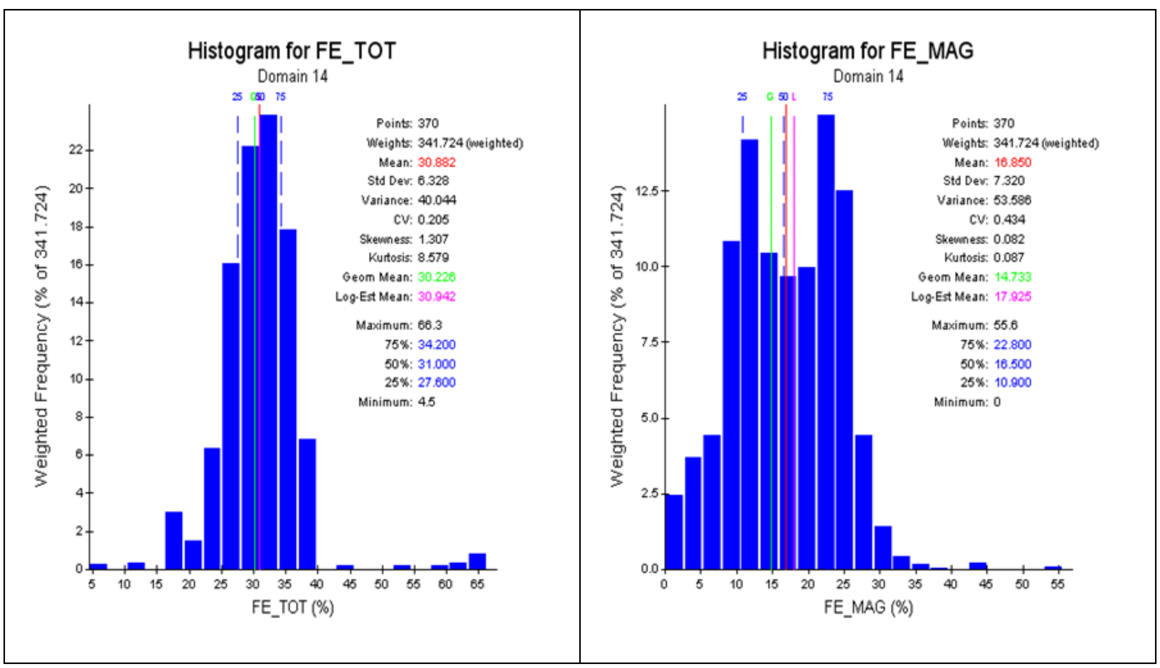


Figure 14-7: Histogram for Assays in SX4F Domain

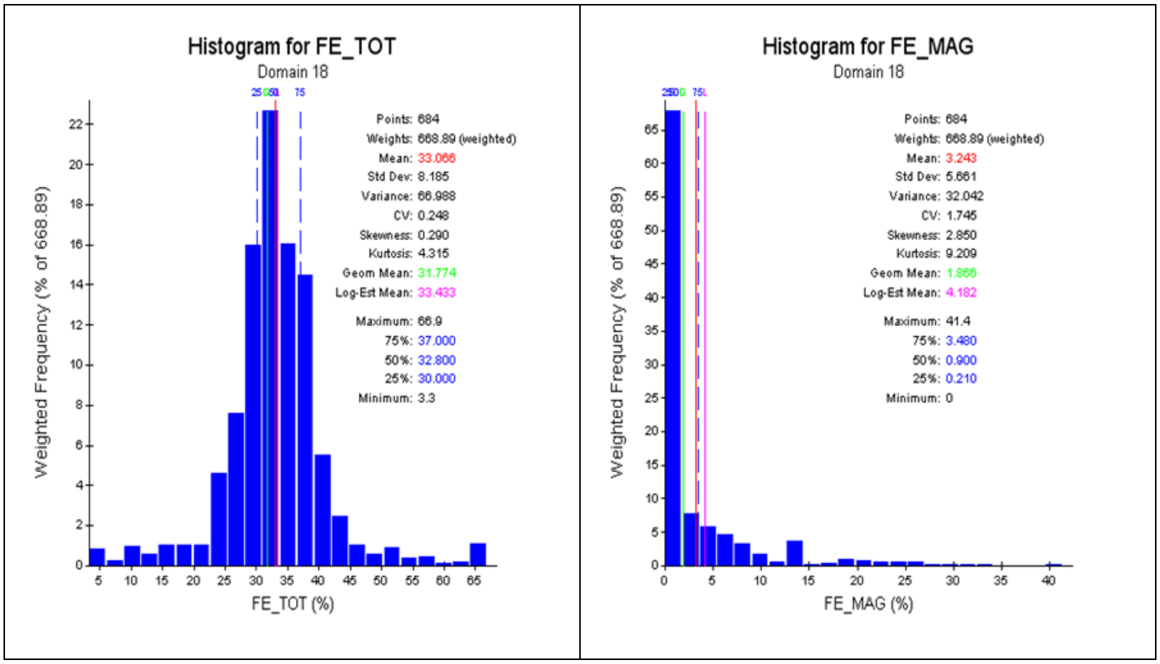


Figure 14-8: Histogram for Assays in SX5F Domain

The original assay intervals have different lengths and, in order to carry out the Mineral Resource grade interpolation, these intervals required normalization to a consistent length. A 5 m composite length was chosen and generated from the raw assays, to ensure that more than one composite would be used for grade interpolation for each block in the model. Regular down-the-drill hole compositing was used. For the purpose of resource estimation, only composites greater than 0.5 m were used in the grade interpolation. This was done to prevent short sample bias and any samples falling below this threshold length were discarded for grade interpolation.

Univariate statistics and variogram analysis were completed for the composited (5 m) drill hole assay data, and the histograms are shown in Figure 14-9 through Figure 14-12 for the units SX1F, SX2F, SX4F (mineralized domains) and SX5F (Oxide-Waste) Domain.

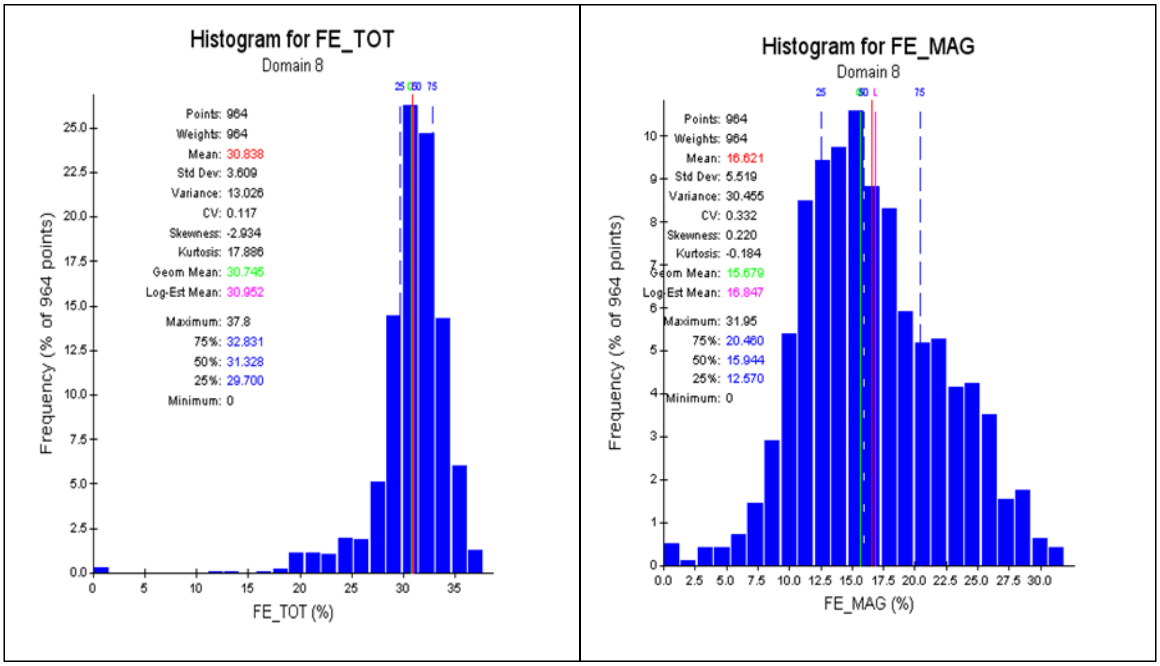


Figure 14-9: Histogram for Composites in SX1F Domain

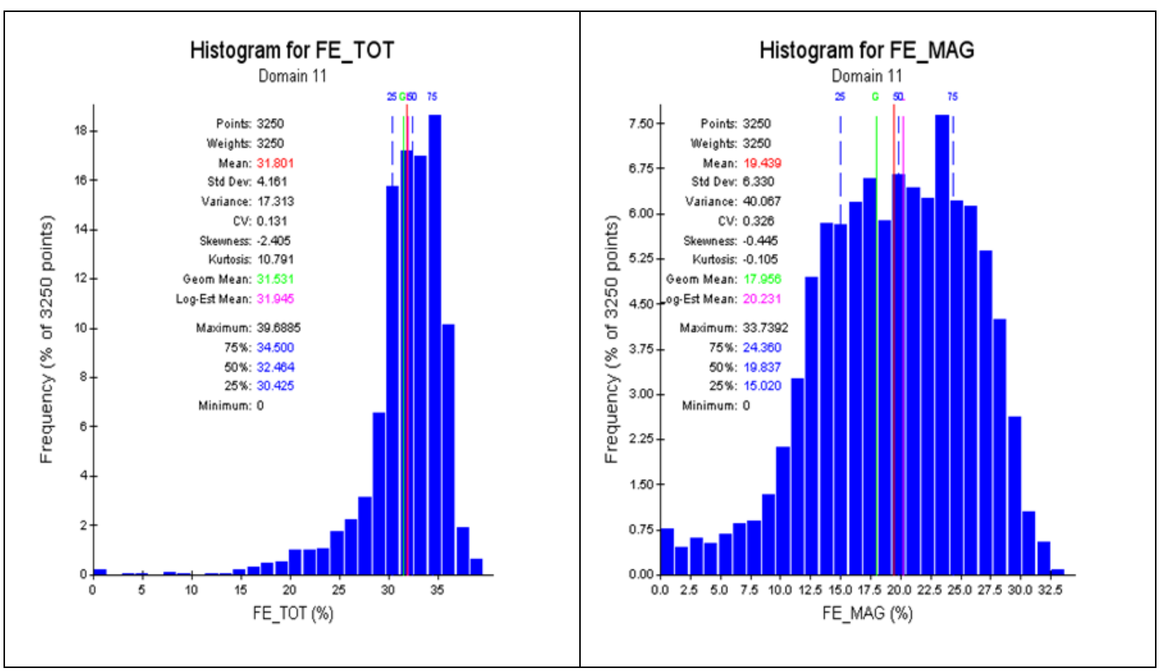


Figure 14-10: Histogram for Composites in SX2F Domain

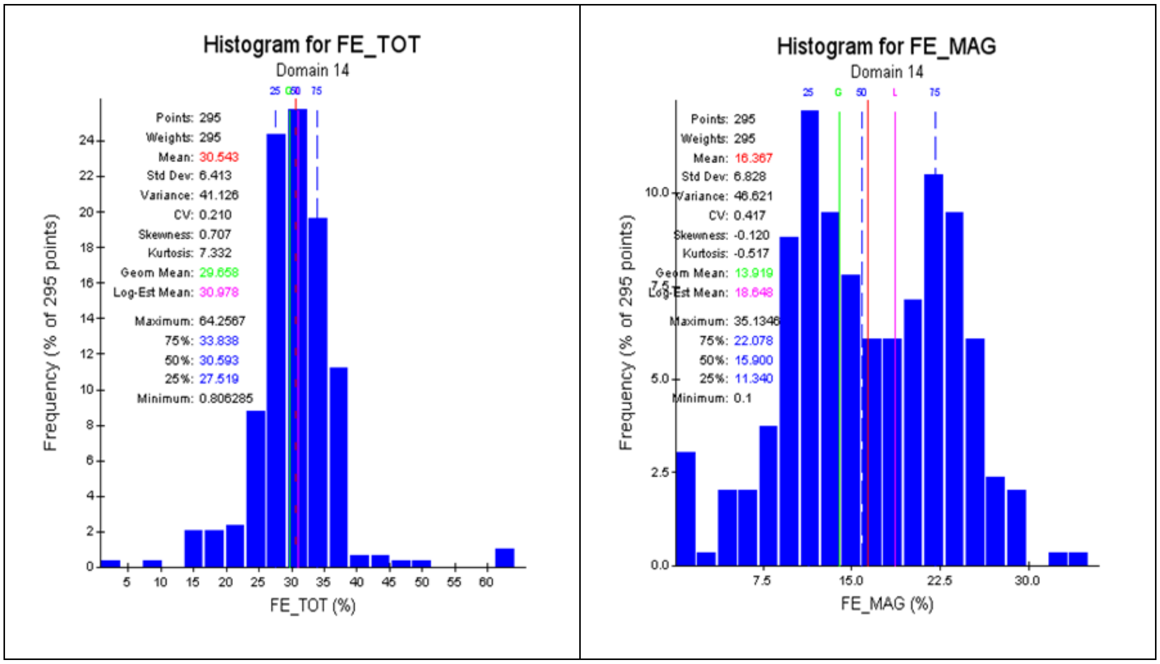


Figure 14-11: Histograms for Composites in SX4F Domain

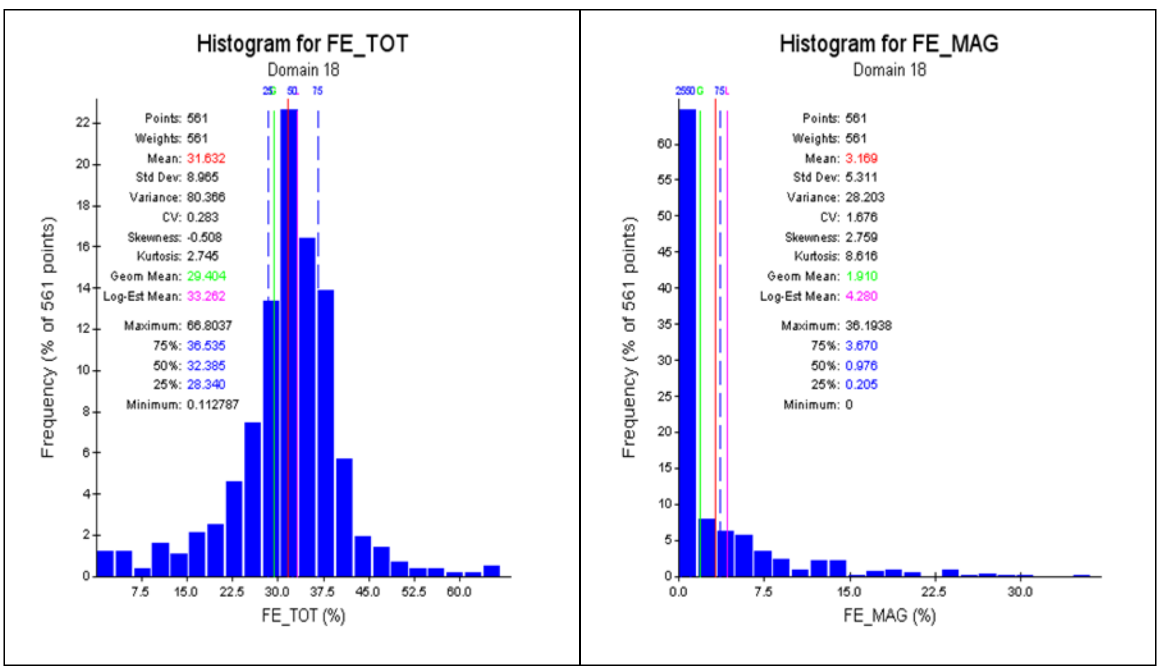


Figure 14-12: Histograms for Composites in SX5F Domain

Table 14-3 summarizes the statistics of the 5 m composites inside the major mineralized domains for the Shymanivske Property that was used to create the histograms illustrated above.

Table 14-3: Basic Statistics of 5 m Composites

Element	Number	Minimum	Maximum	Average	C.O.V.
SX1F - % Fe_{tot} _H	964	0	37.8	30.8	0.12
SX2F - % Fe_{tot} _H	3250	0	39.7	31.8	0.13
SX3F - % Fe_{tot} _H	36	16.4	37.1	29.5	0.17
SX4F - % Fe_{tot} _H	295	0.8	64.3	30.5	0.21
SX1F - % Fe_{mag} _H	964	0	37.8	16.6	0.33
SX2F - % Fe_{mag} _H	3250	0	33.7	19.4	0.33
SX3F - % Fe_{mag} _H	36	3.5	29.7	14.6	0.53
SX4F - % Fe_{mag} _H	295	0.1	35.1	16.4	0.42

14.5.3 Grade Capping

The statistical distribution of the % Fe_{tot} samples showed good normal distributions in all mineralized zones for both the composites and the raw assays. Grade capping, sometimes referred to as top cutting, is commonly used in the Mineral Resource estimation process to limit the effect (risk) associated with extremely high assay values. Black Iron considered the nature of the mineralization and the continuity of the zones and determined that capping was not required for the Shymanivske deposit and therefore it applied no grade capping or top cut to Fe_{tot} and Fe_{mag}. WGM agrees with this assessment.

14.5.4 Density, Specific Gravity

Specific gravity (SG) was previously discussed in detail in Section 7.3 – Mineralization, of this Report.

SG was measured and reported in previous Soviet/Russian reports dating back to 1985 and 1989. The measured data for about 710 samples is available for selected drill holes in different intervals, and for each rock type. A review of this data indicates it is more or less valid and consistent with the logged and recorded lithology. A version of similar density data measurements was compiled and summarized in 2005 by GIC.

WGM conducted SG measurements using bulk density and pycnometer data at both the MCM laboratory in Ukraine and, for validation purposes, at SGS-Lakefield in Canada. The resultant plots from both labs show that SG by pycnometer measurements correlates strongly with % Fe_{mag} on the selected samples. WGM's experience with these types of deposits reveals that the SGs generally correlate well with iron grade. In the case of the Shymanivske deposit, a good relationship between % Fe_{mag} and SG can be expected, as most of the hematite is interstitial to the magnetite and appears to be consistently distributed throughout the mineralization, except in the Oxide Zone. Alteration products, such as limonite/goethite and martite, have developed, particularly in the Oxide Zone, but the extent and distribution of these secondary iron-bearing minerals are not completely understood, particularly at depth. This leads to some uncertainty regarding the determination of density and recoverable Fe for this Mineral Resource estimate, and the Oxide Zone has been considered as waste.

For the purpose of tonnage estimates in this Report, Black Iron used a best-fit correlation line based on SGS-Lakefield confirmatory pycnometer data (see Chapters 7 and 12 of this Report for more detailed explanation). In order to obtain the density of each block in the model, a variable density model was created to relate the SGs with the iron grades. The adopted formula (y=-0.00042* Fe_{mag} +0.0295* Fe_{mag} +3.07) was adjusted for too low and too high values by WGM and a new best-fit line was modeled to be close to polynomial values. Using the variable density model, a 20% Fe_{mag} gives a SG of approximately 3.49.

14.6 Block Model Parameters, Grade Interpolation and Categorization of Mineral Resources

14.6.1 General

The previous Shymanivske deposit Mineral Resource estimates were completed using a block modelling method and the grades were interpolated using an Inverse Distance (ID) estimation technique. ID belongs to a distance-weighted interpolation class of methods, similar to Kriging, in which the grade of a block is interpolated from several composites within a defined distance range of that block. ID uses the inverse of the distance (to the selected power) between a composite and the block as the weighting factor.

Black Iron used an Inverse Squared Distance (ID^2) interpolation method and WGM audited the results. In WGM's experience with similar types of deposits, most interpolation methods (ID, Nearest Neighbour and geostatistical techniques, such as Kriging) give similar results, as long as the iron grades are well constrained within the wireframes and the grade interpolation search ellipses are properly oriented. In this case, the results of the interpolation approximated the average grade of all the composites used for the estimate. WGM is of the opinion that ID interpolation is appropriate and accepted Black Iron's grade interpolation, as supplied.

14.6.2 Block Model Setup / Parameters

The block model was created using the Gemcom™ software package to create a grid of regular blocks to estimate tonnes and grades. The parameters used for the block modelling are summarized below.

The block sizes used were:

- Width of columns = 10 m;
- Width of rows = 20 m;
- Height of blocks = 15 m.

The specific parameters for the block model are as follows:

- Easting coordinates of model (WGS84 – Upper SW corner): 519317.00
- Northing coordinates of model (WGS84 – Upper SW corner): 5297560.00
- Datum elevation of top of model: 130.00 m
- Model rotation (anti-clockwise around Origin): -21.50
- Number of columns in model: 130
- Number of rows in model: 130
- Number of levels: 50

The block model coverage is shown in Figure 14-13 and was large enough to encompass the Property area, as well as any historical projected pit area, down to the -600 m level.

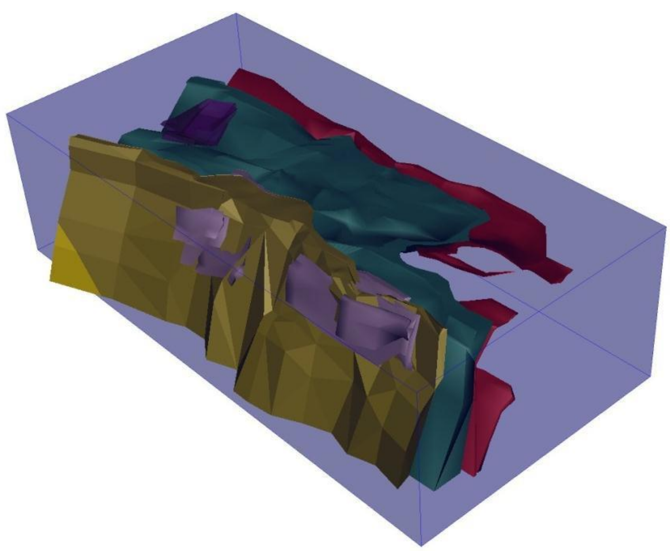


Figure 14-13: Block Model Grid Coverage (pale blue) with the 5 Wireframed Domains Shown from the Upper SW (SX1F in red, 2F in green, 3F in purple, 4F in pink, and 5F in yellow)

For the previous Mineral Resource estimates in 2011, Genivar and Black Iron used smaller blocks (10 m x 10 m x 10 m), which was suitable for historical drill hole spacing but may not have been suitable for the envisioned mining method (large open pit). For the purpose of this more advanced Study and to aid in mine design and have a more realistic block size as would benefit a large open pit operation, WP requested that Black Iron use a bigger block geometry (10 m x 20 m x 15 m high) for the Shymanivske block model. WGM believes that the concept of using larger blocks has merit and does not detrimentally affect the resolution of grade interpolations.

14.6.3 Grade Interpolation

The Shymanivske Project Mineral Resource estimates were completed using a block modelling method and, for the purpose of this Study, the grades were interpolated by the ID^2 estimation technique. The ID^2 method uses the inverse of the distance (to the selected power) between a composite, and the block as the weighting factor.

Experimental variograms were prepared for all three major mineralized domains, using the composited assay dataset for Fe_{tot}. The variograms were constructed by applying an average strike (N21ºE) for the deposit and the other two mutually orthogonal directions. The variograms are traditional and are log transformed. The % Fe_{tot} Head grade (interpolated from 5 m composites) was used as the primary grade element for the statistical and geostatistical assessment; however, % Fe_{mag} was also interpolated into the grade block model and was used for the determining cut-off for the Mineral Resource estimate.

Based on the results of these variograms, a 4-step method was used to estimate grades. Three directions of continuity (strike range, dip range and across dip range) were determined for all three major mineralized domains. Gemcom™ ADA (Azimuth-Dip-Azimuth) angles were extracted from the positive axis rotation to apply to the search ellipsoid for interpolating grades (Table 14-4 to Table 14-7).

These search radii are determined by the maximum range of the variograms for the first pass, which applied to the first search ellipsoid and then extended empirically for the second search. The blocks tagged from the first pass search radius can then be considered for classification in the Measured and Indicated categories.

Since part of both SX1F and SX2F domains are dipping about 70ºSW, two more search ellipsoid profiles were set up to properly interpolate grade in the western limb of the anticline. First, the steep limb was sub-domained with an overprinting wireframe and then all the blocks within this wireframe were set to a “null value.” Then a third and fourth set of search ellipsoids was prepared to run for interpolating grades within this steep sub-domain only. The search parameters were similar to the ones which have been used for SX4F and SX5F domains.

A 4-step search ellipsoid approach was established and based on results of the variography of Fe_{tot} grade for the Shymanivske mineralized zones. This approach also enabled grade to be interpolated within the mineralized wireframes, where a steep angle of the search ellipsoid was required in the western part of wireframed zones. The first search was based on the range of the variograms; the second search was based on twice the range of the variograms; the third search was based on the range of variograms and only applied to the steeply dipping part of the mineralized zone after "initializing" or re-stating the previous values to zeros; and the fourth search ellipsoid was based on twice the range of the variograms, again to interpolate grade only for the steep part of the zones. These ranges were established for all interpolated domains. This 4-step approach was used in order to inform all the blocks in the block model with grade; however, the classification of the Mineral Resources (see below) was based on drill hole density (or drilling pattern); geological knowledge/interpretation of the geology; and some other constraints, such as the presence of alteration (Martite-Oxide zone). The Fe_{tot} grade, interpolated from 5 m composites, was used for the Mineral Resource estimate; however, Fe_{mag} was also interpolated into the grade block model.

Table 14-4: ID² Interpolation Parameters - First Search Ellipsoid

Domain	Principal Azimuth (º)	Dip (º)	Intermediate Azimuth (º)	Intermediate Continuity (m, Y)	Maximum Continuity (m, X)	Minimum Continuity (m, Z)	Max. No. Per Hole	Min. No. Samples	Max. No. Samples
8	22	0	-	150	260	60	2	3	10
11	22	0	-	150	260	60	2	3	10
12	22	0	-	150	260	60	2	3	10
14	82.7	67.7	16.5	130	200	60	2	3	10
18	82.7	67.7	16.5	130	200	60	2	3	10

Table 14-5: ID² Interpolation Parameters - Second Search Ellipsoid

Domain	Principal Azimuth (º)	Dip (º)	Intermediate Azimuth (º)	Intermediate Continuity (m, X)	Maximum Continuity (m, Y)	Minimum Continuity (m, Z)	Max. No. Per Hole	Min. No. Samples	Max. No. Samples
8	22	0	-	300	520	180	None	2	10
11	22	0	-	300	520	180	None	2	10
12	22	0	-	300	520	180	None	2	10
14	82.7	67.7	16.5	260	400	180	None	2	10
18	82.7	67.7	16.5	260	400	180	None	2	10

Table 14-6: ID² Interpolation Parameters - Third Search Ellipsoid

Domain	Principal Azimuth (º)	Dip (º)	Intermediate Azimuth (º)	Intermediate Continuity (m, Y)	Maximum Continuity (m, X)	Minimum Continuity (m, Z)	Max. No. Per Hole	Min. No. Samples	Max. No. Samples
8	82.7	67.7	16.5	150	260	60	2	3	10
11	82.7	67.7	16.5	150	260	60	2	3	10
12	22	0	-	150	260	60	2	3	10
14	82.7	67.7	16.5	130	200	60	2	3	10
18	82.7	67.7	16.5	130	200	60	2	3	10

Table 14-7: ID² Interpolation Parameters - Fourth Search Ellipsoid

Domain	Principal Azimuth (º)	Dip (º)	Intermediate Azimuth (º)	Intermediate Continuity (m, X)	Maximum Continuity (m, Y)	Minimum Continuity (m, Z)	Max. No. Per Hole	Min. No. Samples	Max. No. Samples
8	82.7	67.7	16.5	300	520	180	None	2	10
11	82.7	67.7	16.5	300	520	180	None	2	10
12	22	0	-	300	520	180	None	2	10
14	82.7	67.7	16.5	260	400	180	None	2	10
18	82.7	67.7	16.5	260	400	180	None	2	10

As previously mentioned, ID^2 was the method by which the mineralized domains were interpolated for Fe_{tot} and Fe_{mag}. Ellipsoid search anisotropy was applied with search volume limits along the X, Y, and Z directions set at the range of the variograms and then at two or three times the range to determine the appropriate category. The orientation of the search ellipsoid was the same as that of the variogram model.

The minimum number and the maximum number of samples used to estimate a block in the first pass were three and ten, respectively, which were based on the drilling density and the degree of confidence. The maximum number of samples to be selected per drill hole was limited to two. The minimum number and maximum number of samples used to estimate a block in the second pass were two and ten, respectively, which were based on the drilling density and the degree of confidence (see Table 14-4 to Table 14-7).

A coding precedence was applied in order to resolve overlap in boundary interpretations between the different mineralized domains. Where solids overlapped, a domain code was assigned in Gemcom™, according to the order of precedence (Table 14-8).

Table 14-8: Solid and Domain Precedence for Block Modelling of the Shymanivske Deposit

Precedence Order	Rock Type	Rock Code	Geology
1	SX3F	12	Magnetite-Quartzite
2	SX4F	14	Magnetite-Quartzite
3	SX1F	8	Magnetite-Quartzite
4	SX2F	11	Magnetite-Quartzite
5	SX5F	18	Martite/Magnetite- Quartzite

14.6.4 Mineral Resources Categorization

The Mineral Resource classification is based on certainty and continuity of geology and grades, and this is almost always directly related to the drilling density. Areas more densely drilled are usually better known and understood than areas with sparser drilling, which would be considered to have greater uncertainty, and hence lower confidence.

The historic drilling was not evenly distributed on the Property, and most of the drilling was concentrated in the central part of the deposit. Therefore, the majority of the resources classified as Measured Resources in previous estimates were concentrated in this central part, whereas the northern and southern extensions of the deposit remained predominantly Inferred Mineral Resources. The Black Iron definition drilling program of 2011 (see Chapter 11) was designed to increase the density of drilling throughout the deposit, which would not only help to upgrade resources from the Indicated to the Measured category in the central part of the deposit, but would also upgrade a large portion of the resources in the southern and northern part to the Indicated category. This program was mostly successful in achieving the above tasks; however, Black Iron could not complete the planned definition drilling program on the northern part of the deposit because of a work stoppage and the existence of a maintenance facility still in use by a third party. Some of the Mineral Resources in this area are still classified as Inferred because of a lack of additional information and the impossibility of increasing the drilling density and therefore the confidence of the resources in this area.

The classification of the Mineral Resources relied on a 2-step process. In the first step, blocks were assigned a tag based on the criteria of the search ellipse process. The blocks tagged from the first and third passes of the search radii were considered for classification in the Measured and Indicated categories. The blocks tagged from the second and fourth passes search radii were considered for classification in the Inferred category. The second step was to manually construct "resource category wireframes" by assessing the distribution of tagged blocks and by applying other geological and drilling criteria, such as the Distance Model. The wireframes were first constructed from 3D rings on the vertical cross-sections and then meshed together to define the 3D solids. Finally, all blocks falling inside each category wireframe were assigned to the Measured, Indicated or Inferred classification. The initial tagging by search ellipses was used to help in the definition of the wireframes only. The blocks still remaining outside of any bounding polylines were also categorized as Inferred.

Because the search ellipses were large enough to ensure that all the blocks in the 3D model were interpolated with grade, Black Iron generated a Distance Model, which represented the distance from the actual data point in the drill hole to the block centroid, and reported the estimated Mineral Resources by distances that represented the category or classification. Due to the steeply dipping mineralization along the west sheared limb of the anticline and the lower drilling density producing greater uncertainty for the boundaries of this mineralization, it was decided to reduce the Indicated Resources from this steeply dipping part of the mineralization in some sections. The down-dip distance for the Indicated category was reduced to 60 m along this limb of the anticline. Table 14-9 shows different distance parameters which were used to classify the Mineral Resources in the Shymanivske deposit. The distance criteria came from the variogram ranges and also visual judgment, which was based on the density of drilling in plans and cross-sections.

Table 14-9: Distance Criteria for Classification of Resources Based on Range of Variograms and Density of Drilling

Class	Down Dip (m)	Along Strike (m)
Measured	<100	<100
Indicated	60-150	100-150
Inferred	>150	>150

WGM has abundant experience with types of mineralization similar to the Project; therefore, it used this knowledge to assist Black Iron with the categorization of the Mineral Resources. The continuity of the mineralization in general was quite good; however, the internal continuity of some zones and some waste units is poorly understood because of the folding/geometric complexity. WGM was of the opinion that extending the geological interpretation beyond the more densely drilled parts of the deposit was appropriate, as long as there was supporting data from adjacent sections. This extension was taken into consideration when classifying the Mineral Resources, and these areas were given a lower confidence category, which generally represented the deeper mineralization.

Inferred Mineral Resources are interpolated to a maximum of 650 m (approx.) on the ends/edges and at depth, when supporting information from adjacent cross-sections was available. The average distance for the total Measured, Indicated and Inferred Mineral Resources was approximately 60 m, 100 m and 200 m, respectively. The majority of the deeper mineralization was categorized as Inferred because of the sparse drill hole information over the west limb of the anticline and below about 400 m from surface; the maximum depth that the mineralization was taken to is 600 m elevation (approximately 675 m vertically from surface).

WGM worked with Black Iron extensively on this categorization, and endorses it. With respect to mitigating the remaining concerns, WGM is in further discussions with Black Iron on how to upgrade the classification of the Mineral Resources in areas of lower confidence.

Figure 14-14 to Figure 14-16 illustrate two representative cross-sections and a plan view showing zone outlines and the Mineral Resource categorization for the Shymanivske deposit.

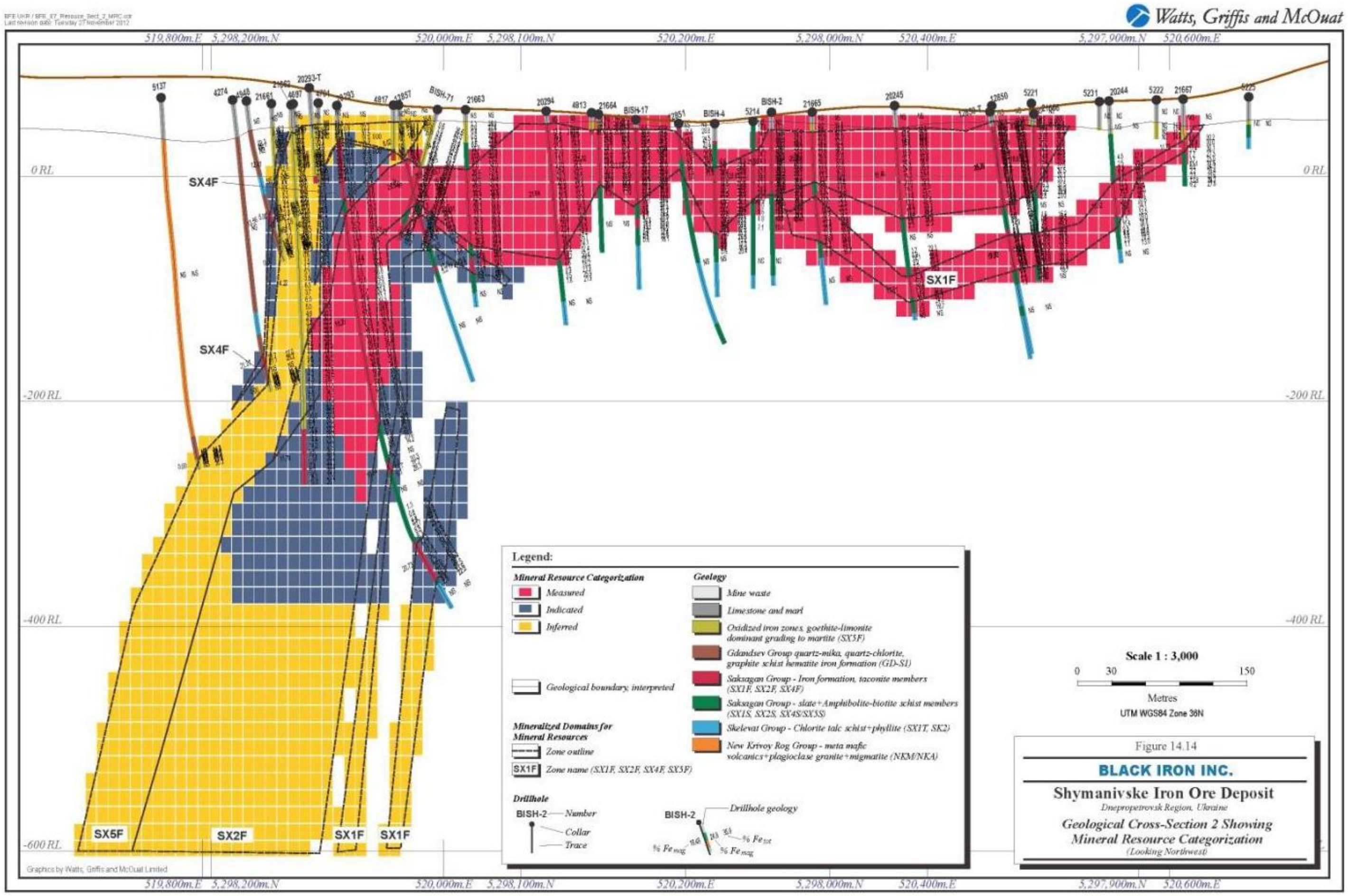


Figure 14-14: Cross-section 2 Showing Mineral Resource Category Block Model

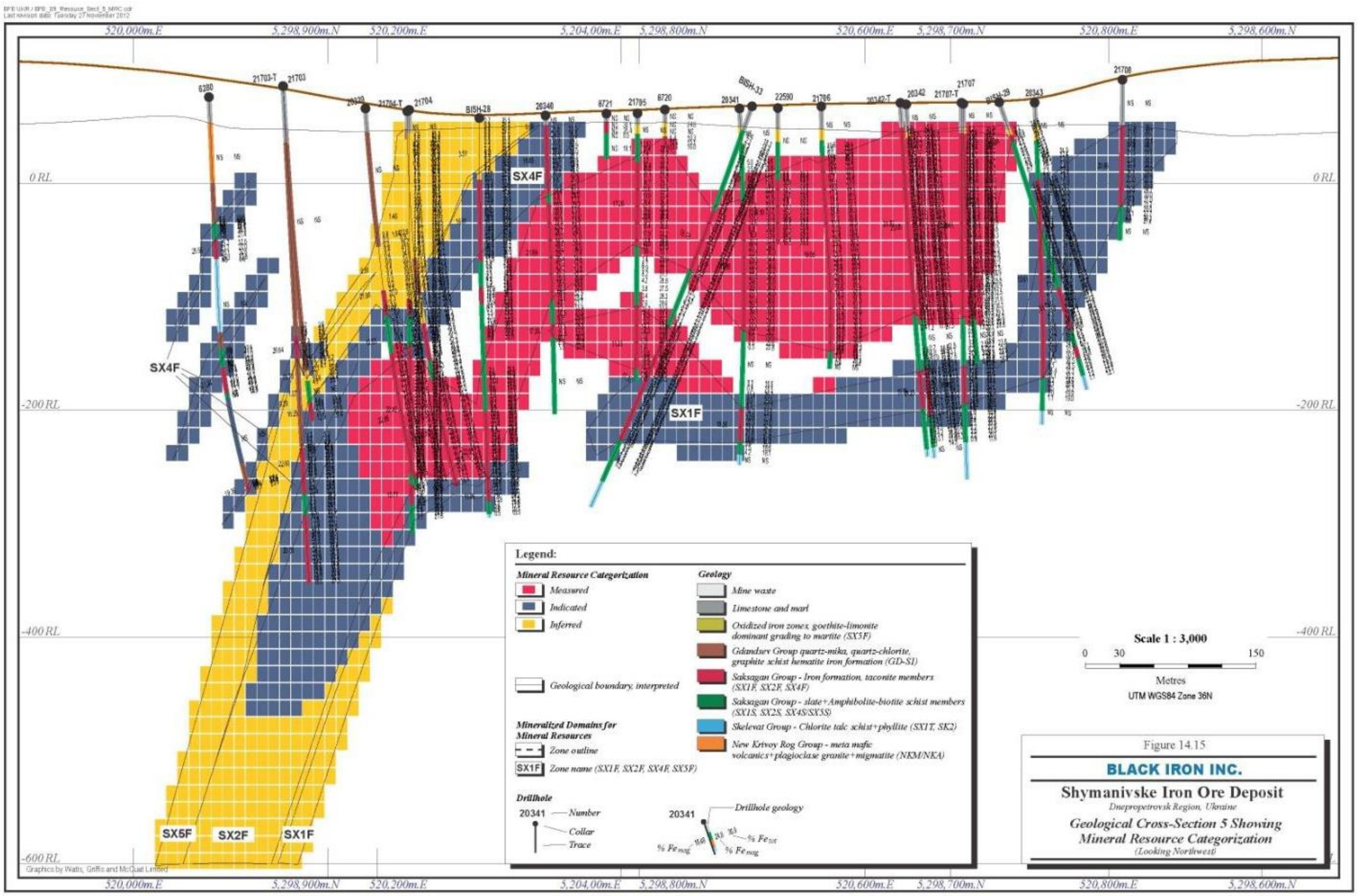


Figure 14-15: Cross-section 5 Showing Mineral Resource Category Block Model

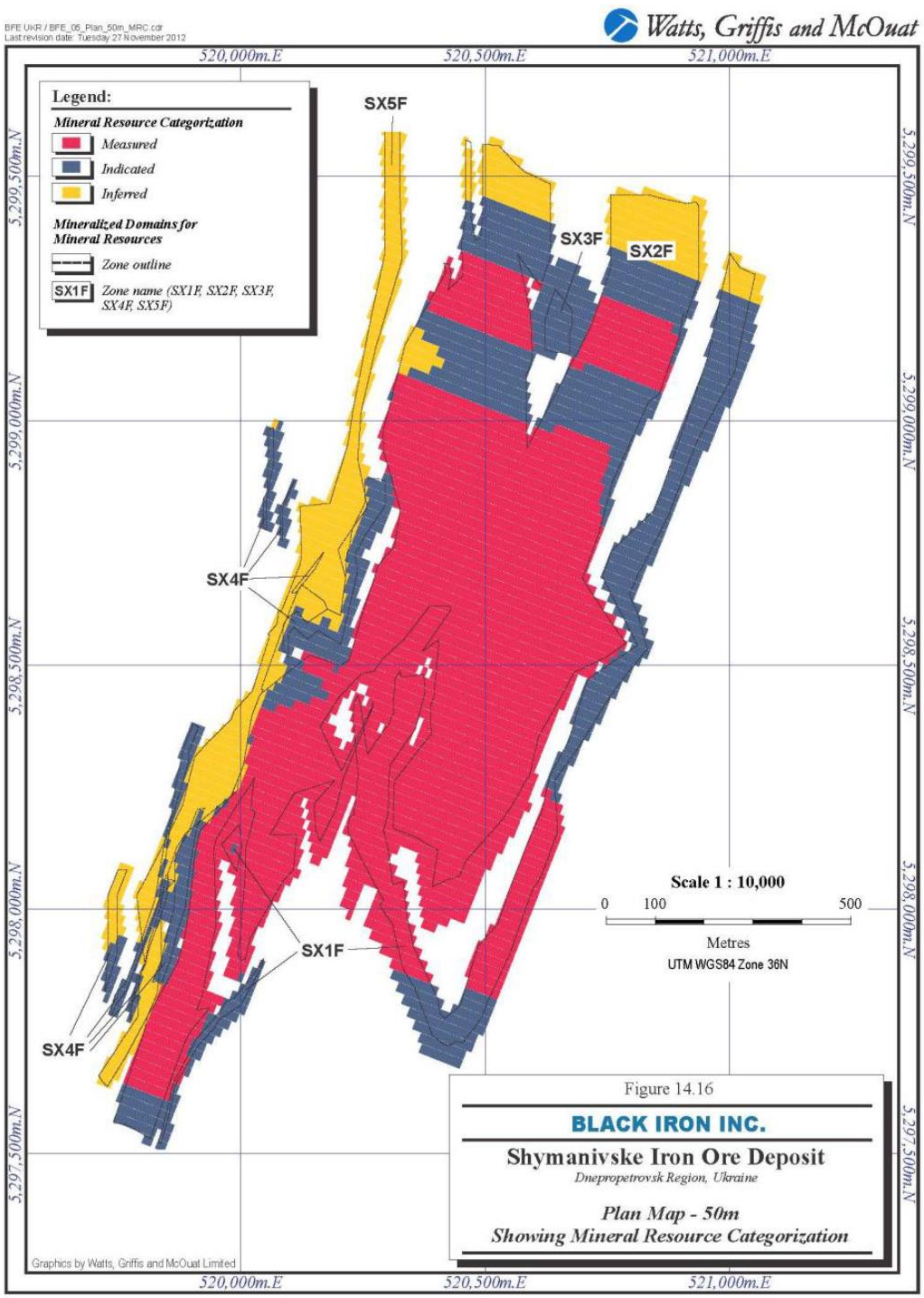


Figure 14-16: Level Plan -50 m Showing Mineral Resource Category Block Model

14.6.5 Mineral Resources Reporting

For the Mineral Resource estimate, a cut-off of 10% Fe_{mag} was determined to be appropriate at this stage of the Project. This cut-off was chosen on the basis of a preliminary review of the parameters that would likely determine the economic viability of a large open pit operation and compares well to similar projects and to projects that are currently at a more advanced stage of study. As a further check on the veracity of this resource cut-off grade, the pit designed for this Study was based on a cut-off that was slightly higher than the Mineral Resource estimate cut-off grade. This was done to produce a desired average head grade (to give the required concentrate grade). In reality, the economic cut-off grade would be slightly lower and the desired head grade would not be achieved (see Chapters 15 and 16). To produce the required concentrate grade, the target mill feed average head grade had to be in the range of 19% to 20% Fe_{mag}. To provide an overall tonnage with this average grade, it was necessary to use a production cut-off grade of about 13% Fe_{mag}, which is slightly above the current Mineral Resource cut-off grade of 10% Fe_{mag}.

The Mineral Resource estimate was classified in accordance with CIM Standards and Definitions, taking into account drill hole spacing, data quality (and attendant confidence), variogram ranges and search volume and grade interpolation. The categorized Mineral Resource estimate for the Shymanivske deposit is presented in Table 14-10 and Table 14-11.

Table 14-10: Mineral Resource Estimate – Measured and Indicated Categories (Cut-off of 10% Fe_{mag})

Category	Horizon	Tonnes (Million) *	%Fe_{tot}	%Fe_{mag}
Measured	SX1F SX2F	44.0 311.1	31.0 32.1	17.0 19.9
Total		**355.1**	**32.0**	**19.5**
Indicated	SX1F SX2F SX3F SX4F	101.6 163.8 6.1 19.2	30.7 31.3 30.7 30.9	16.3 19.0 16.7 17.4
Total		**290.7**	**31.1**	**17.9**
Total Measured & Indicated		**645.8**	**31.6**	**18.8**

* Tonnage and grade numbers are rounded to the first decimal.

Table 14-11: Mineral Resource Estimate – Inferred Category (Cut-off of 10% Fe_{mag})

Category	Horizon	Tonnes (Million) *	%Fe_{tot}	%Fe_{mag}
Inferred	SX1F SX2F SX4F	17.4 169.4 1.5	32.0 30.0 23.6	17.1 18.6 16.1
Total		**188.3**	**30.1**	**18.4**

* Tonnage and grade numbers are rounded to the first decimal.

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. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.

14.6.6 Cut-off Grade Sensitivity Analysis

The Mineral Resources for the Shymanivske deposit were estimated cumulatively for consecutive grade groups by the ID^2 method. This allows for the results to be reported cumulatively for different cut-off grades (COG) and presented in a sensitivity analysis for comparison purposes. Table 14-12 and Table 14-13 present the results of this analysis for the Measured, Indicated and Inferred Mineral Resources, with respect to varying Fe_{mag} COGs.

Table 14-12: Sensitivity Table - Measured and Indicated Mineral Resources

COG Fe_{mag} %	Tonnage* (Million)	Fe_{tot} (%)	Fe_{mag} (%)
25	50.9	34.9	26.4
22.5	135.6	34.1	24.7
20	251.2	33.4	23.1
17.5	382.0	32.9	21.6
15	509.1	32.3	20.3
12.5	605.3	31.8	19.3
10	645.8	31.6	18.8
Total	**645.8**	**31.6**	**18.8**

* Tonnage and grade numbers rounded to first decimals.

Table 14-13: Sensitivity Table - Inferred Mineral Resources

COG Fe_{mag} %	Tonnage* (Million)	Fe_{tot} (%)	Fe_{mag} (%)
25	20.6	34.2	26.5
22.5	44.3	32.7	24.9
20	69.7	32.4	23.6
17.5	104.1	31.9	22.0
15	132.1	31.3	20.8
12.5	166.1	30.4	19.3
10	188.3	30.1	18.4
Total	**188.3**	**30.1**	**18.4**

* Tonnage and grade numbers rounded to first decimals.

14.6.7 Block Model Validation

The validation of the Mineral Resource estimate of the Shymanivske deposit was carried out in two separate steps.

For the first step, block grades (Fe_{tot} and % Fe_{mag}) were compared visually against drill hole assay data and composite data for each section and on plan views. The global validation of the block model results, when compared with the grade of the assay and composite intervals, were confirmed with this visual comparison.

For the second step, the average of the block grades was reported at 0.01% Fe_{tot} cut-off when blocks in all classifications were totalled. This average is the average grade of all blocks within the mineralized domain. The values of the interpolated grades for the block model were compared to the average grade of head and the average grade of composites of all samples from within the domain (Table 14-14).

Table 14-14: Comparison of Average Grade of Raw Assays and Composites with Total Block Model Average Grades for Major Mineralized Domains

SX1F	$\%Fe_{tot}$	$\%Fe_{mag}$
Assays	31.0	16.8
Composites	30.8	16.6
Blocks	30.8	16.5
SX2F	$\%Fe_{tot}$	$\%Fe_{mag}$
Assays	32.0	19.6
Composites	31.8	19.4
Blocks	31.2	19.1
SX4F	$\%Fe_{tot}$	$\%Fe_{mag}$
Assays	30.9	16.9
Composites	30.5	16.4
Blocks	30.3	16.7

The comparisons above show the average grade of all the blocks in the constraining domains to be in close proximity of the average of all assays and composites used for grade estimation, and any variances observed were not considered to be material.

14.6.8 Interpretation and Conclusion

The Shymanivske deposit, located in the Kryvyi Rih area of Ukraine, is part of an iron formation belt (KrivBass Belt) which hosts several iron ore deposits and active mining operations. It covers an area approximately 2 km long by 1.2 km wide. The area has been explored since the middle of the 20th century by geophysical methods, drilling and metallurgical testing.

Mineralization on the Property comprises meta-taconite, similar to deposits of the Labrador Trough in the Canadian Shield. The deposit consists of four mineralized units, three of which (SX1F, SX2F and SX4F) are Magnetite-Quartzite and considered in the Mineral Resource estimate; the other unit is an Oxide Zone (SX5F) consisting of Magnetite-Martite-Quartzite and it is not included in the current resources. The mineralization is folded and faulted and quite structurally complex in some areas.

The drilling was done on cross-sections perpendicular to the strike of the formations with spacing, varying from 30 m to 130 m along sections and from 80 m to 300 m along strike, with vertical depths of 250 m to 550 m, for a total of 57,455.8 m in 385 holes. The present Mineral Resource estimate was completed, by using all historical drilling and information from Black Iron's twin and definition drilling programs. The results for all non-oxidized horizons are summarized in Table 14-15.

Table 14-15: Mineral Resource Estimate for the Shymanivske Iron Ore Deposit (Cut-off Grade of 10% Fe_{mag})

Category	Tonnes (Million)*	Fe_{tot} %	Fe_{mag} %
Measured	355.1	32.0	19.5
Indicated	290.7	31.1	17.9
Total M&I	**645.8**	**31.6**	**18.8**
Inferred	188.3	30.1	18.4

* Tonnage and grade numbers are rounded to the first decimal

A cut-off grade of 10% Fe_{mag} was determined to be appropriate for the purposes of this Report and was chosen on the basis of a preliminary review of the parameters that would likely determine the economic viability of a large open-pit operation. This cut-off compares well to similar projects and neighboring mines in the area. The selected COG is also a “natural COG” of the mineralization and was chosen for the wireframe modelling of mineralized domains; a sharp reduction in grade is evident at, or very near to, the contact of the mineralized horizons with barren quartzite.

The Fe_{tot} grades have been included in this Report, but in WGM’s opinion, the total iron grades in the Mineral Resource estimate should not be relied upon as a basis for evaluating the Shymanivske deposit. WGM questions the reliability of the Fe_{tot} assays for some historic drilling and this uncertainty is summarized in Chapters 7 and 11. Furthermore, because of the considerable Fe-silicate component of the iron mineralization, the Fe_{tot} assays and averages do not, in WGM’s opinion, represent a truly meaningful measure of the deposit. To obtain a truly meaningful measure of the deposit, Fe_{mag} is a much better basis as reported in the tables above.

The total Inferred Resource tonnage for the martite-rich quartzite horizon (SX5F) was historically estimated (111.5 Mt @ 33% Fe_{tot} and 4.3% Fe_{mag}) in previous work from the Soviet era and in the Genivar report (January, 2011). For the current block model, Fe_{tot} and Fe_{mag} grades were interpolated within this SX5F martite domain and are comparable to past estimates, but due to a lack of drilling within this domain, drill holes being abandoned and intersecting this unit at shallow angles, and unknown Fe recoveries of this unit, the results of the SX5F Domain are not included in the current Mineral Resource estimates and it is considered waste for the purposes of this Study. It is possible that this material will be brought into the resource estimate in the future, once further metallurgical testwork and additional drilling are completed.

Because of the lack of outcrops on the Shymanivske Property, the impact of the faulting and thrusting in the structural interpretation of the deposit is debatable and WGM and Black Iron have some differences in this regard. WGM agrees that faulting is important, but believes that a major unconformity is the principal reason for the Oxide Zone. WGM also believes that the stratigraphic assignment of SX5F to this zone and adjacent zones is not very reliable and that it would make less use of the Saksagan Group member stratigraphy in future.

Most of the previous drilling, including the Twin Drilling program, is vertical or sub-vertical in nature. During the definition drilling, WGM proposed drilling with flatter angles to give more information about the location and orientation of faulted blocks and the existence of several projected faults within the deposit from south to north. Although this program partially achieved its goals in delineating some structural elements within the deposit, the program came up short in the steeply dipping areas close to the west limb of the main anticline structure, where some proposed holes were cancelled because of the position of collars on old waste dumps. These waste dumps belong to the neighbouring mines and, at the time of the definition drilling program, Black Iron had been asked to remove the drills from the waste dumps by the neighbouring mine operators. Completion of some of these holes certainly gives a better idea about the presence of major structures, which control the boundary of the Oxide Horizon (SX5F) and the magnetite-bearing quartzite. In the western limb of the Shymanivske anticline, where magnetite-quartzite units dip approximately 70ºSW, swarms of cross-cutting structures dislocate members of the BIF horizons on different levels.

15. MINERAL RESERVE ESTIMATES

Since this Report summarizes the results of a Preliminary Economic Assessment (PEA), no Mineral Reserves have been estimated for the Shymanivske deposit as per NI 43-101 guidelines. The subset of Mineral Resources with the open pit design are presented in Chapter 16.

16. MINING METHODS

The following major changes have been incorporated into the current PEA as compared to the 2014 FS for the Shymanivske Project:

- Inferred Mineral Resources have been considered in the mine design. The inclusion of these resources is predicated on future plans to upgrade them to the Measured or Indicated category.
- A phased Project development plan has been adopted whereby the concentrator and ancillary facilities will first be constructed for a nominal capacity of 4 Mtpa of dry concentrate, to be followed by an additional 4 Mtpa (for a total of 8 Mtpa) in the fifth year of operation. The mine plan has been aligned accordingly.
- Assumptions related to the economic parameters, such as the concentrate selling price and operating costs for performing pit optimization, have been updated. The criteria for selection of the optimal pit to be carried forward to mine planning have been refined.
- A physical constraint related to the Project's mining allotment permit has been incorporated.

The mining method selected for the Project, consisting of a conventional open pit, truck and shovel, drill and blast operation, has not changed from previous studies on the Property. Vegetation and topsoil will be stripped and stockpiled for future reclamation use. Overburden, as well as parts of the historic waste dumps that will be mined, will be sent to either waste dumps or to the tailings facility to be used as construction material. The mineralized material and waste rock will be mined with 15 m high benches, drilled, blasted and loaded into a fleet of haul trucks using electric cable shovels.

16.1 Resource Block Model

The mine design for the PEA is based on the Mineral Resource block model that was prepared by Black Iron and audited by WGM, as presented in Chapter 14 of this Report. The 3D block model is composed of blocks that are 10 m x 20 m x 15 m high and contains a mix of Measured, Indicated, and Inferred Resources. The block model coordinates and rotation are as follows.

- Easting coordinates of model (WGS84 – Upper SW corner): 518,717
- Northing coordinates of model (WGS84 – Upper SW corner): 5,296,153
- Datum elevation of top of model: 205 m
- Model rotation (anti-clockwise around Origin): -21.50

Table 16-1 presents the items in the block model that were used for the mine design.

Table 16-1: Block Model Items

Item	Description
TOPO	Number from 0 – 100 describing percent beneath current topo surface
RTYPE	8, 11, 12, 14, and 18
ORE%	% of block that contains mineralized material
DENS	Density in tonnes/m^3
FETOT	Total assayed iron grade
FEMAG	Magnetic assayed iron grade
RSCAT	Resource Category (Measured, Indicated, Inferred)

Of the five mineralized zones, Rock Type 18 was considered as a waste rock for the purposes of this PEA due to the fact that it is oxidized and the magnetite may not be recoverable. Material coded in the block model as overburden includes *in situ* silts, sands and the clay layer that underlies the topsoil as well as limestone. The overburden also includes the broken rock from the historical waste dumps that will be encountered in the mine area.

16.2 Material Properties

The material properties for the different rock types are presented in the following paragraphs. These properties are important in estimating the subset of Mineral Resources within the open pit design and the equipment fleet requirements, as well as the dump and stockpile design capacities.

16.2.1 Density

Chapter 14 of this Report presented the *in situ* dry density of the mineralized material which varies based on the Fe grade and averages 3.48 t/m^3. A density of 2.9 t/m^3 was used for waste rock and 2.2 t/m^3 for overburden.

16.2.2 Swell Factor

The swell factor reflects the increase in volume of material from its *in situ* state to after it is blasted and loaded into the haul trucks. The swell factor is an important parameter that is used to determine the loading and hauling equipment requirements as well as the dump and stockpile designs. A swell factor of 40% was used for the PEA, which is a typical value used for open pit hard rock mines. Once the rock is placed in the waste dump, the swell factor is reduced to 30% due to compaction.

16.2.3 Moisture Content

The moisture content reflects the amount of water that is present within the rock formation. It affects the estimation of haul truck requirements and must be considered during the payload calculations. The moisture content is also a contributing factor for the process water balance. A moisture content of 2.5% was used mineralized material and waste rock and 10% for overburden.

16.3 Pit Optimization

A pit optimization analysis was conducted to determine the cut-off grade and the extent to which the deposit can be mined profitably. The pit optimization was done using the MS Economic Planner module of MineSight. The optimizer uses the 3D Lerchs-Grossman algorithm to determine the economic pit limits based on input of mining and processing costs, revenue per block and operational parameters such as the Fe recovery, pit slopes and other imposed constraints.

Since this Study is at a PEA level, NI 43-101 guidelines allow Inferred Mineral Resources to be used in the pit optimization analysis and mine plan. Table 16-2 presents the parameters that were used for the pit optimization.

The cost inputs were taken from the results of the 2014 FS with adjustments made by BBA to account for changes in currency exchange rates. The costs and operating parameters that were used are preliminary estimates for developing the economic pit and are different from the operating costs subsequently developed in this PEA and presented in Chapter 21.

Mining dilution and mining recovery were considered in the analysis. An overall pit slope of 47 degrees was used.

Table 16-2: Pit Optimization Parameters

Description	Units	Values
Mining Costs		
Mining cost mineralized material & waste rock	$/t mined	1.25
Mining cost overburden (OB)	$/t mined	1.00
Unit mining cost per bench	$/t / bench	0.02
Processing Costs		
Processing cost (beneficiation)	$/t milled	2.72
Royalty	$/t milled	0.09
Infrastructure	$/t conc.	0.44
Black Iron PMT	$/t conc.	0.46
Environmental	$/t conc.	0.26
Tailings & Waste	$/t conc.	0.05
Transport and Ship Loading	$/t conc.	9.30
Iron Ore Price Model		
Iron Ore Price (FOB Ukraine Port)	$/t	72.5

Black Iron provided BBA with the mining allotment boundary that was used as a constraint for the pit optimization. This boundary was obtained from the Ukrainian government following the release of the Feasibility Study in 2014. The boundary is presented in Figure 16-6, Ultimate Pit Design.

The following formula was used in order to determine the amount of concentrate that will be produced by each block in the model, which is required to determine the revenue of each block. This formula differs from the formula used to calculate annual concentrate production.

Concentrate (t) = Tonnes of Mineralization x % Fe$_{mag}$ x 93% Mill Recovery / 68% Concentrate Grade

Using the cost and operating parameters, a series of pit-shells were generated by varying the selling price (revenue factor) from $37.80/t to $109.20/t. The NPV for each pit shell was calculated and analyzed using the industry standard pit-by-pit graph. This process creates a series of nested pit shells that prioritize the mining of the most profitable material first, which progressively grows in size as less profitable material is mined with increasing revenue factor (RF).

The NPV values allow for relative comparison of the different optimized pits. It should be noted that these values are hypothetical in nature, as they are not derived from a detailed mining plan nor include any capital or sustaining costs. Figure 16-1 presents the results of the analysis.

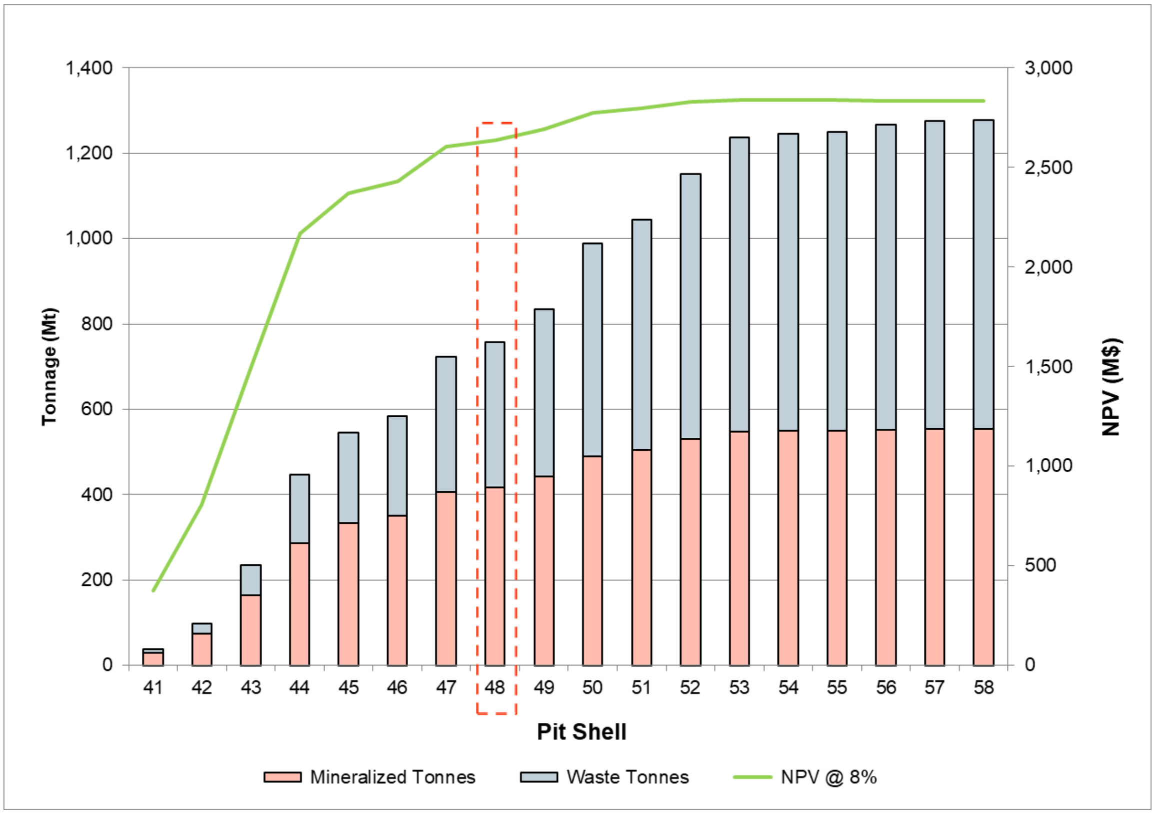


Figure 16-1: Pit Optimization Results

The pit that was selected to be used for the detailed design is Pit Shell #48, which was run with a RF of 0.62. Considering mining dilution and mining loss, this pit contains 392 Mt of measured and indicated mineral resources at an average grade of 19.3% Fe_{mag} and 25 Mt of inferred mineral resources at an average grade of 19.8% Fe_{mag}. The stripping ratio for this pit shell is 0.8:1. Table 16-3 presents the resources within Pit #48. The reasons for this selection are as follows:

- One of the highest undiscounted cash flows;
- One of the highest NPV's at the 8% discount rate;
- Incremental stripping ratio increases considerably for the subsequent pit shells.

Table 16-3: Pit Optimization Results

Material	Tonnage (Mt)	Fe_{tot} (%)	Fe_{mag} (%)
Measured	282	31.4	19.4
Indicated	110	31.2	18.9
Total Measured & Indicated	**392**	**31.4**	**19.3**
Inferred	25	31.3	19.8
		-	
Overburden	93	-	-
Waste Rock	248	-	-
Total Stripping	**341**	-	-
Strip Ratio	0.8		-

Figure 16-2 presents a typical section through the deposit and how the selected optimized pit shell (Pit #48) intersects. For reference, Pit #55 corresponds to the optimization using the base selling price (i.e. RF = 1.0). The analysis indicates that Pit #48 contains approximately 76% of the resources in Pit #55.

It should be noted that the northwest extent of the pit optimization is largely controlled by the inclusion of Inferred Mineral Resources at depth. These resources have been included in this Study with the expectation that future drilling will be performed in this area.

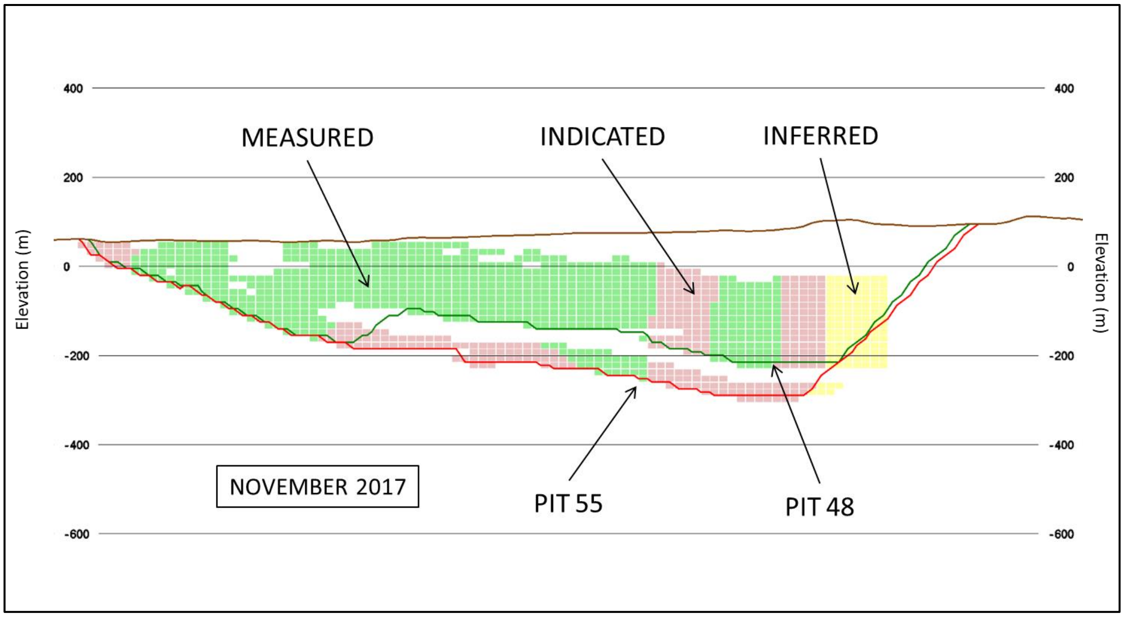


Figure 16-2: Pit Optimization Results Section

16.4 Cut-off Grade

A cut-off grade is calculated for each deposit to determine whether the material being mined will generate a profit after paying for the processing, transportation and G&A costs. Material that is mined below the cut-off grade is either sent to the waste dump or stockpiled for future processing. Using the economic parameters presented in Table 16-2, the cut-off grade for the PEA was calculated to be 3.31% Fe_{mag}. In order to account for a profit margin and to be in line with other projects it was decided to maintain the cut-off grade of 13% that was used in the 2014 FS. Figure 16-3 presents a histogram of the grades and tonnages contained in the Mineral Resources. The histogram shows that the Shymanivske deposit contains a relatively small tonnage below this cut-off.

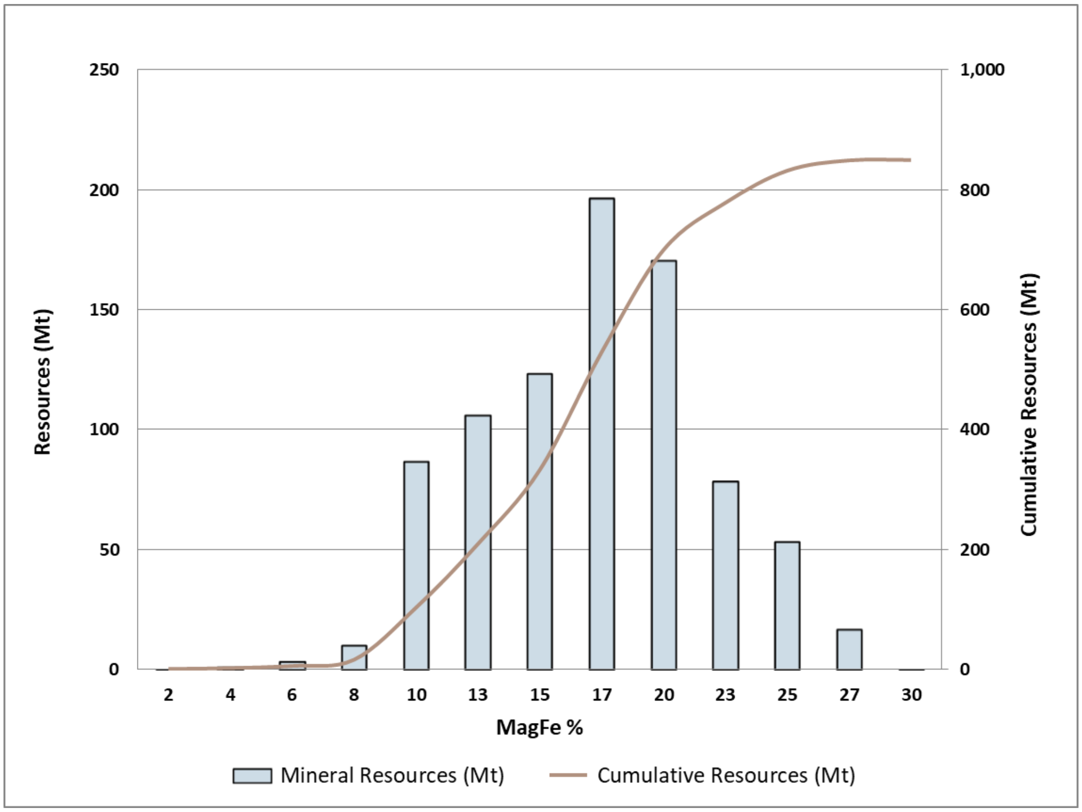


Figure 16-3: Grade Tonnage Curve

16.5 Open Pit Design

The following section presents the design criteria and resulting subset of mineral resources within the open pit design that were used as a basis for the production plan. The pit design uses the optimized pit shell as a guideline and includes smoothing the pit walls, adding ramps to access the pit bottom and ensures that the pit can be mined safely and efficiently using the selected equipment.

16.5.1 Geotechnical Pit Slope Parameters

The geotechnical assessment for the pit slopes was completed by NTF Science and Technology Company for Practical Engineering Geology, Hydro-Geology and Transport (PIGGIT) LLC in a report titled (translated) "*Substantiation of parameters of dump slopes and open pit mine flanks and steps to be taken to ensure their stability, May 29, 2012"*. This report formed the basis for the pit slope design, which was reviewed by the WorleyParsons geotechnical engineering staff, who provided the pit slope design criteria presented in Figure 16-4

In summary, the overall pit slope through the iron formation is 47 degrees. This overall slope is achieved with 15 m high benches, a bench face angle of 60 degrees and a berm width of 10.6 m, which is placed every two benches. The overall pit slope through the overburden formation is 37.5 degrees which is achieved with 15 m high benches, a bench face angle of 60 degrees and a berm width of 10.9 m. Where mining will occur into the historic waste dumps, an offset of 20 m is required from the pit crest, and the dump will be mined in 5 m benches at a bench face angle of 50 degree. A catch bench of 4.2 m will be placed on every bench, resulting in an overall slope of 30 degrees.

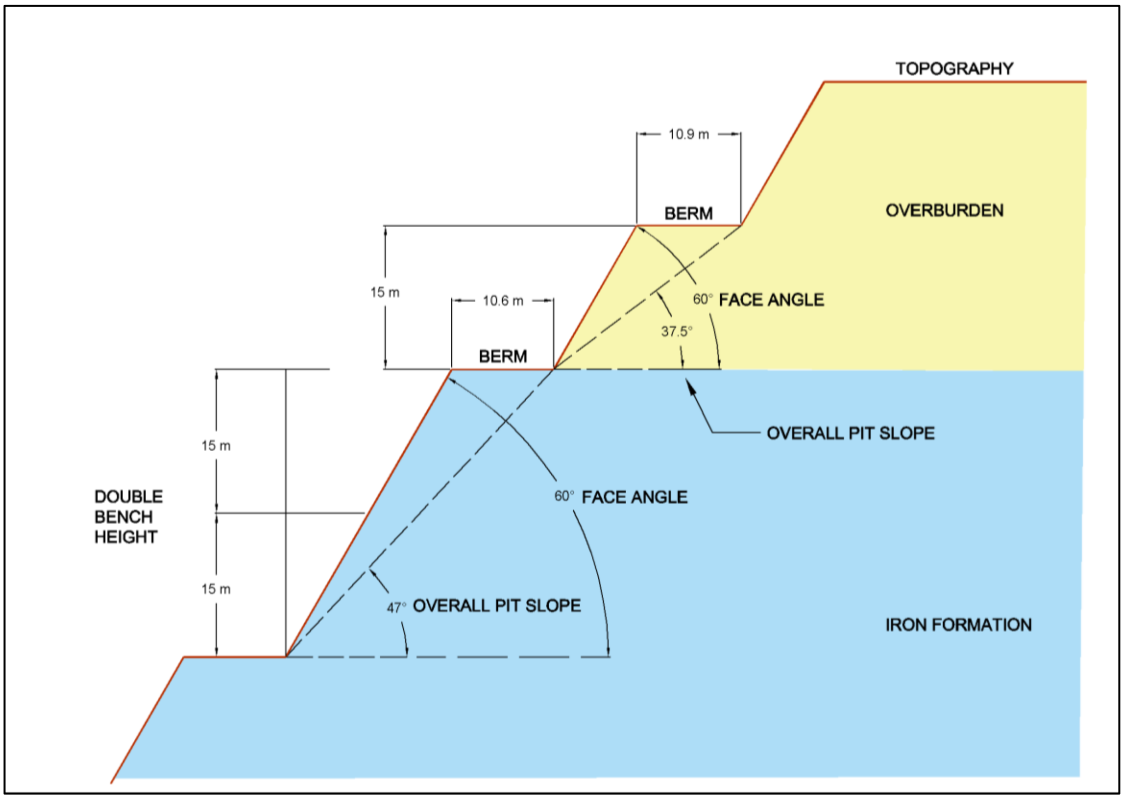


Figure 16-4: Pit Wall Configuration

16.5.2 Hydrogeological and Hydrological Assessment

The hydrogeological assessment for the open pit was completed by PIGGIT in a report titled (translated) "*Analysis of impact exerted by Shymanivske open pit mine, its dumps and industrial site on underground hydrosphere in affected area, July 2012"*.

At the completion of mining the total steady flow of groundwater into the Shymanivske open pit mine is estimated by PIGGIT to be approximately 170 m^3/hr, which is anticipated to begin at a mining depth of 100 m from surface.

16.5.3 Haul Road Design

The ramps and haul roads were designed for haulage with 228 t rigid frame mining trucks, with an overall width of 31 m. For double lane traffic, industry practice indicates the minimum running surface width to be a minimum of three times the width of the largest truck. The overall width of a 228 t haul truck is 8.3 m which results in a running surface of 24.9 m. The allowance for berms and ditches increases the overall haul road width to 31 m. A maximum ramp grade of 10% was used. Figure 16-5 presents a typical section of the in-pit ramp design. Based on Ukraine mining regulations 50 m flat segments were considered for every 60 m vertical separation.

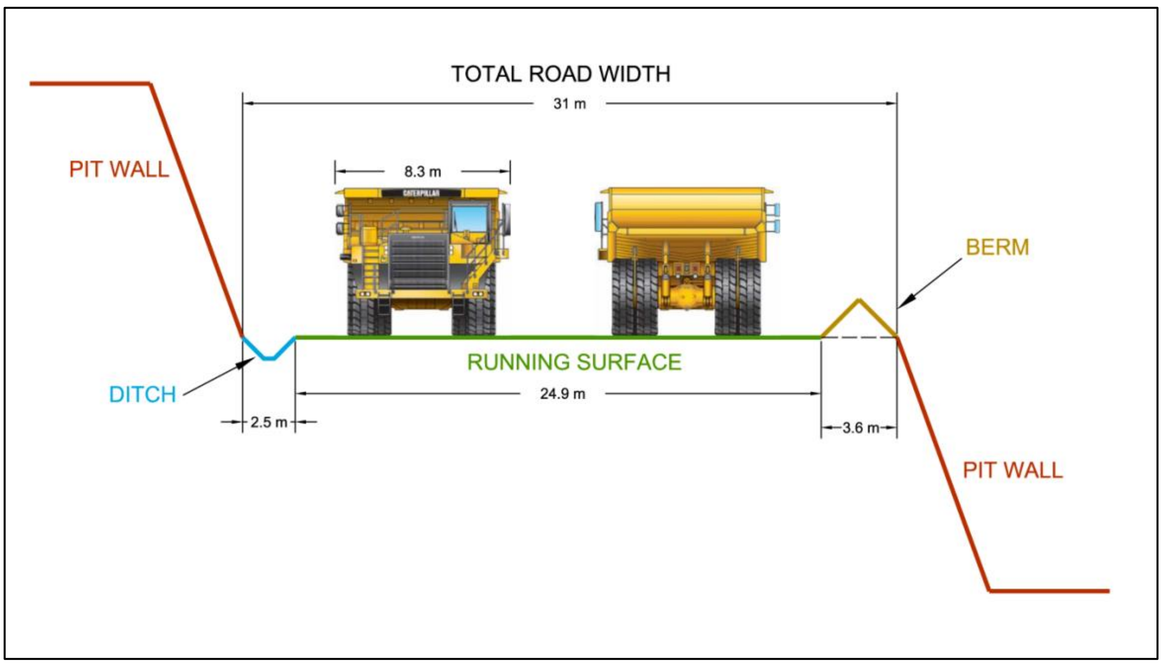


Figure 16-5: Ramp Design

16.5.4 Mine Dilution and Mining Recovery

In every mining operation it is impossible to perfectly separate the mineralized material and waste rock as a result of the large scale of the mining equipment and the use of drilling and blasting. In order to account for mining dilution and mining recovery, BBA retained the same methodology that was presented in the 2014 FS which is based on a dilution skin analysis that was done on the mineralized zones of the deposit. A mining recovery of 2% was therefore applied as well as a dilution factor of 7.1%. The dilution material is assumed to average 9.8% Fe_{mag} and 18.3% Fe_{tot}.

16.5.5 Subset of Mineral Resources within the Open Pit Design

The pit that has been designed for the Shymanivske Project is approximately 1,200 m long and 750 m wide at surface with a maximum pit depth from surface of 300 m. The total surface area of the pit is roughly 2,000,000 m^2. The pit is completely contained within the mining allotment.

Two exits/entrances have been designed for the final engineered pit. One of the pit ramps enters the pit from the north side at the 75 m elevation and is mainly used to access the crusher as well as the topsoil dump located on the North side of the pit. The second pit ramp also enters the pit at the 75 m elevation and is located on the southwest corner to access the waste dump. Both ramps can be used to haul the mineralized material and waste rock depending on which phase is being mined. The two pit ramps meet at the -80 m elevation and each proceeds down to the pit bottoms at the -230 m and -155 m elevations.

Accounting for mining dilution and mining recovery, the open pit design includes 389 Mt of Measured and Indicated Mineral Resources at an average grade of 19.3% Fe_{mag}, and 22 Mt of Inferred Resources at an average grade of 19.6% Fe_{mag}. The pit includes 286 Mt of waste rock and 108 Mt of overburden (including historical waste rock), resulting in a strip ratio of 1.0:1. Table 16-4 presents the subset of mineral resources within the open pit designed for the Shymanivske Project and Figure 16-6 presents a plan view of the open pit design. It should be noted that this PEA includes Inferred Resources. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.

Table 16-4: Subset of Mineral Resources within the Open Pit Design (Above 13% Fe_{mag} Cut-off)

Material	Tonnage (Mt)	Fe_{tot} (%)	Fe_{mag} (%)
Measured	283	31.4	19.4
Indicated	106	31.2	19.0
Total Measured & Indicated	**389**	**31.4**	**19.3**
Inferred	22	31.2	19.6
Overburden	108	-	-
Waste Rock	286	-	-
Total Stripping	**394**	-	-
Strip Ratio	**1.0**	-	-

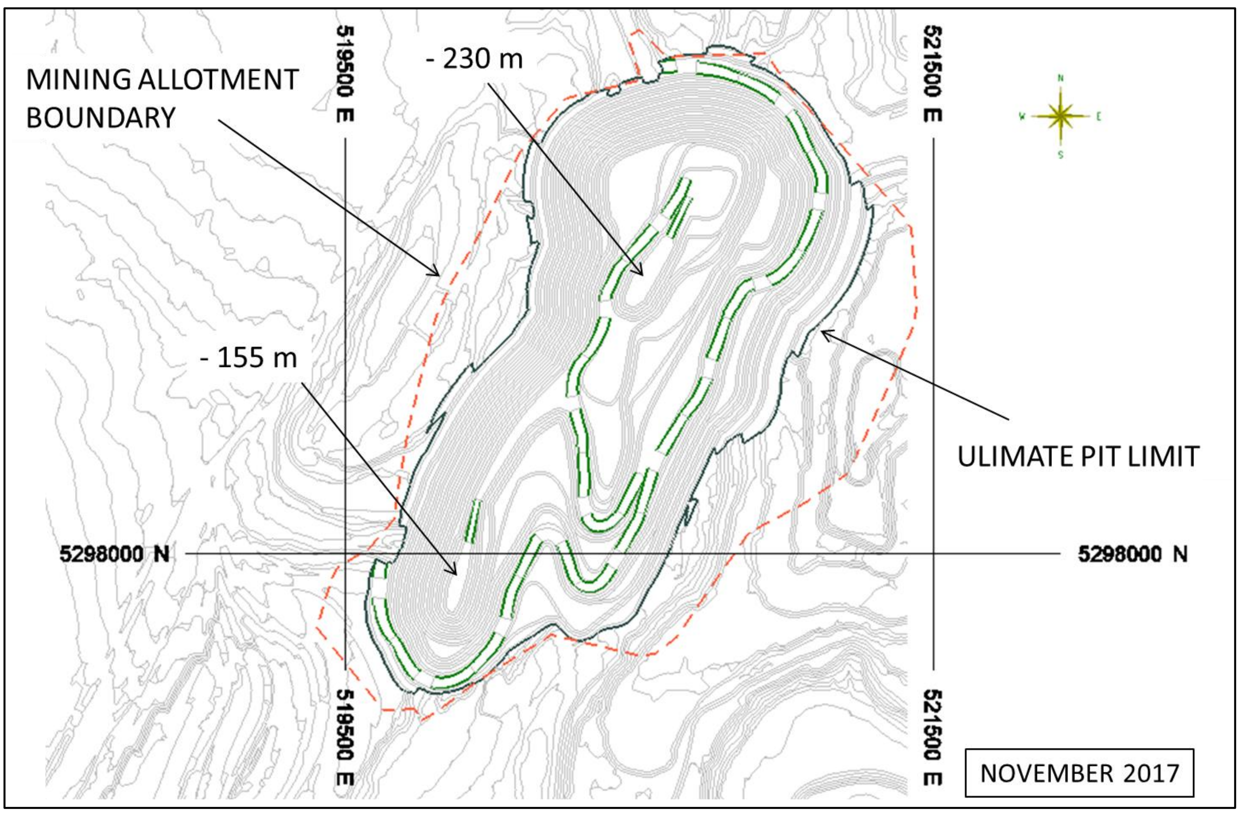


Figure 16-6: Ultimate Pit Design

16.5.6 Phase Designs

A total of three phases (cutbacks) have been designed in order to defer waste stripping and maximize the NPV of the Project. Table 16-5 presents the grades, tonnages and strip ratios associated with each phase and Figure 16-7 presents a typical section showing how the three phases interact. Figure 16-8 presents a plan view of the Phase 1 design and Figure 16-9 presents a plan view of the Phase 2 design. The Phase 3 design is the ultimate pit limit that was presented in Figure 16-6.

Table 16-5: Phase Designs

Description	Mineralization (Mt)	Fe_{tot} (%)	Fe_{mag} (%)	Overburden (Mt)	Waste Rock (Mt)	Strip Ratio
Phase 1	132	31.4	19.8	37	47	0.6
Phase 2	147	31.3	19.1	41	87	0.9
Phase 3	133	31.3	19.1	30	153	1.4
Total[1]	**411**	**31.3**	**19.3**	**108**	**287**	**1.0**

1 - Numbers may not add up due to rounding

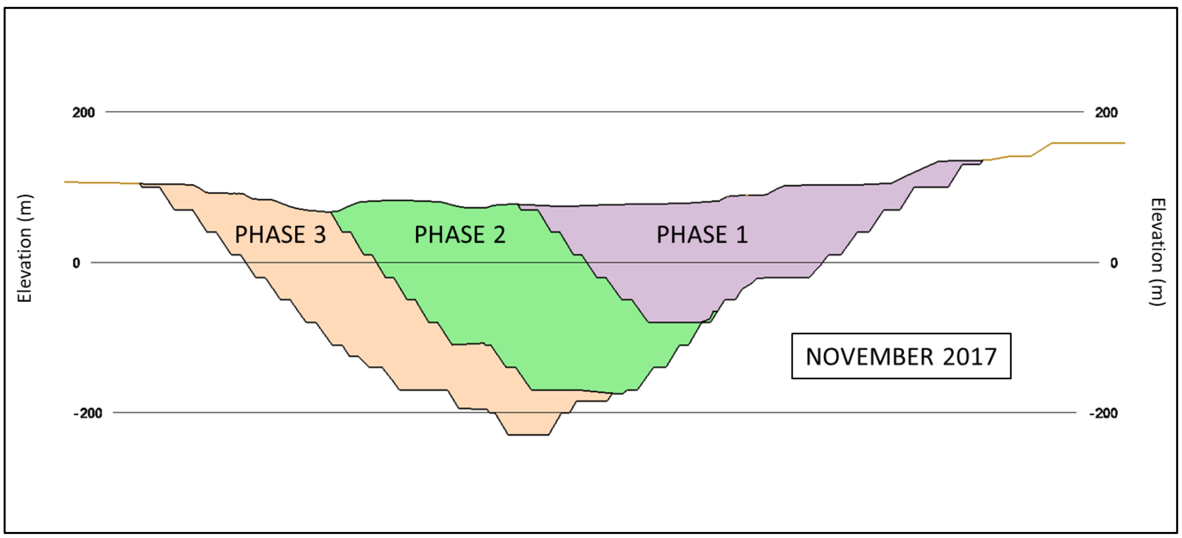


Figure 16-7: Phase Designs

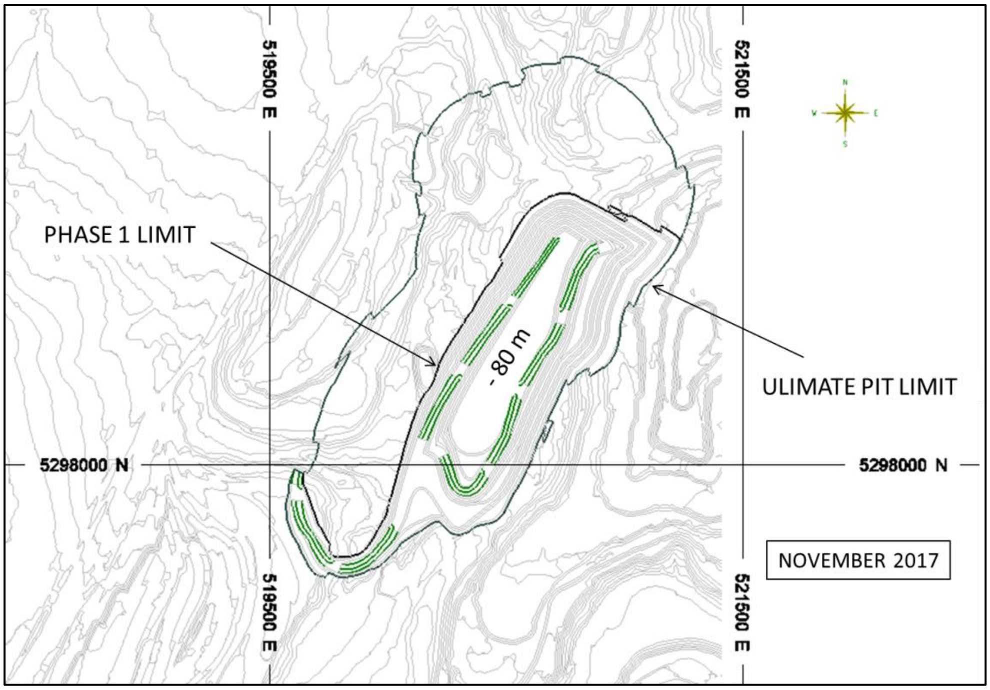


Figure 16-8: Phase 1 Design

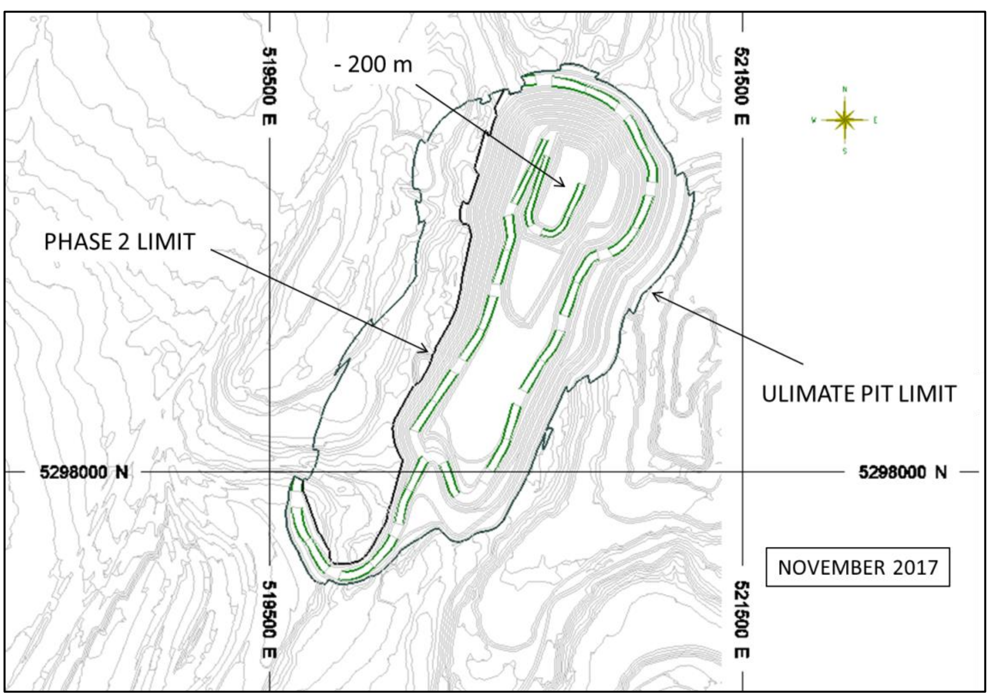


Figure 16-9: Phase 2 Design

16.5.7 Waste Dump and Stockpile Designs

Over the life of the Project, two waste storage facilities will be required. The first facility known as Reclamation Material Stockpile (RMS) will be located on the north side of the pit and will be used to stockpile vegetation and topsoil. The second facility known as Waste Storage Facility (WSF)-1 will be located on the west side of the pit and will be used to stockpile a mix of waste rock and overburden. Figure 16-10 presents a layout showing the location of both facilities. The criteria used for the WSF comes from the report "*Mine Waste Dump- Design Basis Memorandum, 207040-00076–5300-SS-REP-0001, 14 August 2012*". Table 16-6 summarizes the design criteria.

Table 16-6: Waste Dump Design Criteria

Description	Units	Value
Individual Dump Lift Height	m	25
Bench Width	m	8
Bench Face Angle	(H:V)	2:1
Overall Slope Angle	(H:V)	2.3:1
Setback from Roads, Rail, Buildings	m	100

The RMS has been designed to contain 1.5 million cubic metres of topsoil which was estimated assuming the top 300 mm of the ground surface will be topsoil. WSF-1 has been designed to contain 205 million cubic metres of rock and overburden. The footprint of this dump is approximately 285 ha and it will be built to a height of approximately 125 m.

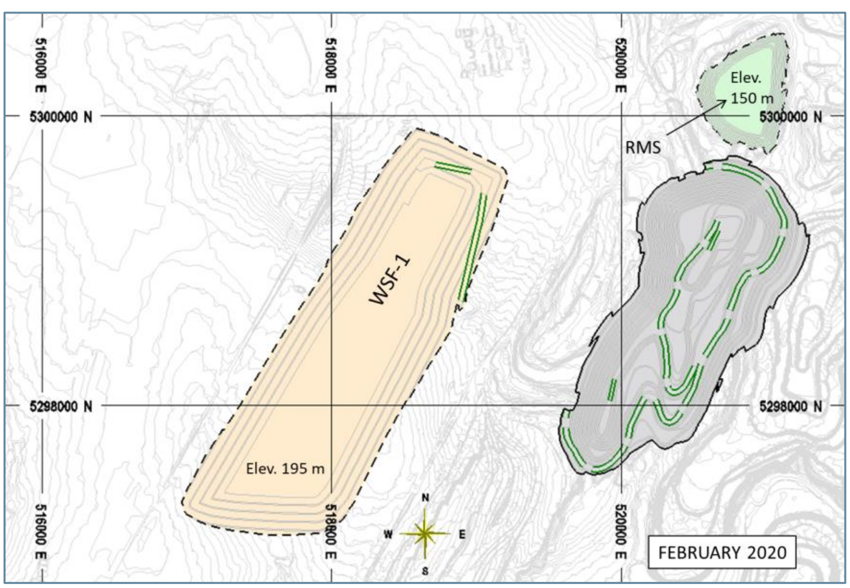


Figure 16-10: Waste Dump and Stockpiles

16.6 Mine Production Schedule

This section discusses the mine plan that was prepared for the PEA and which was used as the basis for the mine capital and operating cost estimate presented in Chapter 21. The mine plan was done in MSSO (MineSight Schedule Optimizer) and was established annually for the life of mine.

The mine plan considers a production ramp up of 75% capacity in Year 1 and begins the expansion phase ramp-up in Year 5 which is 75% of the incremental expansion capacity. By Year 6, the mine plan feeds the concentrator at its full nominal capacity of 28.7 Mtpa.

The mine plan considers a vertical advance rate of no more than five benches per year for each phase. Minimum and maximum grade constraints were also considered to ensure that the grade variations in the mine plan remained within +/-10% of the average for the subset of Mineral Resources within the open pit design. In order to determine the amount of concentrate produced each year, the weight recovery is calculated by using the following equation: Weight Recovery = 1.464 x % Fe_{mag}, as discussed in Chapter 17 of this Report.

The mine plan includes a pre-production phase of one year which is required to strip 11.6 Mt of overburden (including waste rock from the historic waste dumps). This material will be used to construct the starter dike at the Tailings Storage Facility and to build site infrastructure. Table 16-7 presents the mine production schedule.

Mine development will begin in Phase 1 and by the end of Year 2 the pit floor will be at the 10 m elevation. Phase 2 will start in Year 3 to and will facilitate the blending of mill feed and will provide a secondary source of production in case there are operational issues in the main pit of Phase 1. Phase 3 will begin in Year 9 which lines up with the completion of Phase 1.

The total material mined per year during the 17-year mine life averages 45 Mt and ranges from 35 Mt in Year 1 to a maximum of 57 Mt from Years 12 to 14. Figure 16-11 presents a chart showing the tonnages mined each year as well as the strip ratio. The average annual grade remains fairly close to the average of the subset of Mineral Resources within the open pit design of 19.3% Fe_{mag}, reaching a maximum of 20.7% during Year 5 and reaching a minimum of 18.0% during the last year, when a large part of the concentrator feed is from low grade stockpile re-handle. Figure 16-12 presents the mine production schedule by Phase and Figure 16-13 presents the mine production schedule by resource classification. It is important to note that the majority of the Inferred Resources are mined beyond Year 10. Figure 16-14 to **Error! Reference source not found.** show the status of the pit and waste dump at the end of Years 1, 5, 10 and 15 respectively.

Table 16-7: Mine Production Schedule

Description	Units	PP	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Total
Total Mill Feed	Mt	0.0	10.7	14.3	14.3	14.3	25.1	28.7	28.7	28.7	28.7	28.7	28.7	28.7	28.7	28.7	28.7	27.6	18.0	**411.2**
Average Grade Milled (Fe_{mag})	%	0.0	19.3	19.3	19.3	19.3	20.7	20.1	19.0	18.6	18.1	19.5	19.8	20.1	19.8	18.7	19.7	18.8	18.0	**19.3**
Weight Recovery	%	0.0	28.3	28.3	28.3	28.3	30.3	29.5	27.8	27.2	26.5	28.5	29.0	29.5	29.0	27.4	28.8	27.5	26.4	**28.3**
Total Concentrate Produced	**Mt**	0.0	3.0	4.1	4.1	4.1	7.6	8.5	8.0	7.8	7.6	8.2	8.3	8.5	8.3	7.9	8.3	7.6	4.7	**116.3**
ROM to Mill	Mt	0.0	10.7	14.3	14.3	14.3	22.2	28.7	28.7	28.7	28.7	28.7	28.7	28.7	28.7	28.7	28.7	27.6	16.3	**406.6**
ROM to Mill (Fe_{mag})	%	0.0	19.3	19.3	19.3	19.3	20.3	20.1	19.0	18.6	18.1	19.5	19.8	20.1	19.8	18.7	19.7	18.8	18.4	**19.3**
ROM to Stockpile	Mt	0.0	1.8	0.4	0.5	0.2	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.3	0.2	0.0	0.2	0.0	0.0	**4.6**
ROM to Stockpile (Fe_{mag})	%	0.0	23.0	22.9	25.1	25.1	13.3	0.0	12.8	0.0	14.5	14.3	15.3	14.1	14.2	12.9	13.4	0.0	0.0	**20.2**
Stockpile to Mill	Mt	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	**4.6**
Stockpile to Mill (Fe_{mag})	%	0.0	0.0	0.0	0.0	0.0	23.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.4	**20.2**
Waste Rock	Mt	0.0	13.0	7.5	5.5	8.3	13.7	17.8	21.3	21.3	15.2	15.0	16.7	27.6	28.6	28.8	21.8	15.0	9.7	**287.0**
Overburden	Mt	11.6	9.7	11.5	14.7	12.2	14.8	3.5	0.0	0.0	10.4	10.2	9.3	0.0	0.0	0.0	0.0	0.0	0.0	**107.9**
Total Material Moved	Mt	11.6	35.3	33.7	35.0	35.0	53.5	50.0	50.0	50.0	54.5	54.2	55.0	56.6	57.5	57.5	50.7	42.6	27.7	**810.6**
Total ROM	Mt	11.6	35.3	33.7	35.0	35.0	50.6	50.0	50.0	50.0	54.5	54.2	55.0	56.6	57.5	57.5	50.7	42.6	26.0	**806.0**
Stripping Ratio		n/a	1.8	1.3	1.4	1.4	1.3	0.7	0.7	0.7	0.9	0.9	0.9	1.0	1.0	1.0	0.8	0.5	0.6	**0.96**

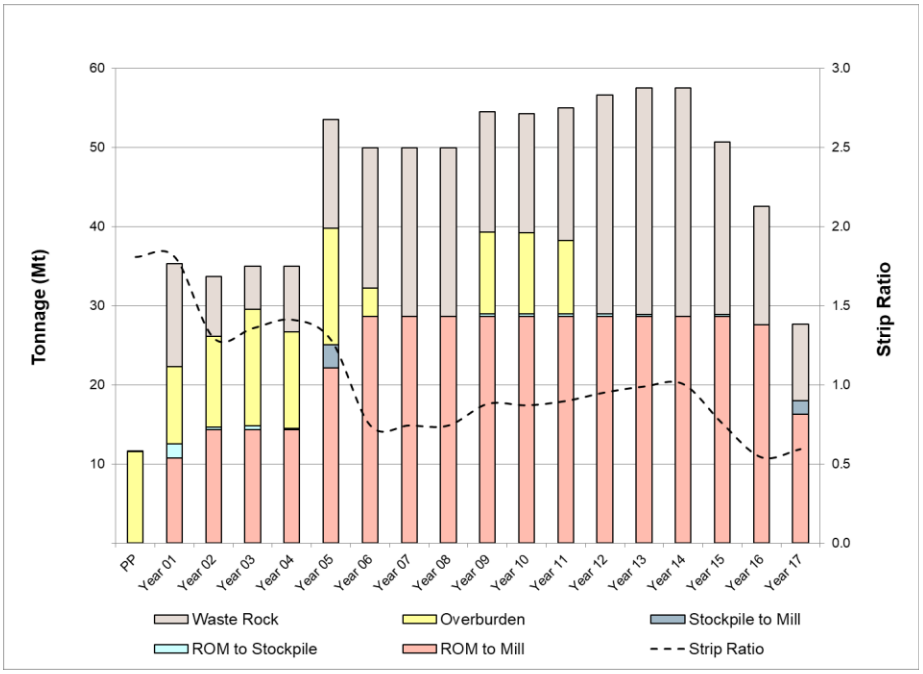


Figure 16-11: Mine Production Schedule

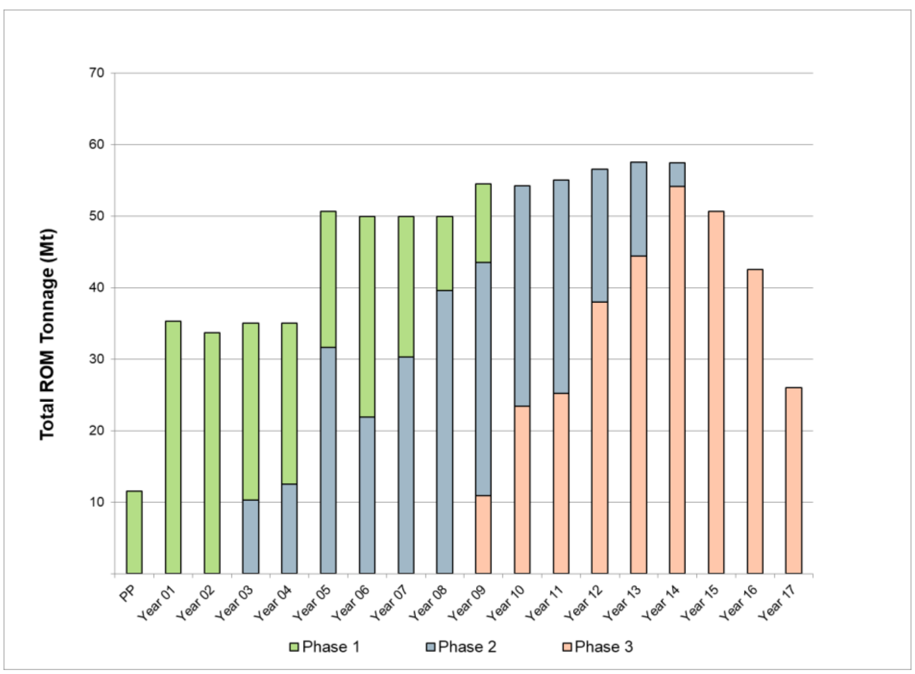


Figure 16-12: Mine Production Schedule by Phase

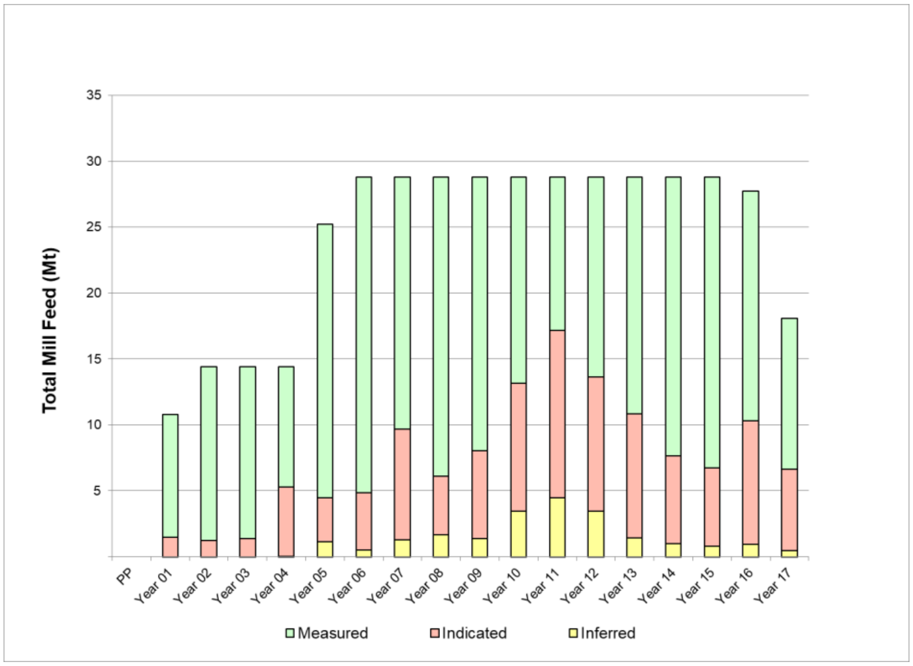


Figure 16-13: Mine Production Schedule by Resource Classification

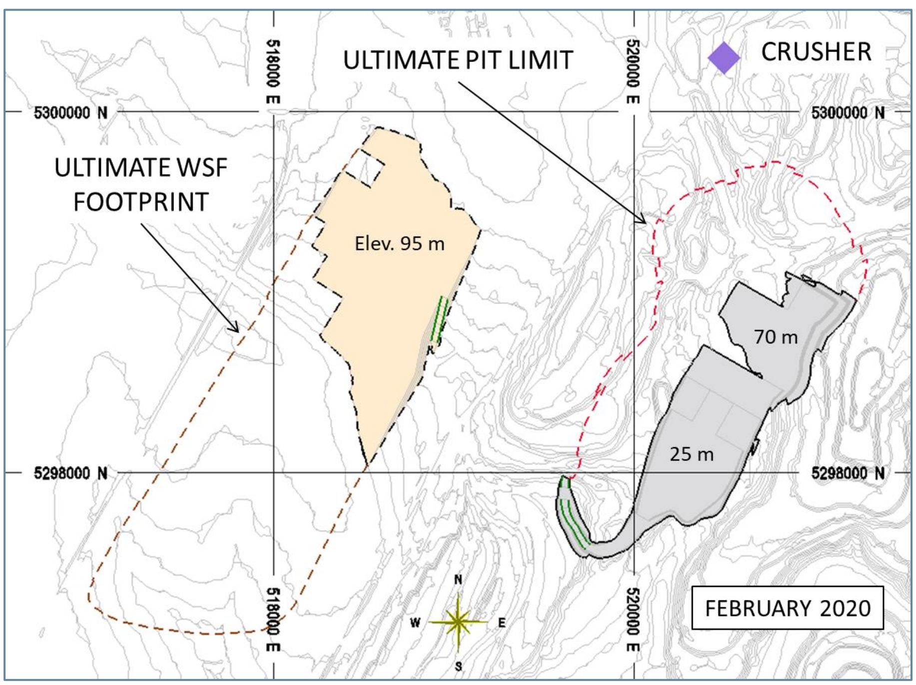


Figure 16-14: End of Year 1

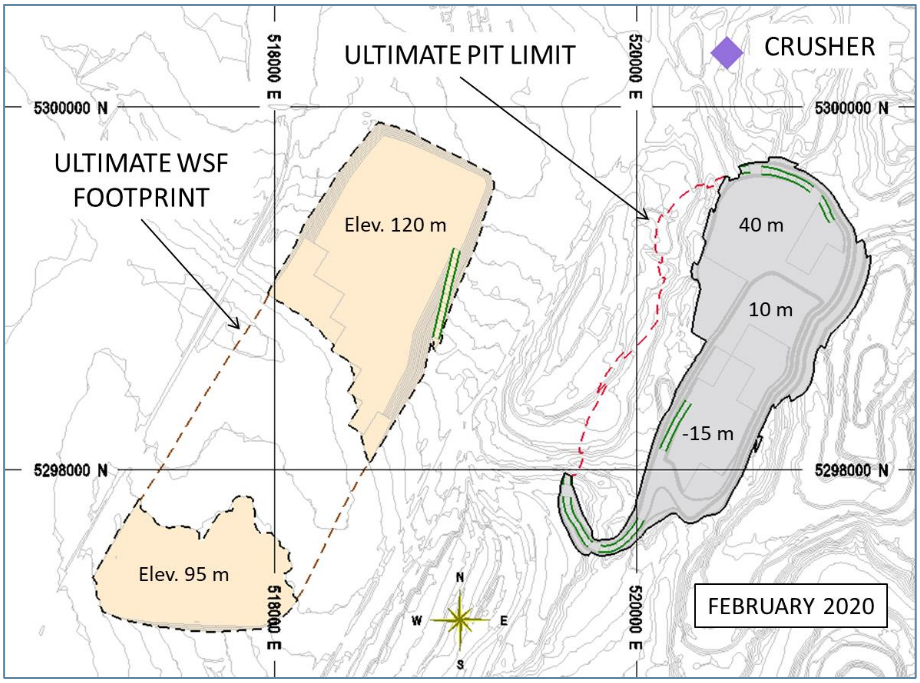


Figure 16-15: End of Year 5

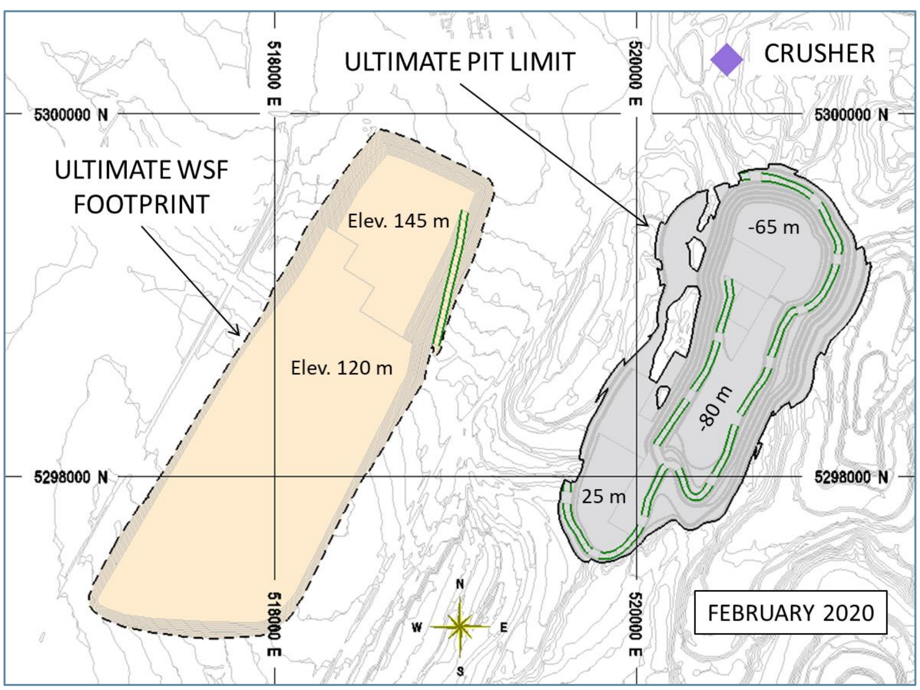


Figure 16-16: End of Year 10

16.7 Mine Equipment

The following section discusses equipment selection and fleet requirements in order to carry out the mine plan. Table 16-8 presents the list of major and support equipment required during peak production. The table identifies the Caterpillar equivalent to give the reader an appreciation for the size of each machine although the specific equipment selection will be done during the procurement phase of the Project. It should be noted that BBA contacted Ukrainian, Russian and Chinese equipment manufacturers in order to estimate the capital cost which is presented in Chapter 21.

Table 16-8: Mining Equipment Fleet

Equipment	Typical Model	Description	Units
Haul Truck	CAT 793	Payload – 228 t	25
Cable Shovel	P&H 2800	Bucket Payload – 63 t	3
Production Drill	CAT 6060	251 mm hole (10”)	4
Wheel Loader	CAT 994	Operating Weight – 200 t	3
Track Dozer	CAT D10	Operating Weight – 80 t	6
Wheel Dozer	CAT 834	Operating Weight – 50 t	3
Road Grader	CAT 16M	Operating Weight – 25 t	5
Water Truck	CAT 777	100,000 Litre Capacity	3
Cable Reeler	CAT 834	Operating Weight – 50 t	3

16.7.1 Haul Trucks

The haul truck selected for the Project is a rigid frame mining truck with a payload of 228 tonnes. A fleet of three trucks is required during pre-production, ramping up gradually to 24 during Year 8. The fleet size was estimated using the following parameters which result in 6,529 working hours per year for each truck as is presented in Table 16-9.

- Mechanical availability – 85%;
- Utilization – 93% (non-utilized time is accrued when the truck is not operating due to poor weather or when the excavator is relocating);
- Nominal Payload – 228 tonnes (130 m^3 heaped);
- Shift Schedule – 12 hours per shift, two shifts per day, 360 days per year (five days of weather delays have been considered per year);
- Operational Delays – 30 min/shift (this accounts for shift change, coffee and lunch breaks, and refuelling);
- Rolling Resistance – 3%.

Table 16-9: Truck Hours (h/y)

Description	Hours	Details
Total Hours	8,760	21 rotations per year (72 hours/rotation)
Down Mechanically	1,314	15% of total hours
Available	7,446	Total hours minus hours down mechanically
Utilized Time	7,021	Weather and operating delays
Working Hours	6,529	93% operating efficiency

Haul routes were generated for each period of the mine plan to calculate the truck requirements. These haul routes were imported in Talpac©, a commercially available truck simulation software package that BBA has validated with mining operations. Talpac© calculated the travel time required for a 228-tonne haul truck to complete each route. Table 16-10 shows the various components of a truck's cycle time. The load time is calculated using a cable shovel with a 35 m^3 (63-tonne) bucket as the loading unit. This size shovel, which is discussed in the following section, loads mineralized material and waste rock in a 228-tonne haul truck in four passes, and in five for overburden.

Table 16-10: Truck Cycle Time

Description	Hours
Spot @ Shovel	42
Load Time(1)	144
Travel Time	Calculated by Talpac©
Spot at Dump	30
Dump Time	42

(1) Four passes at 36 sec/pass.

Haul productivities were calculated for each haul route using the truck payload and cycle time. Table 16-11 shows the cycle time and productivity for the mineralized material and waste haul routes for Phase 2 in Year 10 as an example.

Table 16-11: Truck Productivities (Phase 2 - Year 10)

Material	Cycle Times (min)					Productivity	
	Travel	Spot	Load	Dump	Total	Loads/h	tph
Mineralized Material	22.61	0.70	2.40	1.20	26.96	2.23	446
Waste Rock	30.76	0.70	2.40	1.20	35.11	1.71	343

Truck hour requirements were then calculated by applying the tonnages hauled to the productivity for each haul route.

The average one-way haul distance for the life of mine is 4.1 km for mineralized material to the crusher, 5.8 km for waste to the dump and tailings and 4.7 km for overburden.

16.7.2 Cable Shovels

The three loading machines selected for the Project are electric cable shovels with bucket payloads of 63 tonnes. Using an 85% mechanical availability and 100 minutes per shift in operating delays, it was estimated that three shovels can manage the tonnages of mineralized material, waste rock and overburden in the mine plan.

16.7.3 Wheel Loaders

A total of three wheel loaders, with operating weights of 200,000 kg, will be used for stockpile re-handle as well as alternate loading units when the cable shovels are unavailable.

16.7.4 Drilling and Blasting

Production drilling for mineralized material and waste rock will be carried out with electric powered rotary down the hole (DTH) drills that will drill 251 mm (10”) holes. Using an 88% mechanical availability, 100 minutes per shift in operating delays and a penetration rate of 20 m/h, it was estimated that four drills will be required to carry out the mine plan.

It is assumed that 10% of the overburden will need to be drilled and blasted and that the remainder of the overburden will be mined by ripping and dozing or by free digging. It has been assumed that the overburden drilling will be done by a local contractor.

Bulk emulsion will be used for blasting and the calculations have been done assuming an explosive density of 1.12 g/cm^3. A local contractor will supply and store the explosives and accessories and load the blast holes.

Table 16-12 presents the drilling and blasting parameters that have been designed for the PEA.

Table 16-12: Drilling and Blasting Parameters

Description	Units	Overburden	Mineralized Material	Waste
Bench Height	m	15	15	15
Blast hole Diameter	mm	178	251	251
Burden	m	8.0	6.0	6.0
Spacing	m	8.0	7.0	8.0
Subdrilling	m	1.9	1.9	1.9
Stemming	m	4.0	4.0	4.0
Powder Factor	kg/t	0.16	0.33	0.34

16.7.5 Auxiliary Equipment

A fleet of support equipment including track dozers, wheel loaders, road graders, water trucks and cable reelers have been included in the fleet. The fleet of mining equipment also includes fuel and lube trucks, mechanic service trucks, mobile cranes, a tire handler, transport busses, light plants and pick-up trucks.

16.8 Mine Manpower Requirements

The mine workforce will reach a maximum of 345 employees during peak production. The workforce is composed of 260 employees in Mine Operations, 68 employees in Mine Maintenance, and 17 employees in Mine Technical Services. The mine operations will be composed of four crews in order to provide a 24 h/d continuous operation.

17. RECOVERY METHODS

Various metallurgical testwork campaigns have been performed on the Shymanivske deposit. The testwork results were used to develop the proposed mineral processing flowsheet and to estimate the metallurgical performance of the processing plant. Adjustments have been made in consideration of the % Fe_{mag} differences between the samples selected for the metallurgical testwork and the LOM average grade.

For this PEA Study the process flowsheet has been adapted for the new scale of Project which has a nominal annual capacity of 4.0 Mtpa of dry concentrate production. For the expansion to 8.0 Mtpa, this circuit is replicated. This Chapter describes requirements for a single 4.0 Mtpa production line, unless otherwise indicated. The 2014 FS has been used as a reference for the re-scaled Project. This Chapter provides an update of the process description and serves as the basis for the estimation of the capital and operating costs for the re-scoped Shymanivske Project.

17.1 Process Design Basis

For the current PEA, the process design basis has been updated based on the revised mine plan presented in Chapter 16 of this Report. Table 17-1 presents a global balance of nominal and design tonnages for the mineral processing plant.

Table 17-1: Process Design Basis for Phase 1 of the Shymanivske Concentrator

	Nominal Operating Parameters (Dry basis)		
	Average	**Nominal Hourly Throughput**	**Design Value**
Throughput (fresh feed)	14.3 Mtpa	1,818 tph	2,091 tph
Average Concentrate production	4.1 Mtpa	515 tph	592 tph
Tailings generated	10.3 Mtpa	1,303 tph	1,498 tph
Concentrate Wt Rec %	28.3%*	-	-
Concentrate Fe Rec % - Fe_{mag} Rec %	61.9% - 93.0%	-	-
Crushing circuit utilization %	70%	-	-
HPGR and concentrator utilization %	90%	-	-
LOM Head grade %Fe - % Fe_{mag}	31.4% - 19.3%	-	-
Concentrate Specifications (%)	Fe = 68.0 SiO_2 = 4.5 S = 0.05 max Al_2O_3 = 0.43% P = 0.02 Moisture = 9.0 P_{80} = 32 µm		

* Weight recoveries were determined using the following weight recovery formula "Wt Rec = Fe_{mag}*1.464. This recovery equation was established from testwork during the 2014 FS.

The final concentrate produced is suitable for iron ore pellet feed given its fine particle size. Its high Fe content will make this product highly desirable for production of acid or fluxed blast furnace pellets.

For this Study, the process design is based on using a single high pressure grinding roll (HPGR) unit of sufficient capacity for the design throughput. The sizing of the HPGR was performed in collaboration with vendors that conducted testwork on the Shymanivske mineral samples they were provided. Upstream and downstream major processing and materials handling equipment were sized accordingly. This approach has been adopted in order to optimize the Project capital costs.

Throughput design values provide for process variations from nominal conditions on the basis of +/-15%. Mining, processing and ancillary operations are designed for continuous year-round operations, 365 days per year, 7 days per week and 24 hours per day. The operation is designed to comply with local regulations in matters of environmental, health and safety standards and to best industry practices to maintain a sustainable operation over the life of mine.

17.2 General Process Description and Plant Design

General process and plant design criteria for the Shymanivske processing plant outlined in this PEA are based on the criteria, design, general arrangements and equipment sizing developed during the 2014 FS but have been adjusted to the re-scaled Project. Figure 17-1 and Figure 17-2 present the general block flow diagrams (BFD) for the Project:

- ROM material crushing takes place in a single primary gyratory crusher located in the vicinity of the open pit;
- Secondary crushing takes place in two cone crushers operating in a reversed closed circuit with screens;
- Crushed material is stored in a crushed mineralised material stockpile;
- Crushed material is conveyed to a single HPGR unit operating in closed circuit with screens;
- HPGR screened product is magnetically separated in a cobbing stage using wet, Low Intensity Magnetic Separation (LIMS);
- The non-magnetic cobber tails are sent to coarse tailings dewatering;
- The magnetic cobber concentrate slurry is directed to a ball mill in closed circuit with screens for grinding;
- The ball mill recirculating load passes through a stage of rougher LIMS where the magnetic concentrate is returned to the ball mill feed screens;
- The non-magnetic rougher tails are sent to a thickener for dewatering;
- The primary grinding screen undersize material is fed to tower mills in closed circuit with cyclone clusters for regrinding;

- The tower mill recirculating load passes through a stage of cleaner LIMS where the magnetic concentrate is returned to the tower mill cyclone clusters;
- The non-magnetic cleaner tails are sent to a thickener for dewatering;
- The tower mill cyclone overflow is magnetically separated in a finisher LIMS stage;
- The non-magnetic finisher tails are sent to a thickener for dewatering;
- The finisher magnetic concentrate is fed by gravity to a conditioning tank prior to a stage of reverse sulphur flotation;
- The froth tails are sent to a thickener for dewatering;
- The flotation sink concentrate is sent to a concentrate thickener prior to being filtered via filter presses;
- The filtered tailings are sent to a stockpile to be loaded and shipped via train to the port;
- The general location of the crushing circuit, stockpile, concentrator, load-out, tailings disposal area and other infrastructures are described in Chapter 18 of this Report.

17.3 Preliminary Flowsheet, Mass and Water Balances

The overall PFD for the iron ore beneficiation plant is presented in Figure 17-1 and Figure 17-2. The crushing, grinding and magnetic separation processes are depicted in Figure 17-1, the flotation and dewatering processes are presented in Figure 17-2.

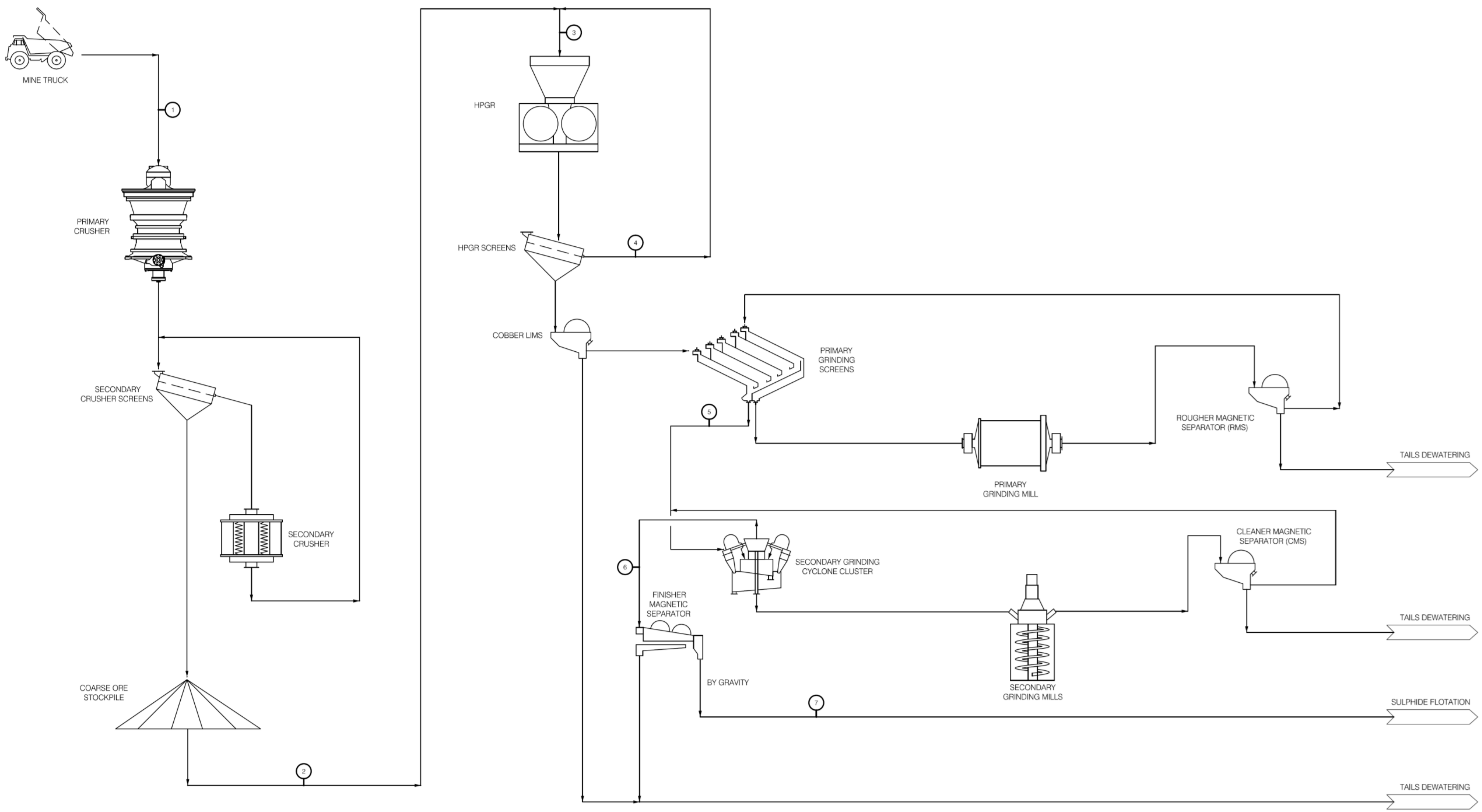


Figure 17-1: Crushing, Grinding and Magnetic Separation Block Flow Diagram

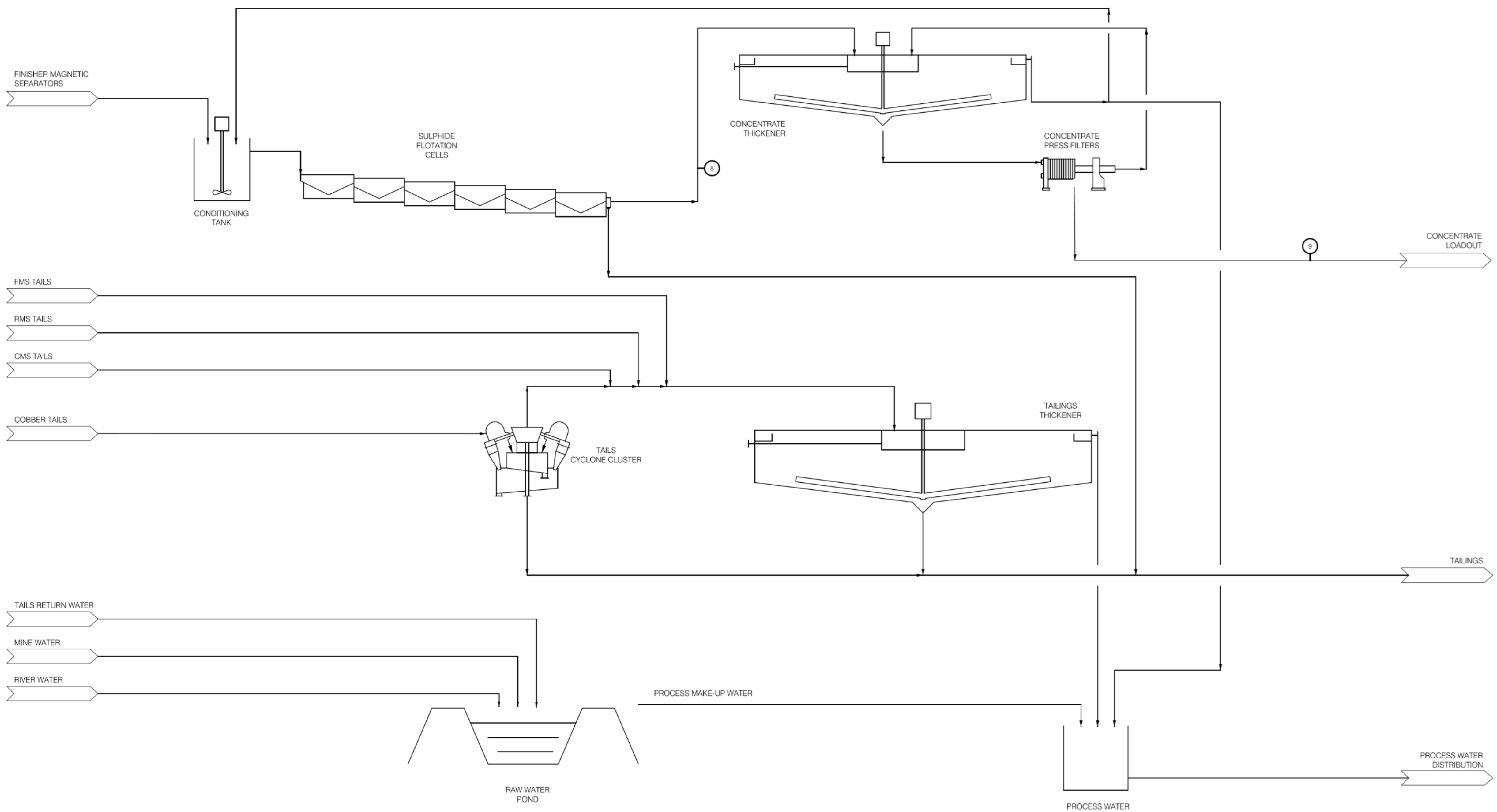


Figure 17-2: Flotation and Dewatering Block Flow Diagram

The nominal mass flowrates for the key metallurgical streams are presented in Table 17-2. The stream numbers indicated refer to numbered streams in the block flow diagram.

Table 17-2: Flowrates (Nominal) of Key Metallurgical Streams

Stream Name	Reference Number	Solids Flowrate (tph)	Slurry Flowrate (tph)	Slurry Flowrate (m^3/h)	Solids Density (%w/w)
Primary Crusher Feed	1	2,896	2,955	911	98.0
HPGR Fresh Feed	2	1,819	1,856	572	98.0
HPGR Feed	3	5,183	5,289	1,630	94.0
Cobber Magnetic Fraction	4	1,818	4,545	3,262	40.0
Primary Mill Classification U/S	5	774	2,127	1,542	36.4
Secondary Mill Cyclone O/F	6	537	2,343	1,918	22.9
FMS Magnetic Fraction	7	525	954	536	55.0
Sulphide Flotation Concentrate (Sink)	8	515	1,287	877	40.0
Final Concentrate	9	515	566	156	91.0

Figure 17-3 presents the site overall water balance and flowsheet. The material and water balances shown in this section are for nominal conditions, and represent a snap-shot of the whole process at the steady state conditions.

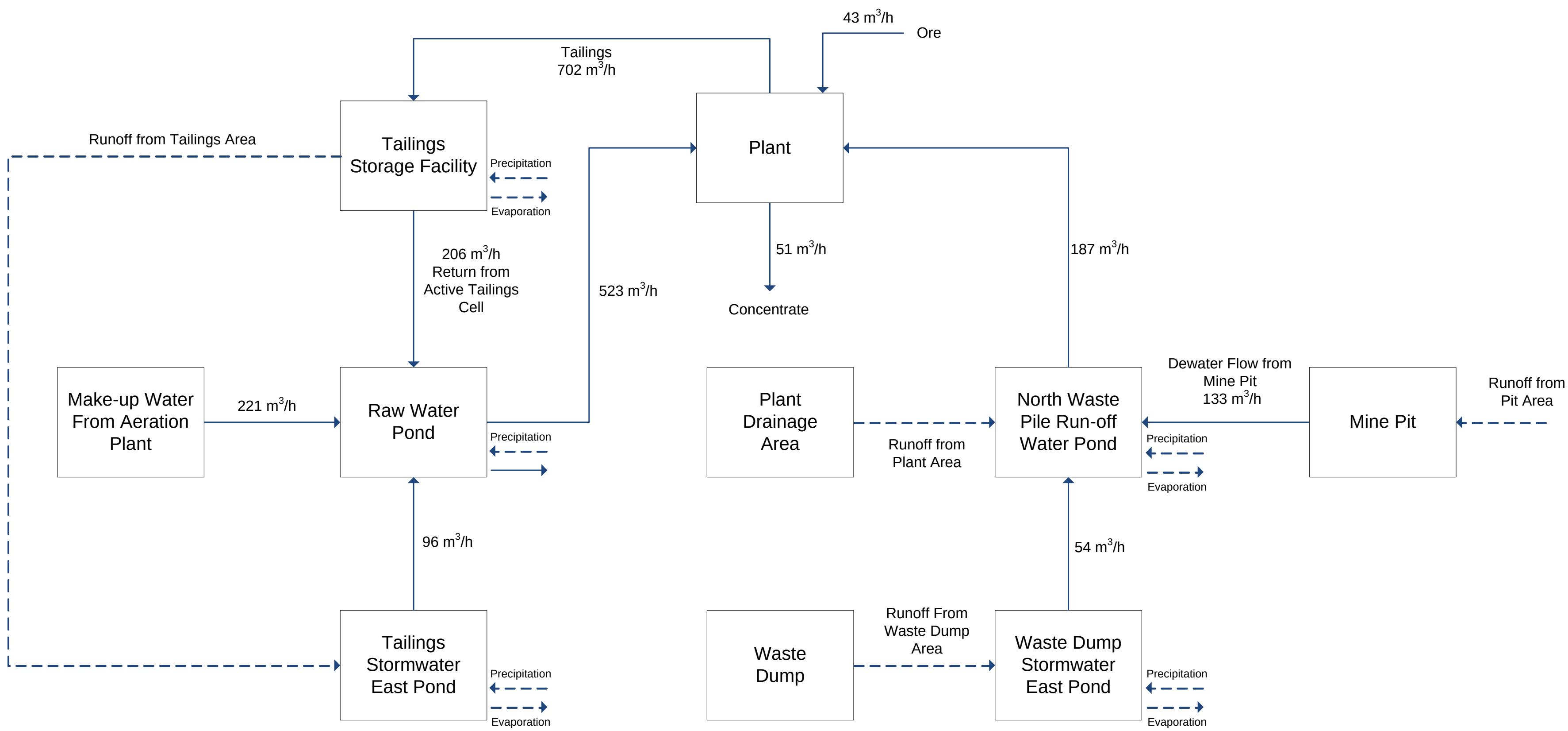


Figure 17-3: Overall Site Water Balance

17.4 Process Description

The following process description outlines the upgrading circuit on the basis of the results of the mineralized material characterization testwork, design criteria and the assumptions presented in this Report. This has been based on the 2014 FS and adjusted by BBA based on the re-scaled Project.

Four main areas are identified in the mineral processing plant:

- Dry Processing (crushing, mineralized material storage, HPGR and screening);
- Wet Processing (cobbing, screening, grinding, re-grinding, magnetic separation, classification, and flotation);
- Concentrate and Tailings Thickening; and
- Concentrate Dewatering, Storage and Handling.

The location of the mineral processing plant and its key infrastructure is shown in Chapter 18.

17.4.1 Crushing, Conveying and Storage

17.4.1.1 Primary Crushing

Material from the mine will be delivered by haul truck to a single 1,372 mm x 1,905 mm (54” x 75”) gyratory crusher equipped with a 450 kW motor.

Crushing and conveying utilization has been designed at 65%; ROM material moisture is assumed to be 2% and have a specific gravity of 3.4 t/m^3. A hydraulic rock breaker operated from the crusher control room is provided adjacent to the crusher to break up and manipulate oversized or improperly positioned rocks.

Material, crushed to a P_{80} (80% passing) of 139 mm, is collected in a surge pocket below the crusher. From the surge pocket, the crushed material is fed by an apron feeder onto a sacrificial conveyor. This conveyor transfers the material to another belt conveyor which then transfers the crushed mineralized material to a shuttle conveyor.

17.4.1.2 Secondary Crushing

The shuttle conveyor from the primary crusher circuit feeds two dry vibrating screens with an effective screening area of 3.66 m by 7.32 m (12' width x 24' length). The screen undersize bypasses the crusher and is sent to the crushed mineralized material stockpile. The screen oversize is conveyed to two 746 kW, MP1000 equivalent, secondary cone crushers. The discharge from the two cone crushers is conveyed back to the secondary crusher screens. The P_{80} of the circuit (screen undersize) is approximately 36 mm.

17.4.1.3 High Pressure Grinding Rolls (HPGR)

The secondary crusher screen undersize conveyor transports the crushed mineralized material to the a stockpile that has a total capacity of 60 hours of concentrator operation. The stockpile is reclaimed by four Stockpile Reclaim Feeders each having a capacity that transfers the crushed material to the Stockpile Reclaim Conveyor that feeds one HPGR unit. The HPGR has a tire size of 2.4 m in diameter by 2.8 m in length with an installed power of 9,704 kW. The HPGR discharge is collected and conveyed to four wet classification screens each with an effective screening area of 4.27 m by 7.32 m (14' width x 24' length). The screen oversize is dumped onto a conveyor which returns to the HPGR for further size reduction. The screen undersize, with a P_{80} of approximately 2.1 mm, is collected in a pump box where it is pumped to the first stage of beneficiation.

Metal detectors and removal devices are located ahead of the HPGR and secondary crushers. These systems sense and extract tramp metallic objects and decrease the risk of substantial damage to the equipment. Dust will be controlled along the dry circuit by dust collectors, exhaust fans and water sprays.

17.4.2 Cobbing

The wet cobbing stage is comprised of eight Low Intensity Magnetic Separators (LIMS). The pulped HPGR screen undersize is pumped through the cobber distributor to feed the LIMS units. The cobber magnetic fraction is collected in launders and is discharged into a pump box equipped with two single-stage centrifugal pumps (one operating and one standby). The pump feeds the primary grinding screen distributor. Tailings are collected in a pump box equipped with two single-stage centrifugal pumps (one operating and one standby). Each operating pump feeds a Tails Dewatering Cyclone Cluster.

17.4.3 Primary Grinding Circuit

The cobber magnetic fraction is pumped through a demagnetizing coil and to the screen distributor to feed fourteen 5-Deck Stack-Sizer screens. The oversize from the primary grinding screens is gravity fed to an 8,000 kW, 6.5 m diameter by 9.7 m long ball mill. The ball mill is in closed circuit with the screens. Prior to being recirculated back to the screens, the ball mill discharge is subject to a stage of rougher magnetic separation (RMS). The primary grinding mill product is discharged into a dedicated pump box equipped with two single-stage centrifugal pumps (one operating and one standby). The pump feeds a 6-way gravity discharge distributor that evenly supplies the RMS units with slurry at the targeted solids density. Tailings from the RMS are collected and pumped to the tailings thickener.

The RMS magnetic fraction is collected and fed by gravity to the cobber magnetic fraction pump box to be pumped back to the primary grinding screens for further classification. Screen undersize is collected into one tower mill cluster pump box to feed the secondary grinding circuit. The screen undersize target size is a P_{80} of approximately 180 µm.

17.4.4 Secondary Grinding Circuit

The primary grinding circuit screen undersize slurry is pumped from the tower mill cluster pump box to three demagnetizing coils and three clusters of hydrocyclones. The pump box is equipped with five single-stage centrifugal pumps (three operating and two on standby). The grinding circuit consists of tower mills in closed circuit with the hydrocyclones. The recirculating load is subject to a stage of cleaning magnetic separation (CMS).

Each hydrocyclone cluster underflow feeds a 4,500 hp tower mill by gravity (three tower mills in total). Each tower mill's discharge is collected in its own pump box. The tower mill discharges are then pumped and combined to feed the CMS units. The gravity discharge distributors evenly supply the ten CMS units with slurry at the targeted solids density. Tailings from the CMS stage are collected and pumped to a dewatering cyclone.

The CMS magnetic fraction, at a target P_{80} of 32 µm, is collected in a launder and fed by gravity back to the tower mill cyclone cluster pump boxes. The overflow from the cyclones is sent to the finisher magnetic separators distributor.

17.4.5 Finishing and Flotation

The overflows from the secondary grinding hydrocyclones are fed to a finisher magnetic separator (FMS) distributor. The gravity discharge distributor evenly feeds eight FMS double-drum units with slurry at the targeted solids density. Tailings from the FMS are collected and pumped to a dewatering cyclone.

The FMS magnetic fraction gravitates through a demagnetizing coil to the sulphur flotation conditioning tank. The conditioning process in the tank involves the addition of an activator and a pH modifier. High-shear agitation is provided to this conditioning tank in order to maximize the reagent adsorption by particles. The conditioned slurry is pumped to the reverse sulphide flotation cells, where reagents, such as the activator, pH modifier, collector, and frother are added at various points within the flotation circuit. The flotation circuit is comprised of six 160 m^3 flotation cells which allow approximately 40 minutes of residence time. The air supply to the flotation cells is provided by dedicated blowers (one operating and one on standby).

After separation, the concentrate slurry (sinks) and rejected sulphides (float) are collected in the respective pump boxes and are pumped to the thickeners area.

17.4.6 Dewatering and Thickening

17.4.6.1 Concentrate Dewatering

The sulphide flotation concentrate is pumped through a magnetizing coil to the launder feeding a 23 m diameter high-rate thickener where it is combined with the recycled filtrate of the filter presses. The magnetizing coil generates magnetic flocculation in the concentrate thickener feed, improving the settling rate and the overflow water clarity.

The thickener overflow gravitates to the process water storage tank, while the underflow is pumped to concentrate storage tanks which provide a 3-hour surge capacity at nominal throughput. From these concentrate storage tanks, slurry is pumped to the dewatering filters.

Concentrate filtration consists of four plate and frame filter presses working in parallel (three operational and one on standby). Each filter can process up to 300 tph and achieve the target moisture content of 9% in the discharge product (filter cake). The operation of every filter press is a batch process and involves feeding, pressing, washing, air drying and cake discharge.

The filtrate from each filter is collected in pump boxes, from where it is pumped back to the concentrate thickener launder. Filter cake is discharged from each filter by gravity and is conveyed to the concentrate stockpile for storage.

17.4.6.2 Tailings Dewatering

The coarse, non-magnetic fraction from the cobbing stage is pumped to a tailings dewatering cyclone. The overflow from the cyclone gravitates to the tailings thickener launder and underflow gravitates to a single tailings pump box collector.

The non-magnetic fractions from the RMS, CMS and FMS stages, as well as sulphide flotation circuit floats, are separately pumped from their respective pump boxes and discharged into the tailings thickener well via the thickener launder. Flocculant is added into the thickener to promote the settling of solids and to preserve overflow clarity. The thickener underflow is discharged into the tailings pump box collector, while the overflow (clarified water) is recycled by gravity to the process water storage tank.

At the tailings pump box collector, the dewatering cyclone underflow combines with the tailings thickener underflow. The combined slurry is the final beneficiation plant tailings, and it is pumped for storage to the Tailings Storage Facility (TSF). The tailings are pumped by a multiple-stage pump system running through a single pipeline.

17.4.7 Concentrate Loadout

The concentrate filter cake from the filter presses is conveyed for stockpiling. The product is stored in a rectangular covered storage pile by a tripper conveyor. The storage pile has a 12,283 t capacity (dry basis), equivalent to approximately one day of production. The concentrate is then reclaimed by three front end loaders. A ramp and tire-stop will be constructed to allow the front end loaders to directly feed the rail cars. Speed control for railcars, when combined with the rail scale on the tracks, ensures efficient loading of the railcars.

Manual loadout of railcars will be replaced with an automated system as the throughput increases in Phase 2, since the capacity will no longer be as economic with front end loader operation.

17.5 General Plant Utilities and Services

The plant utilities and services have been specifically quantified based on the mineral processing plant requirements, as scaled from the 2014 FS. The capital costs have been estimated accordingly. The general utilities and services for the mineral processing plant are described herein.

17.5.1 Water Management System

The water management strategy is discussed in detail in Chapter 18 of this Report. The strategy is based on process water requirements and maximizes water recycling to assure that no net effluent is discharged to the environment.

17.5.2 Reagents Storage and Handling

The reagents storage and mixing facilities are located in the southwestern sector of the beneficiation plant, between the sulphide flotation cells and the tailings and concentrate thickeners. This part of the plant is conceived as a low-traffic area, with appropriate access for the delivery of reagents by truck. The beneficiation plant uses the following reagents:

- Collector;
- Frother;
- Activator;
- pH modifier; and
- Flocculant.

The flocculant is used to aid in the sedimentation of the fine tailings and the remaining reagents are used in the reverse sulphide flotation circuit. The reagents storage and handling area is equipped with dedicated sump pumps which deliver the product to collection locations in the event of spillage. Moreover, a separator wall exists to isolate this area from the main mill building, to protect personnel from hazards. In addition, the facility has all the necessary safety equipment, including a fire-detection system, ventilation system, safety showers and eye-wash stations.

17.5.3 Compressed Air

Dry compressed air is required in the concentrate filtration area as well as for general use throughout the plant. Compressed air for use in the plant is supplied via a compressed-air distribution network. Two different qualities of air will be supplied to different consumers, plant air and instrument air. The air supply system includes the appropriate number of dryers and filters in order to supply the required quality of air. Compressed air, for the specific operation of the filter presses, is provided by dedicated compressors.

17.5.4 Natural Gas

Natural gas obtained from the public distribution system is used in a boiler that produces steam to heat the buildings.

17.5.5 Plant Instrumentation and Process Control

A Process Control System (PCS) will be implemented, along with the automated instrumentation to allow for the automatic control of the plant.

18. PROJECT INFRASTRUCTURE

The major features and designated locations for site infrastructure developed during the 2014 FS were maintained for the re-scoped Shymanivske Project. For this PEA, the site plot plan has been adjusted to reflect the conceptual changes arising from the re-scoped Project. Major site infrastructure consists of the following:

- Shymanivske open pit mine constrained within the mining allotment boundary;
- Overburden and waste-rock dumps;
- Surface water management features (ditches and settling basins) and water treatment facilities;
- Roads, bridges and accesses for mine vehicles and light traffic;
- Mine support infrastructure including mine equipment maintenance shop, truck wash station, fuel loading and vehicle fueling system, explosives magazine;
- Dry process areas and buildings including primary crusher, secondary crushing area, crushed mineralized material stockpile, HPGR area and conveyors;
- Wet process areas including primary and secondary grinding areas, LIMS areas, thickener area and filtering area;
- Concentrate handling including conveyors, covered stockpile, load-out system and rail spurs;
- Designated footprint for capacity expansion (addition of second mineral processing line);
- Tailings storage facility (TSF) and tailings pumping system;
- Various pump houses;
- Main electrical substation and electrical distribution system;
- Diesel fuel receiving and storage area;
- Ancillary buildings.

The Project area is serviced by existing rail and ports. Rail transportation, port terminal and ship loading services will be provided by a common service provider. As such, BKI will not need to build its own infrastructure for these areas. Several port options were reviewed in the previous feasibility studies. For this PEA Study, it is assumed that rail and port facilities will have sufficient capacity and availability to service the Project as previously confirmed by BKI through letters of intent for service supply. Chapter 19 of this Report provides information concerning discussions that BKI has had concerning securing these services.

18.1 General Shymanivske Site Plot Plan

In optimizing the plot plan, the 2014 FS considered the following factors that are maintained for this current PEA:

- Waste pile and crusher locations have been designated in order to minimize haul truck travel distances in consideration of the LOM mine plan;
- Use of existing bridges and service roads, such as the KGOKOR Haul Road Bridge and the transportation corridor;
- Location of the approved tie-in point for rail;
- Ore Flow through the process plant;
- Existing physical constraints on site, including Arcelor Mittal's Rail, Ukrainian National Rail (UNR) and Ministry of Defence warehouses;
- Space for expansion to accommodate a second production line, assumed to be implemented in Year 5 of the Project.

An existing 150 kV power line runs parallel to the west side of the existing Arcelor Mittal private railway, between the designated Shymanivske waste dump and the open pit. Approximately 1 km of this power line will have to be relocated.

Since the existing KGOKOR corridor infrastructure provides ready access to the north end of the military clearance area, it was recognized that it was also ideal to locate the Shymanivske processing plant in this location. Accordingly, the plant was located in the north-west corner, immediately south of the KGOKOR corridor and outside the military clearance zone. This also put the plant in close proximity to the UNR, which will be used to ship iron concentrate.

Iron concentrate will be transported by rail from the new Shymanivske load-out area to the Black Sea port Yuzhny (TIS terminal). The Shymanivske rail station and rail spur are situated immediately south of the concentrator building, and will be connected to the main railway owned by the UNR.

Conveyors to transport the coarse ore from the primary crusher to the plant were generally aligned to follow the KGOKOR transportation corridor and thereby maximize the usage of the area outside the military clearance zone.

Filtered concentrate is conveyed to a covered storage area between the plant and the rail load-out. For the initial 4 Mtpa capacity installation, the railcars will be loaded by front end loaders, manually reclaiming material from the concentrate storage pile. With the addition of the second production line in Year 5, the automated load-out system, as designed in the 2014 FS, will be implemented. In order to accommodate the Shymanivske railcar handling operations, modifications will be required to the existing UNR 6 km bridge that allows military traffic to access its warehouse. The bridge will be extended east to cross over the added Shymanivske rail spur.

The TSF is located immediately across from the UNR rail line, west of the concentrator building. The TSF is situated as close to the beneficiation plant as possible, to minimize pumping distances for the tailings and the return water lines.

The mine maintenance shop and haul truck fuelling area have been located in the vicinity of the KGOKOR bridge in order to take advantage of the available space immediately outside the military clearance area and keep the maintenance shop and fuelling area close to the regular haul truck operations.

Figure 18-1 presents the preliminary site plot plan, as developed in the 2014 FS with the modifications brought about by the re-scoped Project.

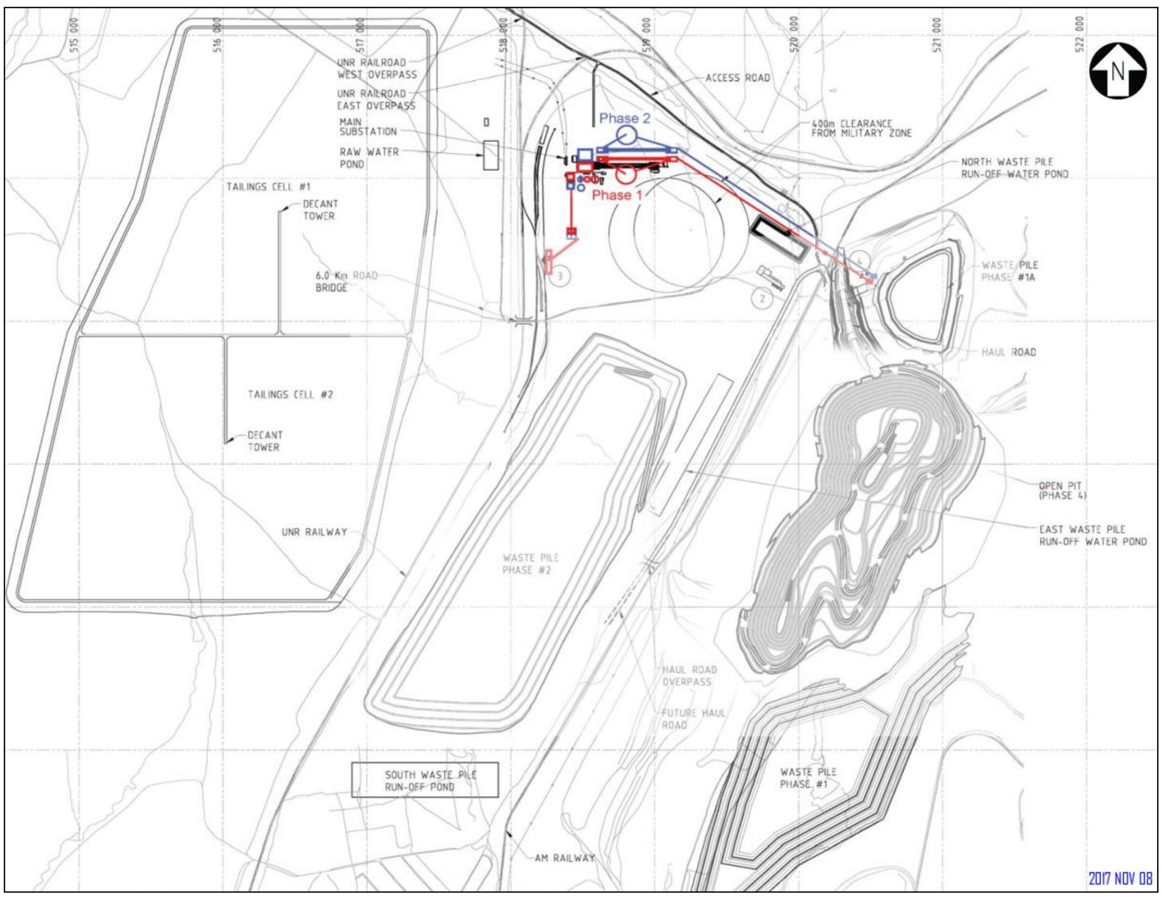


Figure 18-1: Shymanivske Project Preliminary Site Plan

18.2 Power

18.2.1 Power Supply

According to the local power utility consultant, UkrEnergoSetProekt (UESP), electrical power for Black Iron's Shymanivske Project will be drawn from the existing 150 kV Gornaya Substation owned by the local power utility Dneprovskaya ElectroEnergetisheskaya Systema, NEK Ukrenergo. The Gornaya substation is located 30 km south-east of the Shymanivske site.

In the 2014 FS, four options were considered by UESP as the source of power for the Project. The cost estimates for the power transmission and all the upgrades / additions to the existing substations were completed by UESP. Given the reliability, stability and strength of the electrical grid, UESP selected the tie-in to the 150 kV Gornaya Substation as the preferred option.

The power will be delivered to the Shymanivske main plant step-down sub-station via a new 30 km double-circuit 150 kV overhead transmission line with steel reinforced, aluminium conductors. For the purpose of the 2014 FS, UESP confirmed that the local power grid will have sufficient spare capacity to deliver the required power to the Project.

The design provides for two diesel generating units to supply emergency power to the concentrator and to the mine.

18.2.2 Power Load Calculation

In the 2014 FS, the plant site-wide electrical power requirements for infrastructure, service buildings, mining, conveying, crushing, grinding, stockpiling, reclaiming, pumping and other processes were calculated on the basis of equipment sizing. For the present PEA, power requirements were scaled from the 2014 FS for both the initial Phase 1 plant capacity of 4 Mtpa and for the expanded Phase 2 plant capacity of 8 Mtpa. The power demand tables can be seen in Table 18-1 and Table 18-2. The estimated total connected active power per line is 53.5 MW (total installed power, excluding standby equipment). This power demand has been used in the operating cost estimate and to develop the electrical single-line diagrams.

Table 18-1: Power Requirements Phase 1

AREA	DESCRIPTION	CONNECTED POWER (MW)	AVERAGE EFFICIENCY FACTOR	LOAD FACTOR	DIVERSITY FACTOR	POWER DEMAND (MW)	ANNUAL LOAD FACTOR	ESTIMATED ANNUAL ENERGY CONSUMPTION (GW/H)
Beneficiation Plant								
2100	Crushing/Screening	22.0	0.92	0.85	0.84	17.0	0.75	111.5
2200	Grinding/Separation	21.4	0.92	0.85	0.96	19.0	0.91	151.2
2300	Thickening	4.3	0.92	0.85	0.91	3.7	0.91	29.2
2400	Product Delivery	0.0	0.92	0.85	0.91	0.4	0.91	0.0
Total Beneficiation Plant		**47.7**				**39.6**		**291.9**
Mine								
5700	Mine Equipment	7.3	0.92	0.61	0.7	3.4	0.8	23.7
Total Mine		**0.0**				**3.4**		**23.7**
Tailings and Water Management								
3200	Tailings	0.3	0.92	0.85	0.91	0.2	0.91	1.8
5500	Water Supply Sewage & Storm	0.9	0.92	0.85	0.91	0.8	0.99	6.6
Total Tailings and Water Management		**1.2**				**1.0**		**8.5**
General and Infrastructure								
1100	Mine Infrastructure	1.6	0.92	0.85	0.70	1.1	0.99	9.1
5700	Power Distribution	2.3	0.92	0.85	0.91	1.9	0.99	16.6
Total General and Infrastructure		**3.9**				**3.0**		**25.7**
TOTAL		**60.0**				**46.9**		**349.8**

Table 18-2: Power Requirements Phase 2

AREA	DESCRIPTION	CONNECTED POWER (MW)	AVERAGE EFFICIENCY FACTOR	LOAD FACTOR	DIVERSITY FACTOR	POWER DEMAND (MW)	ANNUAL LOAD FACTOR	ESTIMATED ANNUAL ENERGY CONSUMPTION (GW/H)
Beneficiation Plant								
2100	Crushing/Screening	44.0	0.92	0.85	0.84	34.0	0.75	223.1
2200	Grinding/Separation	42.8	0.92	0.85	0.96	37.9	0.91	302.4
2300	Thickening	8.7	0.92	0.85	0.91	7.3	0.91	58.4
2400	Product Delivery	1.1	0.92	0.85	0.91	0.9	0.91	7.2
Total Beneficiation Plant		**96.5**				**80.1**		**591.0**
Mine								
5700	Mine Equipment	10.4	0.92	0.61	0.7	4.8	0.8	33.6
Total Mine		**0.0**				**4.8**		**33.6**
Tailings and Water Management								
3200	Tailings	0.5	0.92	0.85	0.91	0.5	0.91	3.6
5500	Water Supply Sewage & Storm	1.8	0.92	0.85	0.91	1.5	0.99	13.3
Total Tailings and Water Management		**2.4**				**2.0**		**16.9**
General and Infrastructure								
1100	Mine Infrastructure	1.6	0.92	0.85	0.70	1.1	0.99	9.1
5700	Power Distribution	4.5	0.92	0.85	0.91	3.8	0.99	33.3
Total General and Infrastructure		**6.2**				**4.9**		**42.3**
TOTAL		**115.4**				**91.8**		**683.9**

The 2014 FS electrical distribution design, as summarized herewith, is maintained for the current PEA.

- The incoming 150 kV overhead transmission line will feed line bays with an air-insulated 150 kV double bus-bar transfer system contained in the Shymanivske main plant step-down sub-station. The voltage will be stepped down to 35 kV;
- The main 35 kV switchgear will distribute power to all electrical sub-stations and electrical rooms via overhead trays;
- Medium voltage distribution will be done at 6.3 kV.

18.3 Tailings Storage Facility (TSF)

In the 2014 FS, the TSF design was significantly changed compared to the previous design developed for the 2012 FS. The 2014 TSF design was developed by Knight Piesold at a conceptual level and details were provided in the Technical Memorandum 'Shymanivske Iron Ore Alternative Tailings Storage Facility Design' (Knight Piesold, October 2013). For this current PEA, the TSF design developed in the 2014 FS has been maintained and adjustments to the TSF development plan have been made based on the tailings deposition plan (which, in turn, is based on the mine plan) for the re-scoped Shymanivske Project.

18.3.1 Design Data

The 2014 FS was based on a TSF having a storage capacity of 358 Mt. Considering the mine plan presented in Chapter 16 of this Report, it is estimated that about 365 Mt of tailings will be generated over the LOM. This exceeds the design capacity of the TSF by less than 2% therefore, for this PEA, it is assumed that the additional volume can be accommodated with minor design modification particularly given the 358 Mt includes a design allowance. This should be validated and adjusted in the next Project study phase when the TSF should be designed to a feasibility level of detail.

The TSF configuration is based on the following design data:

▪ LOM Tailings Generated:	365 Mt
▪ Total Storage Capacity:	358 Mt
▪ Annual (Yr 1 – Yr 4):	7.7 Mtpa Yr 1 – 10.2 Mtpa Yr 2 to 4
▪ Annual (Yr 5 – Yr 17):	17.9 Mtpa Yr 5 – 20.4 Mtpa Yr 6 to 17
▪ Mine Life:	16.5 years
▪ Slurry % Solids:	65%
▪ SG Solids:	3.0
▪ Dry Density (Design)	1.5 t/m^3
▪ P_{100}:	3 mm
▪ P_{80}:	0.5 mm (501 µm)

18.3.2 Tailings Storage Facility Design

The TSF will operate with two active cells. This will simplify construction since deposition can be ongoing into one cell while the other is raised. The required total footprint for the two cells is approximately 840 ha (2 cells of nominally 420 ha each). Figure 18-2 shows a general, preliminary layout of the TSF.

The external embankment will be constructed using a modified centreline configuration, as shown in Figure 18-3, with the central causeway between the cells raised vertically. Upstream construction may be viable but has not been used as more detailed work will be required to assess seismicity and liquefaction potential.

The construction approach is to build Zone C of the embankments using mine waste hauled directly from the pit. The minimum crest width is 15 m. For embankment zones wider than 25 m two-way traffic can be utilized, while for the embankment between the 25 m width and the 15 m crest, traffic would be one way only, as seen in Figure 18-4.

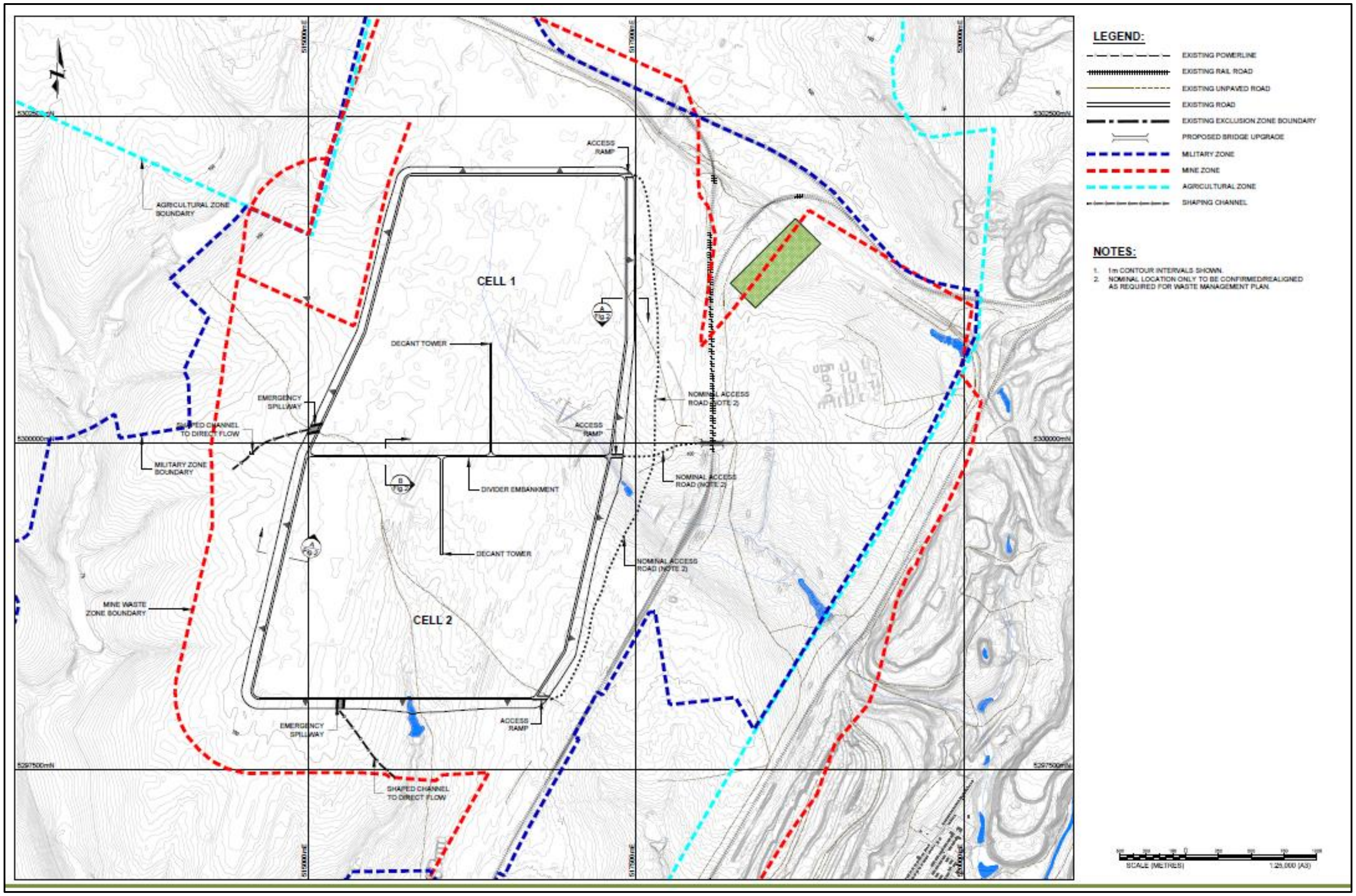
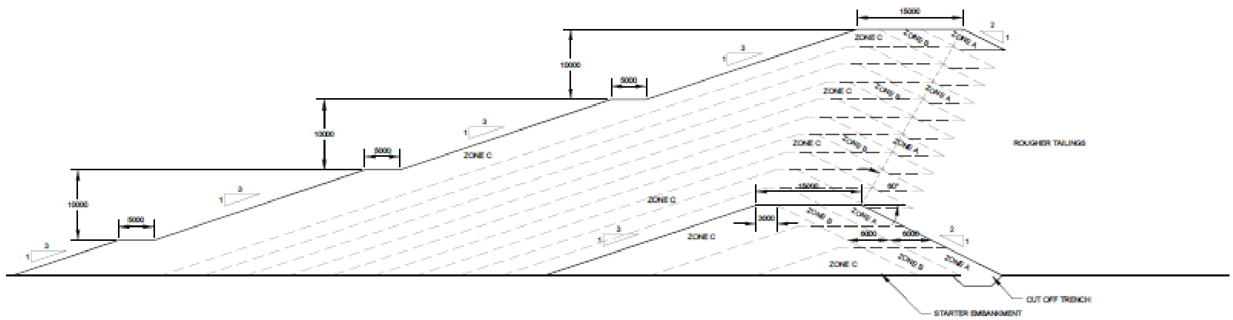
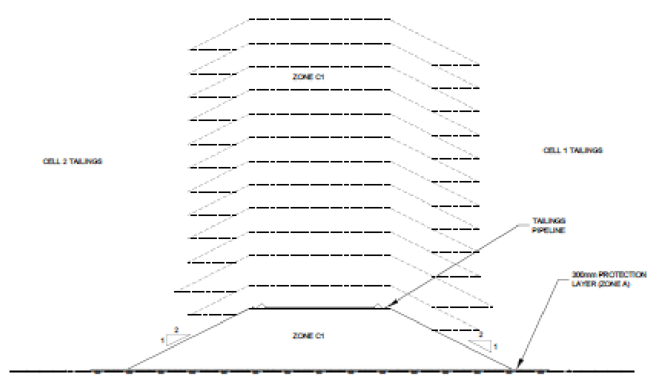


Figure 18-2: Tailings Storage Facility Area



SECTION A TYPICAL TAILINGS FACILITY MODIFIED CENTRELINE EMBANKMENT



SECTION B TYPICAL TAILINGS FACILITY DIVIDER EMBANKMENT

Figure 18-3: Typical Embankment Sections – Sheet 1

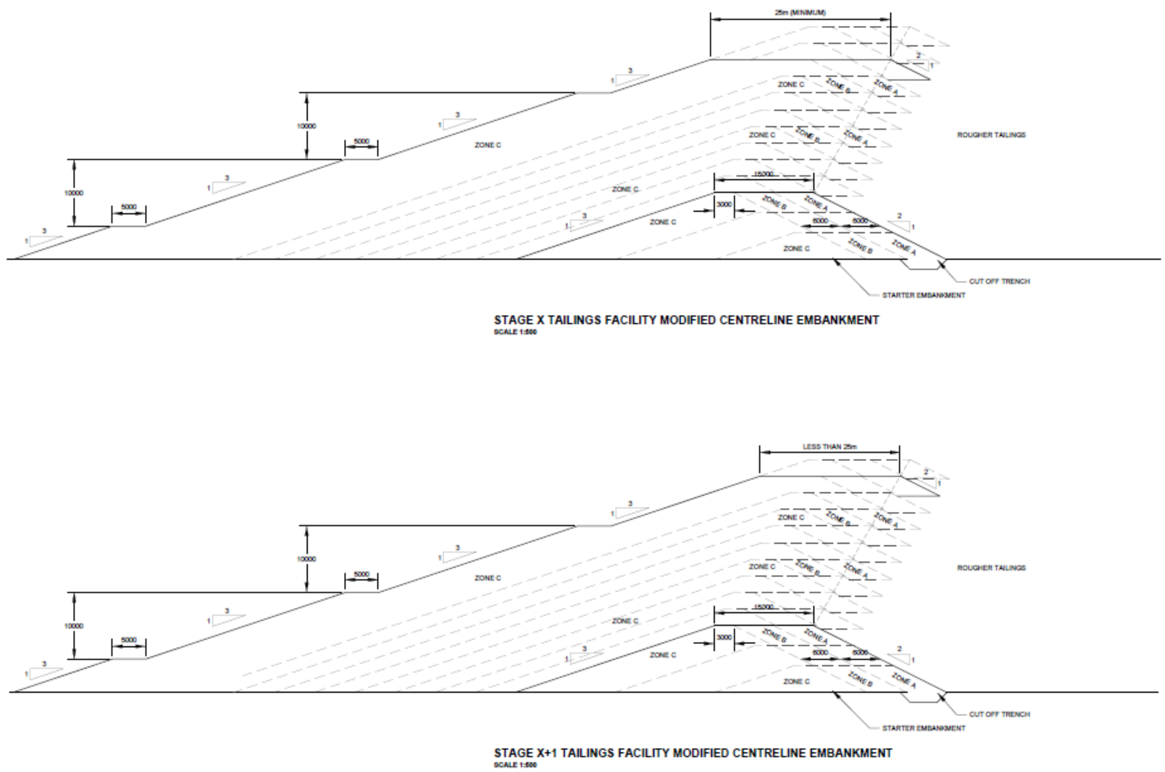


Figure 18-4: Typical Embankment Sections – Sheet 2

The low permeability Zone A of the embankments will be constructed using local borrow materials within the basin area for Stage 1 and stacking nearby deposited tailings for future stages. These zones will be constructed during the summer months. The cut-off trench would be nominally 1 to 2 m depth, depending on the foundation conditions.

Zone B will be a transition zone between the low permeability Zone A (6 m wide) and the Zone C structural layer consisting of direct-haul mine waste. The nominal width of Zone B is 6 m. The grading of Zone B is dependent on the material coming out of the pit for Zone C. If Zone C material is very fine then placement of Zone B will not be required.

Dam construction is done in phases, progressively over the LOM. The initial build is included in the Project capital cost whereas construction taking place in Year 1 of operation and beyond is included in sustaining capital. The LOM cost estimate related to the progressive construction of the embankments is based on the embankment development plan outlined in Table 18-3. This plan was generally aligned with the average annual tailings generation of the re-scoped Project presented in this PEA.

Table 18-3: Embankment Levels

Year	Tailings (Mtpa)	Cell 1	Cell 2
1	7.7	112.0	-
2	10.3	-	-
3	10.3	-	108.9
4	10.3	114.3	-
5	18.0	-	111.3
6	20.6	116.5	113.5
7	20.6	118.9	115.9
8	20.6	121.3	-
9	20.6	-	118.3
10	20.6	123.6	120.7
11	20.6	126.0	123.1
12	20.6	128.4	-
13	20.6	-	125.4
14	20.6	130.7	127.8
15	20.6	133.1	-
16	20.6	-	130.2
17	20.6	135.0	132.5

18.3.3 Deposition Plan and Methodology

The tailings deposition methodology is to utilise subaerial deposition; discharging tailings over the existing tailings surface developing a sloping cone profile towards a central decant in each cell. The beach slope of the tailings is dependent on a number of factors such as SG of the solids, grind size, % solids on discharge and the energy in the tailings at the discharge point. The tailings are very coarse, with a P_{80} of about 0.6 mm (winter) and 0.3 mm (summer), which will tend to steepen the beach. However, the high throughput (20.6 Mtpa) means that the energy at discharge will also be high, which will tend to flatten the beach. Based on all the above factors the tailings slope was estimated to be about 1V:120H (0.83%). For this preliminary stage of design, it was assumed deposition only occurred from the embankments with full development of the cone within each cell. The embankments height allows for the loss of storage volume resulting from the assumed beach slope. The discharge point would be rotated around the facility to develop a smooth beach profile, deposit thin layers and centre the pond on the decant tower.

In the winter the rate of movement of the discharge points would be reduced with longer deposition from single locations to reduce the operator requirements in extreme cold conditions. Due to the completion of each embankment prior to winter there will be sufficient capacity to allow for this focused deposition period through winter.

18.3.4 Water Management

While it is anticipated that the facility will be water negative and thus no large scale pond development is expected, each cell will be provided with an emergency spillway to prevent overtopping of the embankments. The Cell 1 spillway will be located in the southwest corner of the facility and discharge into the western drainage. The Cell 2 spillway will be located on the south embankment and will discharge into the southern drainage. The spillways will be broad crested weirs cut through the embankment with suitable rockfill erosion protection. Based on the 17-year operating period the return interval for the spillway design during the operating mine life period will be 1 in 5,000 years. For closure this will be upgraded.

The two cells are fully enclosed and are located across the top of the catchment. Thus runoff around the perimeter will only occur from the downstream face of the embankment and from the catchments around the cells which might need to be redirected. As such it was concluded that only sediment control systems would be required around the cells. These would consist of diversion drains around the outside toe directing flow into sediment control dams (one each in the primary drainage systems on the south and east sides and some small dams for drainage to the west). The dams would be basic overflow dams, holding water only long enough to reduce the sediment load to an acceptable level.

18.3.5 Dust Control

For active tailings facilities, dust control can be largely achieved in the site climate conditions by proactive management of the tailings. This will involve depositing into both cells alternatively and not allowing the tailings to dry below about 80% saturation.

18.4 Buildings and Services

The Project, for both Phase 1 and Phase 2, consists of a number of buildings, enclosures and ancillary structures. The main process areas within major building structures consist of:

- Primary and secondary crushing and dry screening areas;
- HPGR and cobbing area;
- Regrinding, magnetic separation and flotation area;
- Concentrate dewatering area;
- Tailings pumping area.

Ancillary buildings consist of mine garage and mine and concentrator maintenance shops, employee facilities, HSE and emergency response facilities and offices and administration buildings. The major building structures will be made of structural steel with insulated roof and wall cladding. The major building foundations will consist of cast in-situ conventional reinforced concrete footings. Secondary buildings will be of pre-engineered or pre-fabricated type, when applicable. The required services for each building depend on the operation requirements. Buildings with permanent staff and operators will have climate control systems (HVAC), and the electrical rooms will have HVAC systems for equipment protection. The major process buildings in the wet-processing area will have freeze protection measures. Fire protection, lightning protection and smoke detection have been considered for various buildings.

18.5 Utilities

Utilities design and assumptions used in the 2014 FS have been maintained for this PEA but have been scaled accordingly for Phase 1 and Phase 2 of the Project.

18.5.1 Domestic Sewers

Domestic sewage for the buildings is collected and treated in septic tanks. Three septic tanks have been considered for areas with the highest concentration of operators (main process plant and mine administration building). The sewage will be collected by vacuum trucks and hauled off site for disposal and treatment.

Solid domestic waste will be collected in outside dumpsters by contracted trucks. No disposal site is included in the plot plan.

18.5.2 Natural Gas

Natural gas will be obtained from the public mains distribution system. The natural gas is used by a boiler producing steam for heating the buildings. The gas pressure will be reduced from 410 KPa to 85 KPa, through a pressure letdown station located close to the concentrator building.

18.5.3 Compressed Air

The main user of compressed air is the filter presses. The design provides for sufficient capacity and redundancy for the initial operating line. Capacity will be added with the expansion. Instrument air and plant air for the beneficiation plant is supplied by a separate compressor system.

18.5.4 Diesel Fuel

The main consumer of diesel fuel is the mining fleet. The beneficiation plant uses a small volume of diesel for maintenance and ancillary equipment. No process or heating consumption is anticipated for diesel fuel. The diesel fuel consumption for the mining operation is estimated to average 72,770 L/d over the LOM with a peak of 90,426 L/d occurring in Year 12.

The fuel is received on site by rail in tanker cars with a capacity of 107,000 litres per car. The fuel is unloaded by three unloading pumps and then stored in a main storage tank in the vicinity of the unloading station. The main storage tank will have a capacity of 1,000,000 litres, which is sufficient for a minimum of 10 days of consumption. The diesel is then pumped to a day tank (127,000 litres capacity) located near the primary crusher building via 200-mm pipe. Fuelling stations located near the mine maintenance building will provide diesel for the mine haul trucks and ancillary equipment.

18.6 Roads and Bridges

18.6.1 Roads

Roads on the Shymanivske site are divided into three categories:

- Haul roads;
- Service roads;
- High-traffic roads.

Haul roads are used by mine haul trucks to transport mineralized material to the primary crusher and waste to waste-rock piles. They will have a gravel surface with a width of 31 m. Dust suppression shall be applied to the gravel surface to minimize dust generation. Most of the haul roads will be required in later operating years to provide access to the southern part of the waste rock pile and the estimated costs associated with road construction are included in the sustaining capital.

Service roads are designed for traffic other than haul trucks to access various parts of the Project. Light vehicles and the ancillary fleet can use these roads. The service roads will have a gravel surface and will be designed for light traffic. The existing KGOKOR road on the north side of the plant is also considered a service road and will be used for accessing the north side of the TSF for the construction of containment cells. The service roads at the Shymanivske site have been designed for a thirty-tonne payload truck. The total length of these roads is 6,400 m. The KGOKOR service road will be 9 m wide, while the rest of the service roads will be 6 m wide.

High-traffic roads are located within the main processing plant area and provide access to various buildings and facilities in this area. The high-traffic roads will be 6 m wide and a total length of 2,400 m.

18.6.2 Bridges

The list of bridges at the Shymanivske site is as follows:

- KGOKOR Haul Road Bridge: This is an existing bridge with culvert section design. The bridge is located on the north side of the mine pit and provides elevated crossing over Arcelor Mittal's railway. The bridge is wide enough for two-lane traffic of the haul trucks. The additional load from heavy haul trucks requires reinforcement of the existing walls and a new concrete slab on top of the bridge. Utilizing this bridge for haul trucks provides the most economical solution for crossing the existing rail line and also minimizes/eliminates any service interruption on the Arcelor Mittal railway;
- The 6 km Road Bridge: This existing bridge provides an elevated crossing over the UNR railway connecting the military warehouse area to the city of Kryvyi Rih. This bridge needs to be extended to the east to accommodate the additional rail spurs required by the Project;
- The 118 km Road Bridge: This existing bridge is located on the north-west side of the Shymanivske site, connecting it to the city of Kryvyi Rih. No modification is anticipated for this bridge;
- The UNR Railroad East and West bridges: These two bridges provide access for the existing UNR on the north side of the Project site. No modification is required on these bridges;
- South Ramp Haul Road Bridge: This bridge will be required in Year 2 of the mine life, and the estimated construction costs associated with it are included in sustaining capital. The purpose of the South Ramp haul road bridge is to provide access for waste-haul trucks to the southern part of the waste-rock pile when the south mine ramp is in operation. This bridge will span the existing Arcelor Mittal rail and will be designed to handle haul-truck loads.

18.7 Water (General)

Water consumption in the plant consists of the following:

- Process water;
- Potable water;
- Gland and cooling water; and
- Fire water.

The site water balance developed in the 2014 FS has been scaled and adjusted to the requirements of the re-scoped Project for Phase 2, which defines the ultimate plant capacity. The water balance has been presented in Chapter 17 of this Report and incorporates process requirements and site specific parameters. Water systems at the plant have been designed so that there is no liquid effluent stream flowing outside the mine-site perimeter and no process-water infiltrating the ground.

For the Project area, the water sources have been divided into the following major categories:

- Surface run-off;
- Direct precipitation on water bodies;
- Withdrawals from the Yuzhnaya aeration plant;
- Recycling of clarified water from the TSF to the plant;
- Mine pit dewatering;
- Waste-rock pile run-off collection; and
- Potable water from the Karachunivske reservoir.

The following assumptions were made:

- Water in-flows to the TSF include direct precipitation and slurry tailings from the plant;
- Surface run-off collected in the mine pit is pumped to the North waste pile run-off water pond for plant use;
- The area around the pit is likely to be substantially de-watered by the presence of the near-by YuGOK pit, which itself is in a very low permeability ground-water regime. Detailed design will investigate this issue but the risks associated with ground water and seepage around the pit are deemed to be very low;
- In order to prevent infiltration from the ponds, a compacted clay liner has been included on the walls and bottom of the ponds;
- The use of recycled water from the TSF, water from direct precipitation and surface run-offs is maximized to reduce the demand for make-up water from the Yuzhnaya aeration plant;
- Average monthly precipitation data available to the public for the Kryvyi Rih region are assumed to be representative of the mine site. This data was converted into daily data for the site overall water balance;
- Evaporation data for the Kryvyi Rih area is assumed to be representative for the site.

18.7.1 Process Water

Process water at the Shymanivske Project consists of recycled water and make-up water. For the purpose of this Study, 30% of the water sent to the TSF is assumed to be reclaimed and recycled to the plant. The rest of the required water is provided by storm collection and make-up water from the Yuzhnaya Aeration Plant. The water from the aeration plant is provided to the site free of charge through a 610 mm diameter pipeline that needs to be constructed. The initial water analysis shows too high a level of bio-organics in the water for use in the beneficiation plant without treatment. Hence the water will be treated in the water-treatment plant by ultrafiltration units and associated backwash storage tank/pumps, a neutralization system, and a chemical feed system.

Make-up water requirements will vary from month to month. The local authorities have confirmed a Project water allocation with a maximum annual withdrawal volume of 7.20 Mm^3. This should be sufficient for the re-scoped Project but a more detailed water balance and analysis will be required in the feasibility study.

Treated water will be collected in the raw water collection pond located west of the beneficiation plant next to the TSF. Clarified tailings water is also collected in this pond and then pumped to the process water-storage tank for use.

Mine pit, waste-rock pile, and plant run-off water will be collected in the north waste pile run-off water pond located east of the beneficiation plant. The collected water will be pumped through above-ground piping to the process water tank in the concentrator building for use.

18.7.2 Potable Water

Potable water at the plant will be used for human consumption, eye wash and safety-shower stations. Potable water will be supplied through a 7 km water pipeline from the Karachunovskoe Reservoir, north of the plant.

18.7.3 Cooling Water

Raw water from the raw water pond will be filtered to remove suspended particles and reduce the hardness, for use as gland and cooling water. The filtration will be done by two sand filters, and the filtered water will be stored in the treated water tank.

18.7.4 Gland and Fire Water

The gland water is fed from the fire water tank. A plant-wide pressurized fire-water protection system is used as the main fire-fighting loop. The water is supplied from the raw water pond by dedicated fire water pumps. These pumps (two electric and one diesel) supply raw water to the main fire water loop. The fire-protection system will be designed to comply with local regulations and insurance requirements. The main fire loop around the plant is a 610 mm High Density Polyethylene (HDPE) buried line. The fire main provides the required water to the fire hydrants for fire-fighting. Fire-water monitors have been included around the fuel receiving and unloading area.

A 150 mm above-ground pipe provides the required fire-water to the primary crusher and mine buildings area. The fire loop in this area is also a buried HDPE pipe. Fire-water monitoring has been provided in the fuelling station area.

18.8 Manpower

The mining operations manpower list includes all aspects of the open pit operations, including management, operators, maintenance and technical personnel. The mine manpower is developed from the list of equipment that is required to achieve the yearly production and support goals for the mine including mining of both waste and ore. The total mine manpower ranges from 175 people during pre-production and as the mine is ramping up production to 345 people in Year 12 to Year 15, when the total material required to be mined is the highest.

The beneficiation plant operators are estimated to include 187 workers in Phase 1 and 267 workers in Phase 2, calculated on a 24/7 operation. Total general and administration personnel is estimated to be 59 workers in Phase 1 and 74 in Phase 2.

18.9 Off-Site Infrastructure

The 2014 FS report provided a comprehensive analysis of off-site infrastructure, including railway and port facilities as well as logistics. These facilities are available to BKI to support its Shymanivske Project for both its construction and operations.

18.9.1 Railway Transportation

Black Iron's Project will require the movement of 4 Mtpa of dry concentrate (4.4 Mtpa wet) in Phase 1 of the Project and 8 Mtpa of dry concentrate (8.8 Mtpa wet) in its ultimate Phase 2, from the Kryvyi Rih area Moiseevka rail station to the Black Sea ports of TIS-Ruda (Yuzhny), as shown in Figure 18-5. Railcars will be loaded at the mine site using loaders in Phase 1 and a new load-out facility will be constructed in Phase 2, which will connect to the UNR via a new rail spur. Electric locomotives will be used to transport the trains.

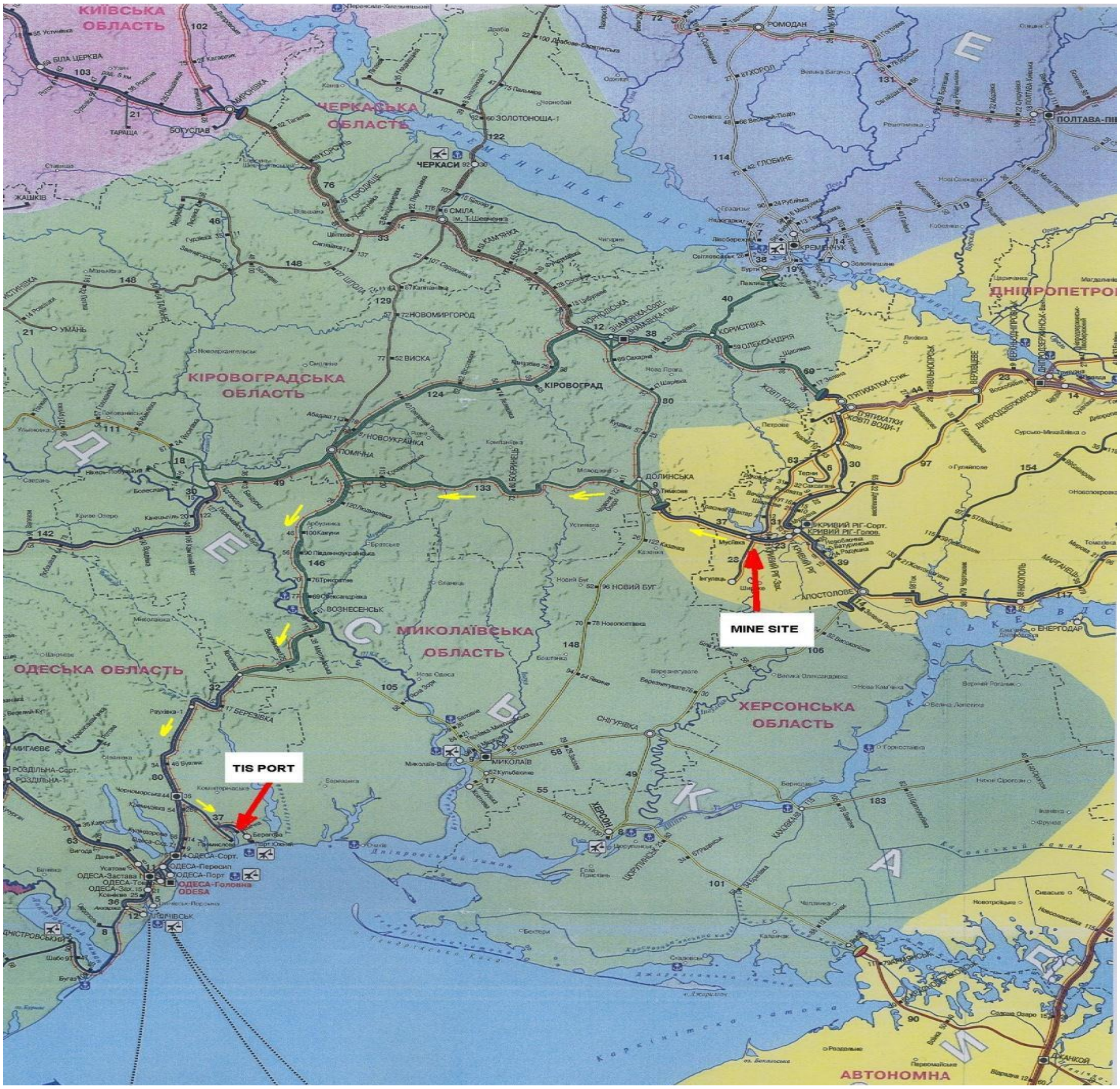


Figure 18-5: Rail Transportation Map to Port of Yuzhny

In the 2014 FS report, details of a rail study were provided outlining rail logistics and challenges. Seeing that the rail service is provided by a third party service provider, BKI is not required to make any capital investments other than the connecting rail spur. Railcars and locomotives are provided and operated by the rail service provider and are treated as an operating cost to the Project. The trains for loading are brought in based on a defined schedule aligned with plant production, for both Phase 1 and Phase 2 of the Project.

18.9.1.1 Train Sizing and Requirements

It is expected that concentrate rail trains will use the open-gondola cars owned by UNR that are typically used in Ukraine for iron ore rail service (poluwagons). Each train will consist of 55 gondola cars in accordance with the standard UNR train size. Each car will be capable of handling 69 t of product, and a complete train of 55 cars will therefore move 3,795 t of product, on a wet basis. The railcar fleet will be equipped to accommodate rotary dumping in order to unload the cars at the Black Sea port Yuzhny.

A typical round-trip time to the port, unloading and returning, is anticipated to be five working days. The 55-car train is the basis for the system design, as it is understood that this train length and weight meet the criteria for the most restrictive conditions for all sections of the expected travel routes. With a five-day cycle time, up to 1,000 railcars may be required to service the BKI operation for Phase 1 and 2,000 railcars for Phase 2.

18.9.1.2 Rail Spur Design

In order to facilitate the development of the mine-site rail system, BKI engaged SPKR (local railway design consulting company) to develop a rail layout and interface with the UNR, in order to secure approval to connect to the mainline. In August 2012, BKI received the preliminary Technical Conditions (criteria for approval) that will govern the tie-in with the UNR, which are based on the SPKR layout.

The layout features two tie-ins which will be installed in the vicinity of the UNR at the 6 km mark to accommodate Project rail operations. One new turnout will be located to the north, near existing switch Number 1 and the second will be located to the south, near existing switch Number 6. Both turnouts will direct the trains to the south-east. Most of the new rail line will be installed immediately to the east of the UNR right-of-way, which is presently treed. Ultimately, eight tracks will be arranged to handle the majority of the train movements. One track is extended to the north, to allow an entire empty train to pass under the load-out station planned for Phase 2 of the Project.

At the south end, two tracks have been provided to allow trains to off-load diesel. In addition, the switches and rail will be used to allow locomotives to move between the main tracks.

To accommodate shipping and receiving consumables and items being sent out for maintenance purposes, a dead-end track parallel to the ore-loading track has been included. A preliminary layout of the Phase 2 site rail and rail spur is presented in Figure 18-6.

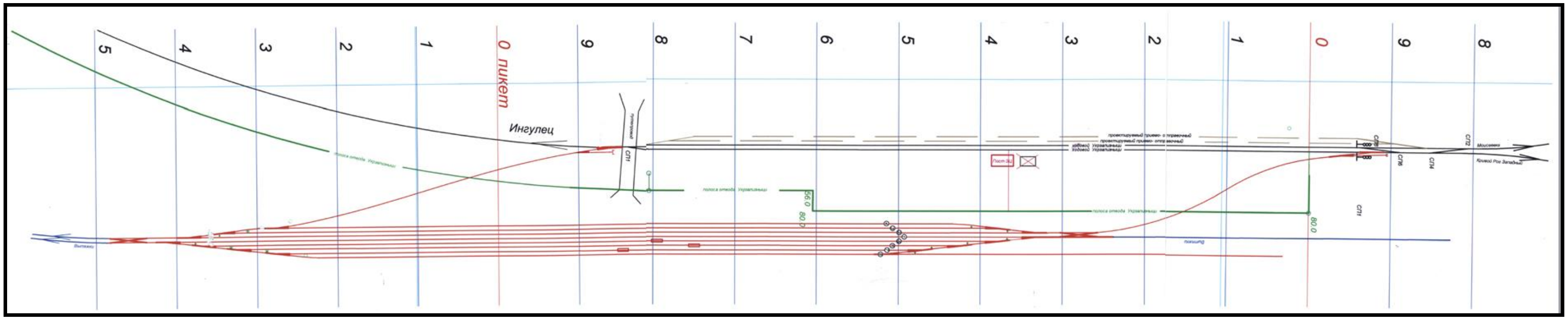


Figure 18-6: Rail Spur Configuration

In order to facilitate the ore-loading process, diesel locomotives will be used for on-site shunting operations. To minimize the time that UNR electric locomotives will spend on-site, it is expected that there will be one main electrified track where the empty train will be delivered. The UNR locomotive will arrive from the north and drive directly into the receiving track, uncouple from the train and return to the main line via the south switch. When UNR locomotives are coupling to filled trains, they will again approach the tracks from the north, couple to the full train, and then depart through the north spur. Therefore, only the minimum required length of track will be set up to accommodate the UNR electric locomotives.

Once an empty train has been delivered to the site and the UNR locomotive is clear, a diesel locomotive dedicated to shunting the trains on-site will, as required, relocate the train to adjacent tracks to accommodate the general flow of traffic. It is expected that both commercial and technical inspections of the railcars will be carried out and any defective cars will be removed from the train. Once the train has passed inspection, it will be ready for loading. Loaded trains will be moved to tracks to await the arrival of the next available UNR electric locomotive. Train waybills and related documentation will be assembled and ready for transfer to UNR personnel.

18.9.2 Port Terminal and Ship Loading

The preferred port for the shipping concentrate produced by the Shymanivske Project is the TransInvestServis (TIS) terminal at port Yuzhny near Odessa, in the Odessa region. This port has developed rapidly in the last 20 years and has an on-going, well-planned development program for many years to come. All aspects are being developed in a balanced manner:

- Lengths and number of quays;
- Water depth and channel width;
- Material unloading, handling, storage and ship-loading facilities;
- Railway siding capacity for sorting, and placing for unloading;
- Capacity of connecting lines to the main line of the Ukrainian railways system (UNR); and
- Supporting services and utilities.

The capacity existing in 2014 within open storage areas was approximately 1 Mt of product and further land is owned by TIS to increase this capacity to meet Black Iron's needs. There are three open-storage areas equipped with stacker / reclaimer machines and serviced by front-end loaders and conveyor systems. This set-up provides great flexibility among the unloading points, storage areas and ship loaders for export and import. Sufficient handling and storage capacity exists for both Phases of the Shymanivske Project.

Two ship loaders can handle approximately 50,000 t per day in total. Ships of up to 240,000 t can be accommodated in the port. Each mooring has a total length of 250 m, but longer ships can use two berths. Water depth is currently 15 m, and the Government recently awarded a contract to dredge the port to 21 m. This work started in September of 2017 and is planned to be completed in 2019. This will allow for full loading of capsize vessels at the berth as opposed to the current practice of needing to top off larger vessels in deeper water. The entry channel is single-lane and plans are to widen it for two-way traffic.

The port of Nikolaev is located in the city of Nikolaev, on the left bank of the bend of the Yuzhny Bug River, 35 km upstream from where the river flows into the Dneprovskiy Liman. Nikolaev lies nearly 115 km to the east of Odessa. The port is open for navigation the whole year round. This port is closer to the Shymanivske Project than the port of Yuzhny but it has limited ship-loading capacity and shallower depth. This port can provide BKI with added logistics flexibility to get its product to market.

19. MARKET STUDIES AND CONTRACTS

19.1 Iron Ore Selling Price Assumptions

As part of this present PEA Study, it is required that a selling price be determined in order to perform the Project Economic Analysis. BKI has not recently undertaken a formal market study and must therefore resort to other means to reasonably assume the selling price of its concentrate.

Iron ore product prices have been traditionally tracked using benchmarks. The most quoted benchmarks used by the industry are:

- Platts Iron Ore Index ("IODEX");
- Metals Bulletin Iron Ore Index ("MBIOI");
- The Steel Index ("TSI"), owned by Platts.

The IODEX and MBIOI 62% Fe, CFR China Port indices are commonly used as the benchmarks for basing off-take agreements. Indices based on 65% Fe iron ore products have also become an important benchmark to differentiate higher quality iron ore products.

Adjustments in the form of a premium or penalty are made to account for higher (or lower) Fe content. The spread between the 62% Fe index and the 65% Fe index provides a good measure of the premium attributed to higher grade products. Quality premiums/penalties are also tracked for other elements such as SiO_2, Al_2O_3 and P, which have an important impact on downstream operations such as sintering, pelletizing, ironmaking and steelmaking.

Since mid-2017, the spread between the 62% Fe index and the 65% Fe index has increased substantially compared to more typical and historic levels. This is a prominent shift in the iron ore market that recognizes 'value in quality' of iron ore products. This shift has been driven by Chinese steelmakers in a concerted effort to increase productivity, reduce costs and more importantly, reduce greenhouse gas emissions. As demand for higher quality feedstocks increases, premiums follow suit. It is generally agreed that this trend will be sustainable in the longer term.

For this PEA Study, BKI has performed a market price analysis for iron ore based on historical pricing trends (Hatch 2017). As a first step, a comparison of the spot price, the 36-month trailing average and the 3-month trailing average between the Platts 62% Fe and 65% Fe indices was performed and is presented in Table 19-1. It should be recalled that the BKI concentrate has a Fe content of 68%.

Table 19-1: Iron Ore Spot and 36-Month Trailing Average (Source: Bloomberg)

Index Name	Spot Price Nov. 10, 2017 ($/dmt)	36-Month Trailing Average ($/dmt)	3-Month Trailing Average ($/dmt)
Platts IODEX 62% Fe CFR North China	62.60	61.88	68.60
Platts IO Fines 65% Fe CFR North China	81.50	70.96	90.24
Price Premium for 65% Fe Index	18.90	9.08	21.64

Furthermore, a comparison of the published Platts 65% Fe CFR North China composition and the BKI concentrate composition was made and associated unit premiums/penalties were determined as presented in Table 19-2. As can be noted, for Al_2O_3 and P, the BKI concentrate is well below the Min-Max range covered by the Platts benchmark suggesting that the BKI concentrate is of superior quality for these two parameters. Only the BKI concentrate SiO_2 content is above the Platts reference value thus generating a penalty.

Table 19-2: BKI Impurity Premium/Penalty (Source: Bloomberg Nov. 10, 2017)

Parameter	Platts 65% Fe Reference	BKI Concentrate	Premium/Penalty per Differential	Within Min-Max
SiO_2 Content	3.5%	4.5%	$3.30/dmt per 1% SiO_2	4.5% to 6.5% SiO_2
Al_2O_3 Content	1%	0.43%	$1.38/dmt per 1% Al_2O_3	1.0% to 2.5% Al_2O_3
P Content	0.075%	<0.020%	$1.11/dmt per 0.01% P	0.09% to 0.12% P

Using the aforementioned data and recognizing that the BKI 68% Fe concentrate benchmarks well with the indices used in this analysis, including its low content in Al_2O_3 and P, the assumed CFR selling price for the Economic Analysis presented in Chapter 22 of this Report was determined as follows:

- The Platts IODEX 62% Fe CFR China index 36-month trailing average value of $61.88/dmt (the lowest between spot price and 36-month trailing average) was assumed as the base price;

- The assumed premium for 65% Fe (from 62% Fe content) of $21.64/dmt based on the 3-month trailing average was used as it was deemed to be more representative of the market forces driving for higher Fe grade iron ore products. The 3-month average also attenuates the high level of day to day volatility in the %Fe premium experienced over the past months. As such, the BKI concentrate, grading 68% Fe, would attract a premium of $43.28;
- Concerning premiums/penalties for impurities, the BKI concentrate would attract a net premium of $3.57/dmt;
- The total CFR China selling price used for the Economic Analysis in this PEA is $108.73/dmt;
- The current shipping price from Port Yuzhny to the Port of Quingdao China is $10.50/ wmt ($11.54/dmt) resulting in a FOB Port Yuzhny selling price of $97.19/dmt.

19.2 Off-Take and Agreements

Black Iron has hired a highly experienced Senior Vice President Corporate Development with over 30 years of experience selling iron ore to steel mills and trading houses. This person has re-initiated offtake discussions on a pre-paid basis with some of the groups Black Iron had engaged prior to 2015.

19.3 Railway Transportation Negotiation Status

A letter of intent (LOI) has been entered with Ukraine's National Railway to provide up to 20 Mtpa of capacity to move product from Moiseevka rail station located near Black Iron's Shymanivske Project to Port Yuzhny. There is no minimum or take or pay obligations outlined in this LOI.

19.4 Port Agreement

A LOI has been entered with TransInvestServis (TIS) to provide up to 9.5 Mtpa of storage and ship loading capacity at their privately owned berth located at port Yuzhny.

19.5 Electric Power Supply

A LOI has been entered with the local power utility Dneprovskaya ElectroEnergetisheskaya Systema, NEK Ukrenergo to provide up to 140 MW of electricity from the Gornaya substation located 30 km south-east of the Shymanivske site.

20. ENVIRONMENTAL STUDIES, PERMITTING, AND SOCIAL OR COMMUNITY IMPACT

For this current PEA, this Chapter is based largely on the 2014 FS report and updated based on developments since its publication. In turn, the 2014 FS relied substantially on the 2012 FS report.

20.1 Environmental and Social Management of the Project

20.1.1 Management Resources Committed to the Project

The Project has an experienced environmental and social manager, employed by Black Iron, who is located in Kryvyi Rih and has extensive experience with the local conditions in addition to iron ore and metallurgical environmental norms. Alexander Sobko, an accredited Ukrainian Environmental Engineer, with over 24 years of experience, former head of the Kryvyi Rih ecological inspectorate, is in charge of these aspects of the Project.

The environmental and social Manager commissioned the Ukrainian Design Institute Tyazhpromavtomatika (TPA) to undertake environmental and social baselining and impact-assessment activities. TPA subcontracted work-packages to individual experts.

20.1.2 Overview Regulatory Requirements

Prior to May 2017, the Ukrainian EIA, or the Otsinka Vplyvu na Navkolyshne Seredovysce (OVNS), was required by law to be approved by a State Environment Review (SER) prior to commencement of project development activities. Legally, the OVNS can be prepared and submitted only by a suitably authorized Ukrainian design institute.

The OVNS process has some similarities to an Environment, Social and Health Impact Assessment (ESHIA), as undertaken in other countries. However, the OVNS process is generally viewed as a compliance procedure, whereby the determination of the calculated emission and pollutant level that falls beyond a statutory sanitary (or buffer) zone, must be reduced to compliance limits. This determination is the basis for the regulatory approval decision.

In comparison, the international ESHIA process, as codified by the World Bank, puts more emphasis on a risk-based determination that incorporates environmental, social and health aspects in the design and planning process from the outset of a project, with a view to creating a sustainable project with acceptable environmental, social and/or health risks. This procedure requires either eliminating, in the design phase, any major causes of potentially adverse impacts or providing management strategies for the impacts from the outset.

As of December 18, 2017, organizations planning any activity that has the potential to significantly impact the environment are required to perform an EIA subject to the requirements imposed by Law No. 2059-VIII regarding Environment Impact Assessment adopted on May 23, 2017. Article 3 of the law lists activities that are capable of having significant impact on the environment and includes extraction of minerals and processing of minerals.

The adopted Law will not apply to organizations that had obtained a permit to perform one of the relevant activities before the Law entered into force (i.e. before December 18, 2017), subject to certain exemptions. All environmental expert assessment (EEA) results obtained before December 18, 2017 will remain valid and will have the same status as any EIA results.

Public consultation must be carried out as per the new law and the ESIA is reviewed by an authorized body (Ministry of Ecology or local environmental authorities).

Considering that no environmental expert analysis will have been completed on the Shymanivske Project before December 18, 2017, the Project will be subjected to the new law. For this Study, it is also assumed that the modification to applicable regulations regarding the EIA will not have a significant impact on the permitting schedule for the Shymanivske Project. BBA recommends that a more detailed analysis of this new Law be performed at the next Project study phase to fully assess any impacts the new Law may have on the Project.

20.1.3 Applicable Environmental Legislation

Mandatory regulatory requirements and standards for the Project include the following:

- Ukrainian laws and regulations;
- International environmental treaties and conventions that Ukraine is signatory to; and
- International agreements.

Voluntary codes and practices referred to in this Chapter include:

- Guidelines and standards from the World Bank / International Finance Corporation (IFC); and
- Industry association standards (cf. industry best practice).

In summary, primacy is given to national standards, so that, whenever the Ukrainian regulatory framework is unclear on environmental and/or social matters, the Project shall follow the guidelines and standards from international sources, as well as industry best practice, whenever possible.

20.1.4 Previous Work

The following documents have been used as the basis for assessing potential Project-related impacts and possible mitigation measures:

- "Shymanivske Project Feasibility Study - High-Level Scoping Report on Potential Environmental, Health and Social Aspects of the Proposed Shymanivske Iron Ore Project, Dnepropetrovsk Region, Ukraine" (WorleyParsons, 2012a);
- Report of the First Series of Sampling (TPA, 2012);
- Stakeholder Engagement Plan (Black Iron, 2012a);
- "Environmental and Social Basis of Design" (WorleyParsons, 2012b);
- "Water Quality Design Criteria" (WorleyParsons, 2012c);
- "Water Management Basis of Design" (WorleyParsons, 2012d);
- "Design Criteria Air Quality / Dust" (WorleyParsons, 2012e); and
- "Design Criteria Noise / Vibration and Blasting" (WorleyParsons, 2012f).

20.1.5 Status of Environmental Work

Since 2010, Black Iron has been reviewing the environmental and social baseline and context of the Project and establishing appropriate data-collection programs, impact-assessment studies, consultation programs and design criteria, so that the Project can meet the required environmental and social standards. BBA (2011) outlined the general environmental and social compliance requirements for the Project, including an overview of the regulatory process.

In April 2012, following a technical and commercial tendering process, Black Iron Inc. commissioned TPA to undertake the ESIA baseline surveys and to define the boundaries of the Sanitary Zone. Baseline data collection commenced in June 2012, in line with a program of surveys that had been designed collaboratively between TPA and WorleyParsons.

Prior to this, WorleyParsons had undertaken desktop studies and literature reviews to develop a better understanding of existing conditions in the Project area. This information was used as the basis for the preliminary environmental aspects risk register and assessment to identify the priorities for baseline data collection, given the absence of available existing, site-specific information.

WorleyParsons conducted a number of surveys in tandem with the ESIA baseline surveys, in order to enhance the design and engineering work and develop a more comprehensive understanding of project risks and approaches to managing the risk assessment. The "Scoping Report" (WorleyParsons, 2012a) presents the findings of these surveys and outlines potential environmental and social issues and risks that need to be addressed by the Project during the design phase and during construction and operations.

TPA conducted the first round of ESIA baseline surveys during the months of June and July 2012.

20.2 Environmental Setting

This section presents a summary of available information regarding the existing environmental and social conditions in the Project area. Specifically, it addresses air quality, ambient noise levels, soils and geology, ecology and biodiversity, and water and socio-economic issues. Additional information about existing conditions is presented in the 2012 FS and the 2014 FS Reports.

The Shymanivske iron ore deposit is part of a well-established iron ore mining area with several active iron ore mining operations surrounding it. The special permit under which the Project operates covers an area of 256 ha and is located 330 km south-east of Kiev, in central Ukraine.

The Shymanivske deposit is located 8 km south of the city of Kryvyi Rih and approximately 6 km south-east of the Karachunivske Reservoir. The site is surrounded by the villages of Rudnichnoe, Stepnoe, Chervona Polyana, Zelyonyi Gay and Moiseyevka (Figure 20-1). Project development and operation will be in addition to the existing mining activity in the surrounding area north of the villages of Novoselivka, Lativka and Starodobrovil's'ke.

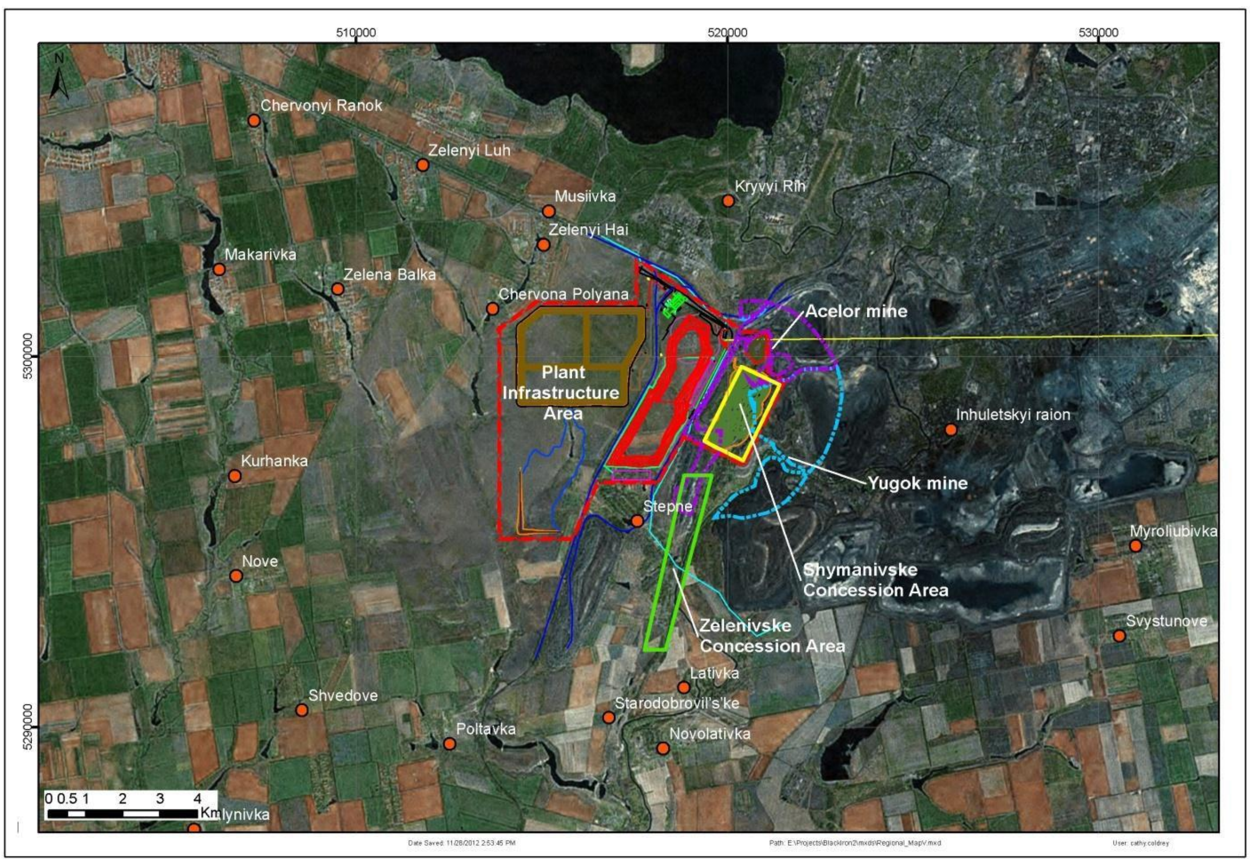


Figure 20-1: Location of the Shymanivske Deposit

The city of Kryvyi Rih is dominated by heavy industry, particularly mining and metallurgy. Directly to the east of the Shymanivske Project site lie the mines of Arcelor Mittal Kryvyi Rih (also known as Kryvorizhstal) and YuGOK (the Southern Ore Mining and beneficiation plant). Land use in the wider, arable region of Kryvyi Rih is primarily agricultural.

20.2.1 Air Quality

Air quality is a significant existing issue in Kryvyi Rih. Local air quality is adversely affected by gaseous emissions and dust generated by existing mining activities and related metallurgical processing industries. Air quality data from government monitoring stations (PSZ), located in the city of Kryvyi Rih, provide a general overview of the conditions in the vicinity of the Project from 2008 to 2011, but this data is not considered representative of the background levels at the Project area because the monitoring points are located more than 10 km from the site.

Three short-period rounds of monitoring were conducted between July and August 2012 at selected locations within the Project area by TPA and WorleyParsons to measure background levels of:

- Nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and carbon monoxide (CO); and
- Total suspended particles (TSP) and particulate matter (PM_{10} and $PM_{2.5}$).

Results from the air quality monitoring campaigns are described below and compared with national and international standards, which were applicable during the test period, as follows:

- The site-specific background concentrations of NO_2 and CO measured by TPA and WorleyParsons were below the limits set by national and international standards;
- SO_2 concentration at one of the locations tested by TPA was found to be 0.45 mg/m^3, which is slightly above the limit set by the EU for a 1-hour average period (0.35 mg/m^3) but is below the national standard (0.5 mg/m^3);
- SO_2 concentration at four of the sampling locations measured by WorleyParsons were found to be equivalent to or slightly exceed the WB/IFC daily limit of 0.02 mg/m^3 averaging 0.025 mg/m^3, they were below the limits set by the national legislation;
- Total dust levels measured by TPA during their monitoring campaign were in the range of 0.18 - 0.32 mg/m^3, which exceeds the national limit for a 24-hour average period (0.15 mg/m^3) but they are below the one-time maximum national limit (0.5 mg/m^3);
- Similar results were found by WorleyParsons (0.07 – 0.4 mg/m^3) during its first monitoring campaign (8-hour sampling, July, 2012), although these results were obtained at different locations and are not directly comparable;
- The total dust levels measured during the second monitoring campaign by WorleyParsons (August, 2012) were below the one-time maximum national limit, but at two of the locations, the 24-hour dust levels exceeded the national 24-hour average limit during four out of the seven sampling periods (averaging 0.19 mg/m^3).

Although the rounds of sampling are somewhat limited, the results indicate that baseline air quality conditions at the Project site are adversely affected by existing operations and activities.

20.2.2 Noise

Existing sources of noise in the Project area include the active mining operations of Arcelor Mittal and YuGOK, the double-track Moiseyevka–Kryvyi Rih railway line, and traffic on the road network that connects Kryvyi Rih with various villages located south of the city. There is no industrial or commercial activity in the villages near the Project site and traffic levels are light.

TPA and WorleyParsons undertook noise-monitoring surveys at various locations around the Project site during July, 2012.

The results of TPA's monitoring showed that:

- The highest LA_{eq} level (52dBA) and LA_{max} level (68 dBA) were found in the village of Zelyonaya Balka. Neither of these levels exceeds the national limits of 55 dBA for LA_{eq} and 70 dBA for LA_{max};
- Zelyonaya Balka is the largest settlement in the vicinity of the Project and has the best-developed infrastructure and largest population. The high noise levels are thought to be attributable to higher levels of automobile traffic at this location, although this requires confirmation.

TPA did not identify any sources of continuous industrial noise at any of the monitoring locations.

In contrast, during its monitoring survey, WorleyParsons recorded a LA_{eq} of 62.8 dBA at one of the monitoring locations and found that the national standard of 70 dBA for LA_{max} was exceeded at five of the ten monitoring locations. Only natural background noise from normal activities was identified. It was unclear as to why the background noise baseline at the non-industrial residential monitoring points exceeded the national standards when only low-level noise sources were apparent. Therefore, the possibility of a pervasive background industrial noise-base from the mining and metallurgical industries in the vicinity should be considered. Field procedures and selection of permanent noise-monitoring stations require validation. In brief, it is recommended that the results of the WorleyParsons monitoring survey be taken as the baseline conditions and that repeated noise measurements be taken to confirm the baseline.

20.2.3 Soils and Geology

The Shymanivske iron ore body has been described earlier in this Report. The majority of the land in the vicinity of the Project site is covered by low, humic (high organic content) black soils, which occupy undulating plains and gentle slopes. Heavy loam soils dominate in the north of the region, while light loams dominate in the south.

Historically, variable thicknesses of mining waste (waste rock) have been dumped on the natural superficial deposits of the east and west flanks of the Project's primary ore body. This material has substantially settled and re-vegetated over time but, judging by its deposition as an informal mining waste, it is expected to contain sizeable void space and heterogeneity.

TPA conducted a limited surface soil survey during May and June, 2012, and collected soil samples at 16 locations (not randomized or stratified) across the Project site. The results of the survey were as follows:

- There are indications of low-level industrial fugitive contamination of surface soils, including exceedances of the maximum allowable concentrations (MAC) for lead, cadmium and copper in at least one of the sampling locations. The source of heavy metals is believed to be wind-blown dust from neighbouring mine/ processing sites.
- Soils are generally not saline, but are reported to contain relatively high levels of nitrate exceeding the maximum allowable concentration and varying levels of phosphorus and fluorides, at times exceeding the MAC. The recorded levels may indicate industrial contamination: fluorides belong to one of the priority pollutants of soils in the Dnepropetrovsk Region, where high levels are associated with industrial emissions from alumina and non-ferrous plants.
- No issues associated with contamination from radiation, pesticides, petrochemicals or hydrocarbons were identified, although the testing to date has not been carried out at a sufficient sampling density to rule out the possibility of contamination hot-spots being present and undetected.

An intrusive geotechnical test program, comprising ten medium-depth boreholes, was completed to provide more site-specific details on the sub-surface geology.

20.2.4 Ecology and Biodiversity

Although existing mine and neighbouring industries have affected the ecological value of the Project area and pockets of important habitats and ecosystems still remain, there are no designated protected areas in the vicinity of the site. An overview of flora and fauna in and around the Project site is described in the 2014 FS report.

20.2.5 Water

Groundwater

Information collected as part of the scoping exercise indicates that there are likely to be two groundwater bearing units in superficial geological units within the boundaries of the Project site: a shallow upper Quaternary loess-type aquifer and a deeper aquifer unit in the Pontic and Sarmatian sand and limestone. The Sarmatian limestone is reported to be karstic at the mines located to the east of the Shymanivske deposit. Limited deeper groundwater is present in the basement bedrock, principally confined to fracture and fissure areas.

The upper Quaternary aquifer is recharged through infiltration and from leakage through storage ponds and man-made drainage ditches located on the neighbouring mine sites. The Quaternary aquifer is underlain by low permeability Miocene-Quaternary clays, which, in turn, overlie the Pontic-Sarmatian aquifer. This lower aquifer comprises up to 15 m of fine-grained sand and fissured limestone, which is occasionally clayey and karstic. The aquifer overlies a low-permeability Palaeogene Kiev clay, which is present above the basement rock across the whole area.

Groundwater flows are generally towards the Inhulets River, although they are complicated locally by the presence of ravines and localized leakage from the storage ponds on neighbouring sites. Groundwater in the limestone can also discharge to the streams located within the site area.

Historically, the groundwater quality in the area has been compromised by leakage (gradual and catastrophic) from storage ponds at other mine sites. This has reportedly led to a reduction in reliance on groundwater as a source of drinking water in the surrounding villages (mainly to the south of the current mine sites), with mains water supplied instead. However, three drinking-water wells have been identified in Zelena Balka and Zelyonyi Gay, located to the north and west of the expected location of tailings storage facility. Water from these locations has been sampled by TPA as part of their ESIA baseline sampling studies.

The results of the chemical tests on pre-Project baseline water sampling from the wells indicate that the water does not meet the requirements for drinking because it contains levels of suspended solids, organic substances, salinity, sodium, cadmium, nickel, magnesium, manganese, sulphates and chlorides—all of which exceed the national standards.

Further testing includes packer tests to determine aquifer properties, and is taking place in conjunction with the geotechnical program.

Surface Water

The Shymanivske Project site is located approximately 5 km to the west of the River Inhulets and 6 km south of the Karachunivske Reservoir. A small unnamed tributary of the River Inhulets drains across the Project site and there are several small tributaries and ponds surrounding the site.

The River Inhulets is a tributary of the River Dnieper. The Karachunivske Reservoir impounds the River Inhulets to the west of Kryvyi Rih. The River Inhulets is predominantly supplied by rainfall-runoff, although there is some groundwater recharge (Alyokhina et al., 2007). Concerns have been raised about high levels of contamination in both the Inhulets and the Dnieper basin, which provide a range of environmental services. Identified contamination sources include mining and metallurgical processing and particular concern is expressed about the capacity of these systems to take any further degradation or impact from human activity (Borysova, O. et al., 2005), particularly as the Dnieper is a trans-boundary system.

TPA conducted a surface-water sampling campaign in May and June, 2012, at 17 locations in and around the Project site. Six of the sampling points were located on the River Inhulets, one at Karachunivske Reservoir and the remaining ten on the ponds surrounding the site.

A summary of the results of the pre-Project baseline surface water monitoring for the River Inhulets and Karachunivske Reservoir is presented below and in more detail in the 2014 FS report.

- The water is moderately saline with total dissolved solids (TDS) exceeding the standard MAC for public utility use;
- Sulphates levels are 4 to 15 times greater than the $MAC_{fishery}$ and up to three times greater than MAC_{p-u};
- Chlorides (Cl^-) are generally below permissible levels, although at one sampling point on the River Inhulets just to the south of the YuGOK mine site, the chlorides are 1.5 times the $MAC_{fishery}$;
- The concentration of calcium immediately downstream from Karachunivske Reservoir is above $MAC_{fishery}$;
- The concentration of magnesium exceeds the $MAC_{fishery}$ value at all sampling points. The high concentration of sulphates, calcium and magnesium in the surface waters correlates with high values of TDS;
- Concentrations of sodium are up to 2.3 times that of the $MAC_{fishery}$;
- The values of chemical oxygen demand (COD) and biochemical oxygen demand (BOD) indicate that the surface waters are polluted by organic substances;
- High levels of aluminium, manganese, copper, nickel, zinc and chromium are present at several of the sampling locations;
- Levels of arsenic, petrochemicals and phenols are found to exceed the $MAC_{fishery}$ standards at a number of sampling locations.

Pre-Project baseline testing of water samples from the ponds surrounding the Project site also indicate that the water has been impacted and, in some instances, significantly polluted (the pond in Chervonaya Polyana) with very high sulphate and chloride concentrations.

Environmental concerns have been raised with respect to the mines located to the north of the city, which store both effluent and produced waters from abandoned mines in their tailings dams. Between November and February every year, this water is released into the River Inhulets about 7 km downstream of the city limits. The Inhulets is continuously flushed with water that is released from the Karachunivske and Makorty reservoirs, respectively, in order to improve the water quality.

20.2.6 Socio - Economic Setting

The main source of employment for Kryvyi Rih is mining and metallurgical processing. In 2009, 70% of the local population was employed in the steel industry. The impact from such a high density of mining and metallurgical activity in one location is apparent.

Currently, there are five villages in the direct vicinity of the proposed Project (Rudnichnoe, Stepnoe, Chervona Polyana, Zeleny Hai and Moiseyevka), and many more are potentially influenced by wind or groundwater or the waters of the River Inhulets. The development of the Shymanivske Project will necessitate the relocation of Rudnichnoe village, which has a population of approximately 1,200.

In addition to contamination of water sources in and around Kryvyi Rih, the city has high concentrations of pollutants in atmospheric air and soil (Pistunov and Antoniuk, 2011). It is reported to be the most polluted city in the Dnepropetrovsk region and high rates of disease have been recorded in the population. The number of cancer cases (tracheal, bronchial and lung), all forms of tuberculosis, strokes, cardiac infarction, iron deficiency anaemia and pregnancy pathologies have increased (Pistunov and Antoniuk, 2011). Studies have determined that population disease rates are often related to onco-pathologies in Kryvyi Rih and are highly correlated with polluting factors such as lead concentration in the environment.

Currently, the villages of Chervona Polyana and Zelyonyi Gay are separated from the existing mine sites by over 5 km of fields. With the development of the Shymanivske Project, the closest infrastructure to the eastern side of Chervona Polyana and Zelyonyi Gay will be the expected location of the tailings management facilities.

20.3 Preliminary Identification of Issues

Bordered by the mines of Arcelor Mittal Kryvyi Rih and YuGOK and located on disturbed land, the Shymanivske Project is characterised as a brownfield site. Its environs show extensive geomorphological change and are characterized by relatively high levels of historic pollution.

Given that there is already a high level of degradation caused by current industrial activities in the area, the focus of an assessment of a new project such as the Shymanivske Project is to understand what will be the cumulative effect, if any, and try to determine the significance of it. This should lead to a determination of how acceptable any change in conditions from the current environmental and socio-economic conditions will be.

It is entirely plausible that the magnitude of Project-related impacts for some environmental media, such as dust concentrations, will be relatively small while the significance of the incremental increase will be great because of degraded conditions.

The key environmental and social issues associated with the Shymanivske Project are summarized below, for each of the environmental and socio-economic media previously considered. A more detailed description is provided in the “Scoping Report” (WorleyParsons, 2012a).

20.3.1 Air Quality

NO_x, SO_x and CO

The principal source of airborne emissions is expected to be the exhaust emissions from generators, engines, vehicles and heavy equipment. The impact of these activities on air will be quantitatively assessed as part of the ESIA. The impact assessment will require an estimate of the Project's contribution to existing background levels, and the results obtained will be compared with the applicable air quality standards.

Provided that standard control measures are included in the engineering design and operation of the Project, it is not expected that the Project will cause a significant increase in the levels of these gases so that they exceed the permissible national limits.

Dust

Dust emissions will be produced during all stages of the mine lifecycle from a multitude of sources, including vegetation clearance during the construction phase; earth movements, such as the creation of new access roads, grading and levelling of the railway route and the placement of auxiliary installations, the movement of vehicles and operation of heavy equipment on unpaved roads; and bulk material and waste management, such as loading, unloading, road transportation and stockpiles.

During the operational phase dust will be generated by mining, blasting, processing and will be a consequence of wind erosion from waste rock dumps, overburden and ore stockpiles and the tailings facility.

Given the indications that background dust concentrations at certain locations around the Project site are already exceeding national limits due to dust emissions unrelated to the Project, dust-control measures for principal dust sources will be a main objective and stipulation for the Project.

In order to systematically design and focus on key dust sources and determine the most beneficial control measures, additional air quality surveys are required during a range of climatic conditions and an air-dispersion model will need to be developed. This will enable accurate predictions of expected contributions of dust from routine operations and an accurate determination of the Project's impact on dust levels and associated air quality.

Initial analysis of predominant wind direction during the years 2000 to 2010 indicates that the wind mainly blows from the northeast to the southwest ("Scoping Report," WorleyParsons 2012a). This means that dust produced by the proposed Project, in particular activities on the mine pit, waste dumps, process plant and tailing pond, blows away from the densely populated areas in the southern end of Kryvyi Rih. Therefore, the plant site and production facilities are favourably located so that there are no communities in the prevailing wind direction towards the south-west.

20.3.2 Noise

Principal sources of noise during the construction phase will include fabrication and construction, piling, ground preparation, machinery engines, vehicles used for transport, loading and unloading of rock and materials, and chutes and power generation if diesel generators are required for emergency purposes. During the operation phase, sources of noise will include vehicle engines, loading and unloading of rock into steel dumpers, shovelling, ripping, drilling, blasting, transport (including corridors for rail, road, and conveyor belts), crushing, grinding, and stockpiling.

Noise emissions from the Project will be controlled, so that they do not exceed the national standards of 55 dBA for LA_{eq} and 70dBA for LA_{max}. Control measures shall be implemented to ensure that the noise emissions from the Project, measured at appropriate compliance points when overlain on the background levels, do not cause national standards to be exceeded.

Additional noise monitoring over a prolonged will be carried out to establish noise emissions around the site and how they vary at different times of day, on different days of the week and under different meteorological conditions. This information will be incorporated in a model to map noise “hot spots”. Predicted noise emissions will be calculated for the construction and operations phases of the Project and these emissions will be included in the model. The model can then be used to identify the required control measures to be implemented, in order to protect key receptors from elevated noise emissions over the lifecycle of the Project.

Key receptors are the villages of Rudnichnoe, Stepnoe, Chervona Polyana, Zelyonyi Gay and Moiseyevka. Seeing that the village of Rudnichnoe will need to be relocated, efforts should be made to relocate it to a site where it would not be a receptor.

20.3.3 Soils and Geology

The immediate footprint of the Shymanivske Project will experience a range of irreversible soil impacts associated with the land-use change. The principal soil issues are:

- Outside the site boundary, there is the potential for contamination of soils from windblown dust, contaminated groundwater or surface water and/or through the disturbance and mobilization of current anthropogenic or natural soil contamination;
- There is uncertainty as to whether oxide layers in the deposit, containing pyrrhotite and pyrite, have the potential to be net acid-generating and to result in acid rock drainage;
- The loss, erosion and compaction of productive soil resource that will be required at a later stage for rehabilitation purposes;
- Preliminary information has also highlighted the potential for hazardous ground conditions, comprising either unexploded ordnance (UXO) and/or contaminated ground that is present on the military land identified to be annexed for Project purposes. A thorough evaluation of the former military site to remove and manage these uncertainties and to limit liability is required.

A full assessment will be undertaken as part of the ESIA and control measures designed to mitigate the impacts of the Project on soils, landform, and land use.

20.3.4 Ecology and Biodiversity

The following issues have been identified as having a potential impact on the current ecology and biodiversity of the area:

- Land clearance;
- Land / aquatic ecosystem burial;
- Habitat loss, fragmentation and disturbance;
- Drainage alteration;
- Exposure to contaminated run-off;
- Spread of alien invasive species;
- Reduced dispersion of seeds by fauna;
- Displacement of fauna;
- Deterioration in water quality; and
- Increased sedimentation/turbidity in freshwater ecosystems.

The extent of any impacts on the ecology and biodiversity in the area will be confirmed by the ESIA. However, preliminary data indicate that there will be no notable reduction in biodiversity in flora and fauna in the surrounding area. At the same time, the control measures will need to be implemented to ensure that the protected species listed earlier are not adversely impacted.

20.3.5 Water

Groundwater

The final pit depth is approximately 250 m, comprising an open cut through the overburden and the excavation of footwall material.

The working open pit mine will require dry in-pit conditions, and progressive dewatering will be required through the life of the pit extension to ensure dry working faces and to avoid potential heave issues across the pit floor.

The effect of dewatering on neighbouring water-supply wells and the potential for the inadvertent inflow of off-site contaminated water into the pit will be assessed through further ESIA assessment and groundwater study work.

Surface Water

There are a number of ways in which the Shymanivske Project has the potential to impact the local hydrology and surface water.

The process plant water requirements and a general water balance for the Project have been presented in Chapter 17 of this Report. This will be drawn from a combination of sources:

- Process water recirculated from TSF as well as rainfall-runoff water entering the TSF;
- Rainfall-runoff from waste dump, plant areas and mine pit;
- Direct precipitation onto the storage ponds; and
- Make-up water.

Make-up water requirements will be sourced from the Yuzhnaya water treatment plant. Water from the Yuzhnaya aeration plant will require treatment prior to use. As make-up water is being sourced from the Yuzhnaya water treatment plant rather than from Karachunivske Reservoir or the River Inhulets, the levels/flows in these water bodies will not be directly affected.

The design of the site drainage system allows all site rainfall-runoff and rainfall-runoff collected in the perimeter drains to be retained within the site and recycled for use within the process plant. There will be no net outflows from the site and hence no treatment requirements. All water will be stored in open water bodies, or stored in entrained tailings, or lost through evaporation from the water and tailings storage facilities. This will reduce the demand for make-up water and the potential for contamination of local water bodies. However, it will also mean that water bodies and/or aquifers will be impacted and lead to lower flows and storage, if they are dependent on rainfall-runoff collected in the perimeter drains or from within the Project boundary for recharge.

The site drainage is designed to handle flows up to and including a 100-year flood lasting 24 hours. There is a risk of contamination of surface water by outflows from the TSF pond, water collection ponds and site drainage system during extreme flood events, including those in excess of a 100-year event. Given the volumes of water involved in such events, it is expected that there would be significant dilution of any contaminants. There is also a risk of contamination of surface water and soils from hydrocarbons and antifreeze / glycol used during the servicing and washing of vehicles and machinery.

The ESIA will confirm the impacts of the Project on the local hydrological system and on surface-water quality and it will identify control measures to mitigate impacts.

From the preliminary scoping studies, the following hydrology issues have been identified:

- Reduced flow in the River Inhulets and other nearby watercourses, as industrial runoff is retained within the Project boundary. This will potentially have an impact on aquatic ecosystems, riparian vegetation/habitats and downstream communities.

- Increased flood risk to nearby and downstream communities as the Project alters the geomorphology of the landscape. This will potentially have an impact on aquatic ecosystems, riparian vegetation/habitats and local communities.
- Potential for contaminated water in the waste-rock dump, TSF and storage ponds to discharge to surface water and groundwater during flood events that exceed the design capabilities. This will potentially have an impact on aquatic ecosystems and human health and may pose a threat to the potable water supply.

Regarding the water management strategy and design, the 'Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Industries' (European Commission, January, 2009) recommends dam design's be based on an once in 100-year flood for **low hazard dam** and for once in a 5,000 to 10,000-year flood for **high hazard dam.** The definition of low and high hazard is not given. In Directive 2006/21/EC on the management of waste from the extractive industries, **category A** waste facilities could be considered similar to a high risk dam:

- Criteria for determining the classification of waste facilities;
- A waste facility shall be classified under category A if:
  - A failure or incorrect operation, e.g. the collapse of a heap or the bursting of a dam, could give rise to a major accident, on the basis of a risk assessment taking into account factors such as the present or future size, the location and the environmental impact of the waste facility; or
  - It contains waste classified as hazardous under Directive 91/689/EEC above a certain threshold; or
  - It contains substances or preparations classified as dangerous under Directives 67/548/EEC or 1999/45/EC above a certain threshold.

Commission Decision of 20 April, 2009, on the definition of the criteria for the classification of waste facilities in accordance with Directive 2006/21/EC, gives more details on the classification.

Considering the fact that people live near the dam and the size of the dam, it is likely that the dam would be considered category A and high risk as per European definition. In the next study phase, BKI should review its design criteria for extreme rainfall events. Should Ukraine align closer to European standards (as has been done for ESIA requirements), it is possible that the Project will need to redefine its design criteria based on permitting requirements.

20.3.6 Socio-Economic Issues

Mining is expected to continue for about 17 years at the proposed mining rate and based on the subset of mineral resources within the open pit quantified in Chapter 16 of this Report. The net export value of the mine product and the capital invested to establish the mine are expected to bring economic benefits to the mine area and Ukraine as a whole. Part of the economic benefit from the mine will be transferred to society in the form of wages and a more skilled workforce, disbursement for procurement of supplies, social investments and payment of revenue to the government. The socio-economic impacts of the Project are expected to be largely beneficial over the entire life cycle of the Project.

To date, Black Iron has completed a preliminary audit for the resettlement of Rudnichnoe village. A Stakeholder Engagement Plan was developed and is progressively being implemented. A Resettlement Action Plan is to be drawn up, with a view to undertake a progressive resettlement process of Rudnichnoe once the construction of the mine is initiated.

A socio-economic impact assessment will also address community health issues associated with dust, noise, traffic hazards and any issues arising out of the on-going brownfield ground investigations. Dust is highlighted as a particular priority requiring expert health-impact assessment procedures to mitigate risks associated with respiratory health, nuisance, discomfort, visibility and reduced quality of life, if encountered in large amounts. Finer grades of particulate matter (with a diameter $<PM_{10}$ and $<PM_{2.5}$) are known to be significant morbidity factors, which can be exacerbated by silica content, composition and particle characteristics.

Following a full assessment of Project impacts during the ESIA, control measures will be included in the Project design (infrastructure and operating regime) to ensure that significant socio-economic impacts, such as noise, are mitigated at source to guarantee that limits at sensitive receptors are adhered to.

20.4 Mine Closure

Ukraine has an emerging policy and practice with respect to progressive reclamation, and only a general reference to mine closure and reclamation is included in the Code of Ukraine on Mineral Resources, No. 132/94-VR, July, 1994. The Code generally states that a territory disturbed during the course of the Project must be reclaimed and brought to a state suitable for further public use.

From International Comparative Legal Guide (ICLG) Mining Law 2016:

"According to the Subsoil Code, mining sites or their separate parts must be liquidated or conserved following the exhaustion of the mineral reserves, as well as in those cases where technical and economic substantiation demonstrates that further development of a particular deposit or its separate parts would be inexpedient or impossible.

Both liquidation and conservation require that mining sites should be brought into the condition ensuring the safety of people, property, and the environment; while conservation should additionally ensure the preservation of deposits, excavations and wells for the whole conservation period.

Liquidation and conservation must be performed in coordination with the mining control authorities and other relevant State bodies as prescribed in the Order of the State Committee of Ukraine for the Control over the Labour Protection No. 41 "On Approval of *the Procedure of Co-ordination of Liquidation and Conservation of the Mining Enterprises or their Land Plots" dated 12 March, 1999.*

In general, the subsoil user must ensure that no damage is done to people, property and the environment. According to the Subsoil Code, any abandonment and decommissioning activities may be performed only under control and upon the consent of the State Service for Industrial Safety and local authorities in compliance with the approved technical project documentation (which includes social and economic substantiation, technical reasons and explanations for such closure, environmental consequences and a list of measures to avoid the negative impact, suggestions with respect to future resumption of mining works, etc.). Such project documentation is subject to various approvals including environmental and technical expertise. The subsoil user is also required to draft the complex plan for the social protection of employees, the development of social infrastructure, etc."

Definitive reclamation requirements are subject to specific mine licence agreements and conditions, as set out in the mining permit. Nonetheless, it is prudent for an operator, in terms of risk and liability management, to establish a well-researched provision and strategy for progressive mine rehabilitation and closure throughout the mine lifecycle.

The Project has not yet developed a conceptual closure plan. However, key site infrastructure, such as the tailings facility and waste-rock dumps, have undergone economic and technical assessment of varying options in order to determine the optimum design case and take into account environmental factors.

A formal mine-closure plan will be developed prior to confirmation of the final project design and approvals submission and it will address issues such as bonds, percentage of annual rehabilitation and community development and livelihood diversification. All these factors are complex instruments requiring negotiation as a condition for an individual mining agreement. Financial bond assurance will be confirmed during the mine-licensing process, which will be based on the level of commitment selected to progressive rehabilitation and management. The process will be reviewed to achieve the optimum comprehensive mine-closure plan.

Guidance on international best practice for mine closure will be referred to, namely the International Council on Mining and Minerals (ICMM) Planning for Integrated Mine Closure: Toolkit (2008), as well as other reference documents, which will be required to maintain conformance with the World Bank (IFC) environmental and social performance standards. They include:

- "World Bank in Mining and Development, It's Not Over When It's Over: Mine Closure Around the World" 2002;
- European Commission. Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities. 2009;
- "IFC EHS Guidelines on Construction and Decommissioning," 2007;

- "Mining for Closure: Policies and Guidelines for Sustainable Mining Practice and Closure of Mines," United Nations Environment Programme (UNEP), United Nations Development Programme (UNDP), Organization for Security and Co-operation in Europe (OSCE) and the North Atlantic Treaty Organization (NATO), 2005.

The mine-closure plan will address the following procedures, according to the Guidelines of the International Institute of Environment and Development, 2002:

- Removal of infrastructure;
- Implementation of public safety measures;
- Re-contouring and revegetation (rehabilitation);
- On-going maintenance of site structures and monitoring of environmental issues;
- Operation of site facilities required to mitigate or prevent long-term environmental degradation;
- Completion of company involvement in sustainable community economic and social programmes;
- Establishment of schedule and costs;
- Conceptualization of the expected final landform and surface rehabilitation, including removal of plant and equipment and stabilization and reclamation of dumps and impoundments;
- Production of a risk assessment to help set priorities for preparatory work;
- Presentation of a cost-benefit analysis of different options as the plan is being prepared, reviewed, and updated;
- Presentation of a management plan for how closure will be implemented; and
- Proposition of post-closure monitoring arrangements (i.e., who monitors, for how long and who pays).

The estimated cost of closure and rehabilitation is discussed in more detail in Chapter 21 of this Report.

20.5 Mine - Waste Rock and TSF Management

20.5.1 Waste Rock Management

The Mine Waste Dumps shall be capable of containing the waste rock and overburden generated by the mine plan over the entire life of the mine. The waste pile design is described in Chapter 16 of this Report. It is recommended that a mine waste management plan be developed in accordance with EU Directive 2006/21/EC and EC Best Available Techniques Reference Document, which would lead to reasonable prevention and planning for the physical and chemical characteristics of the mining waste from the Project. The mine waste management plan would indicate clearly the requirements with which the waste facilities should comply in regard to location, management, control, closure and preventive and protective measures to be taken against any threat to the environment in the short and long term and especially against the pollution of groundwater by leachate infiltration into the soil.

The primary means of monitoring at the Mine Waste Dump shall be done by installing stakes or rods around the earthworks as they proceed, spaced nominally at 50 m intervals, laterally and transversely (i.e., perpendicular to the perimeter of the waste dump and parallel to the fall line). These installations will give a visual indication of any movements that may occur during filling operations.

In addition, six pairs of inclinometers and vibrating wire piezometers shall be installed to provide a means of measuring pore pressures and any lateral movements that may occur at the toe of the earthworks.

The monitoring program shall allow for:

- Validation of design assumptions, including the amount of strength gain;
- Measurement of the rate of pore pressure dissipation or build up; and
- Determination of the magnitude of any lateral movements, particularly adjacent to sensitive infrastructure, such as railway lines to the west and east of the site.

In addition, a series of four settlement pins shall be installed in the ground at the same locations as the inclinometers and vibrating wire piezometers. These will be offset at approximately 20 m spacing and aligned perpendicularly to the Mine Waste Dump perimeter. The settlement stations will provide a means of monitoring any ground surface deformations that may occur as filling proceeds and facilitate a means of changing construction sequencing or design of any remedial measures that may be required in order to prevent a failure of the earthworks.

20.5.2 TSF Management

The TSF design adopted in the current PEA is based on the conceptual design developed by Knight Piesold, as described in Chapter 18 of this Report. Limestone and waste rock shall be used in the construction of the perimeter berm, roads (including in the preparation of an aggregate surface) and containment dikes in the TSF. The use of limestone in the TSF containment dikes will aid with acid neutralization. The preliminary design for the TSF assumes the construction of a traditional slurry tailings contained by dikes comprising mine waste rock. The TSF has been designed to:

- Provide a permanent and secure containment of all solid waste material within an engineered impoundment;
- Limit the dust generation by the TSF footprint to comply with the environmental regulatory levels;
- Maximize recycling of return water to increase water availability for the plant operation;

- Convey the 100-year design flood and the Probable Maximum Flood, without incurring catastrophic damage. It should be noted that this flood design criterion should be reviewed in light of what was discussed in Section 20.3.5 of this Report;
- Minimize seepage by rapidly establishing a low-permeability, consolidated tailings mass.

The monitoring plan for the TSF shall address potential deformations in the foundation materials, excessive settlements in the tailings dam crest, seepage under the tailings dam and groundwater conditions during the construction and operation of each cell.

The monitoring instrumentation program for the TSF shall include the installation of piezometer, pressure gauges, a seepage flow weir and settlement monument inclinometers to provide data in order to predict trends in the behaviour of the foundation materials, groundwater, tailings dam and deposited materials.

The magnitude of tailings consolidation and subsequent settlement shall be determined and based on laboratory consolidation testing on tailings samples and field observations and monitoring during the tailings disposal.

20.6 Environmental Path Forward

The Shymanivske Project has been re-scoped for this current PEA and will likely be subject to an updated FS prior to engaging in the EPCM phase of Project development. As such, as part of the FS update, a comprehensive gap analysis consisting of a complete review of the environmental work done so far, and requirements of the new environmental legislation, needs to be performed to help plan the path forward leading to Project permitting.

20.6.1 Overall Environmental and Social Management

The definition of the Environmental and Social Management (ESM) system to be implemented by BKI for its Shymanivske Project should be in accordance with ISO 14001:2004. An Environmental and Socio-Economic Management Plan (ESMP) for the Shymanivske Project will be required throughout the life-cycle of the Project (i.e., the planning and pre-construction, construction, operation and mine-closure phases). The ESMP will have to remain a “living” system with continuous improvement targets and monitoring programs.

The ESMP shall contain plans for the management of all foreseen Project-related impacts as well as catastrophic events and emergency-response plans. It will present in detail, for each phase of the Project, all the measures that will be implemented to enhance positive impacts and minimize negative ones. Further, it will present the monitoring programs required to demonstrate whether mitigation and control measures are achieving their objectives. The results of monitoring will alert Black Iron Inc. to any potential issues that may arise throughout the life of the Project, allowing the company to take appropriate corrective action(s) to ensure that the Project does not have a negative impact on the surrounding environment and local communities.

The ESMP shall contain, among other things, a number of individual Management Plans, addressing all aspects related to a particular facility, or a sensitive receptor, or an activity of the Project. This is envisaged to include separate plans for waste-rock and tailings management, an Air Quality Management Plan and a Water Management Plan. Over time, a suite of management plans will evolve to include the following recommended plans:

- Oil and Pollutant Spill Plan;
- Hazardous Materials Control Plan;
- Erosion Control Plan;
- Workplace Emergency Preparedness Plan; and
- Traffic Safety Plan.

Each plan shall contain a monitoring program that details what is to be measured (parameters), in addition to the necessary monitoring equipment and its location, and the timing, duration and frequency of measurements.

The following sections present the details of the requirements of individual aspects of the ESMP, which will be further developed in subsequent stages of the Project.

The ESM Manual shall provide guidance to all levels of management and its sub-contractors, consultants or agents, to protect the environment and society in all phases of the Project, and upon its decommissioning.

The ESM Manual shall describe environmental and social matters and explain how to handle them in accordance with ISO 14001:2004, OHSAS 18001:1999, ISO 26000 and the national regulations in Ukraine. It will determine the commitment to a policy of prevention, reduction and elimination of undesirable environmental and social effects.

The ESM System is best viewed as an organizing framework that should be continually monitored and periodically reviewed, to provide effective direction for BKI, and delineate the ways that ESM should respond to changing internal and external factors during the Project.

20.6.2 Dust and Air Quality

The key environmental concern is controlling and minimizing dust concentrations. Dust concentrations at certain locations around the Project site have been measured to be in excess of national limits already. Given these measurements, the Shymanivske Project will have to be designed in such a way that it does not exacerbate the problem.

An initial air quality study considered the potential release of dust from the site because of earth-moving and mining activities associated with the construction and operation of the Project.

A Dust Emissions Study (WP, 2012g) then evaluated the emission sources to determine the potential impacts within a 100 km by 100 km domain, centred at the Project. Dispersion modelling was performed and an emissions inventory was established, using emission factors from several sources: the United States Environmental Protection Agency (US EPA) AP-42 emission estimation manual; the US EPA NONROAD model for unpaved road emissions; and other emission estimation manuals, such as the "Australian National Pollutant Inventory" (NPI).

The main contributor to the ambient air levels of particulate matter is the open pit mining operation. These emissions contribute almost 60% of the predicted ambient air-particulate matter.

However, the dust work conducted to date has considered only unmitigated circumstances. Significant impacts on surrounding areas are predicted, and so an action plan has to be developed and implemented to reduce dust emission and improve air quality. This may best be done in consultation and cooperation with other mining companies in the area, in order to effect change collaboratively. It is essential that the dust-modelling work be continued and advanced to include impact assessments which consider scenarios under different mitigation measures.

Mitigation measures have been proposed for the Project; these comprise a combination of the following:

- Engineering controls, such as installing enclosures for transfer points and sizing stations, conveyors and bins, leading to 75% reduction of dust emissions from this material handling equipment;
- Dust-suppression measures which can lead to a 40% to 80% reduction of dust emissions from granular haul roads;
- Reduction of blast areas to produce smaller amounts of emissions and drilling and blasting conducted during low-wind conditions, where possible;
- Use of fogging systems and wind barriers to reduce emissions from waste-rock piles;
- Reduction of drop heights;
- Prevent spillage from trucks occurring and reducing the amount of silt that is present on the road, in order to reduce road emissions;
- Timing the processing with meteorological events, such as wind and rain;
- Storm-water management to prevent flooding of unpaved roads and reduce track-out;
- Sizing of trucks appropriately, to reduce the number of vehicle trips; and.
- Design of haul roads, to minimize kilometres (km) travelled.

The components of an Air Quality Management Plan for reducing Project impacts on air quality during the construction phase are outlined below.

- Machinery combustion gas emissions (NO_X, SO_2, CO, etc.):
  - Review machinery permits and ensure appropriate maintenance;

  - Minimize unnecessary journeys and adopt a policy of switching off machinery and equipment when not in use;
  - Consider using machinery, equipment, vehicles and materials that are fuel-efficient; and
  - Improve maintenance of transport routes.
- Controlled and uncontrolled fires (airborne emissions):
  - Prohibit open fires in order to minimize air emissions, avoid accidents and minimize fire risk during the construction phase.

In addition to these measures, air quality shall be monitored through the life of the Project, within the Project site and in the surrounding environs, as indicated by the environmental baseline studies. Pollutant levels shall be monitored against the baseline data and appropriate measures shall be taken at the source of emissions, if statutory limits are exceeded.

Air quality monitoring will be conducted by two possible techniques: passive and active air measurements. The monitoring plan shall state which methodology is to be adopted and it shall identify the pollutants to be monitored. In addition, TSP, PM_{10} and $PM_{2.5}$ shall be monitored.

As mentioned above, it is important to develop a strategy to reduce dust in the proposed Project area as a whole, taking into account the dust produced by neighbouring sources. The next steps should include a cumulative-impact assessment of dust, looking at synergetic and additive effects and including a multivariate analysis.

It should be noted that for health impact assessment purposes, it would be beneficial to obtain acute and chronic air concentrations, including $PM_{2.5}$ 24-hour maximums and contaminant one-hour maximums.

20.6.3 Water Management

The Shymanivske Project will impact the water environment in a number of ways, namely:

- Water use for mineral processing, utilities, construction and infrastructure;
- Water generation through pit dewatering;
- Water retention and modification of hydrology due to large-scale development and variably porous and permeable mass material storage facilities, such as rock dumps and tailings ponds;
- Modification of hydrology through designed drainage and outflow; and
- Water storage, treatment and discharges associated with the Project.

The following mitigation measures shall be implemented because significant impacts on hydrology and hydrogeology are anticipated:

- Robust surface and groundwater monitoring programs;

- Appropriate engineering design measures to contain and capture infiltrating water escaping the waste-rock dump, TSF and storage ponds (e.g., lining with a geomembrane);
- Development of minimum required environmental flows in affected watercourses; and
- Acid-base accounting of waste-rock material to guide an assessment of optimal dump locations.

The following monitoring program shall be implemented:

- A network of groundwater monitoring wells shall be installed and regularly sampled, in order to develop a sufficient baseline of data so that the existing groundwater conditions are understood, and sources and impacts can be correctly attributed;
- All installed wells and test devices shall be monitored to record changes in groundwater levels and quality in the ground around the mine, waste dump, TSF and process areas;
- Based on the results of the monitoring, modelling should be undertaken to assess any potential adverse changes in groundwater, streamflow and water quality in areas adjacent to the mine, waste dump, TSF and process areas. Modelling shall also be used to determine pit dewatering rates;
- The parameters to be sampled in the groundwater-quality monitoring shall be according to the “Water Quality Design Criteria” report (WorleyParsons, 2012b);
- The monitoring plan shall also cover streamflow and water-quality monitoring, both on-site and at key locations in the surrounding area (e.g., on downstream watercourses, ponds, etc.);
- Streamflow shall be monitored at a maximum of a daily time-step throughout the life of the Project, so that seasonal variations can be identified. Low-flow conditions are of major interest as this is when the influence of the mine will be at its most significant;
- The parameters to be sampled in the surface-water quality monitoring shall be according to the “Water Quality Design Criteria” report (WorleyParsons, 2012b).

20.6.4 Soil

At this stage, the recommendation is that an initial, non-intrusive review, sampling and liability assessment be undertaken as soon as possible to meet the necessary Ukrainian contaminated-land environmental legislation and regulatory requirements.

The environmental liability assessment ascertains the nature and extent of contamination (if any) in relation to pertinent regulatory standards, and with respect to media (i.e., soil, vapour, groundwater, sediments-affected, potential human or environmental receptors, and potential pathways of exposure). Contaminated site characterization services include:

- Phase 1 (non-intrusive) desk-based Environmental Site Assessments;
- Site Audits and Due Diligence reporting;

- Phase 2 (intrusive) Site Investigations;
- Risk Assessments;
- Groundwater Assessment;
- Remediation Design and Implementation; and
- Environmental Monitoring Programs.

20.6.5 Further Environmental Activities

The following environmental and socio-economic activities are planned for the Project:

- Completion of the ESIA;
- Establishment of a dedicated, automated weather station on-site and installation of permanent flow-gauging and water-quality monitoring points on the River Inhulets, along with the development of an environmental database to manage results;
- Submission of an official Declaration of Intent;
- Calculation of the extent of a Sanitary Zone for the Project;
- Design and undertaking of a specific cumulative effects impact assessment associated with dust and air quality. The assessment must systematically review the planning principles and goals for the Project; dust and emission sources; spatial and temporal boundaries; direct, indirect and potential multivariate effects; confirmed baseline conditions; environmental factors, such as weather conditions or seasonal effects (thermal inversions, etc.); incremental stress assessment; pathways; receptors and thresholds;
- Development of a specific, support document based on the outcomes of the cumulative effects impact assessment that clarifies the incremental impact associated with the Project, as compared with the existing baseline conditions. This document will be designed to highlight for authorities the relative impact of the Project and to provide a clearer basis for analyzing alternatives and setting goals for compliance, monitoring and management;
- An economic analysis may be required to clarify the impact and opportunities associated with cumulative dust impacts and modernization, in order to achieve best-practice mine operations. If this is the case, a risk-based methodology aligned with international best practices will be applied;
- Establishment of a forum for working with existing operators to address and plan for the amelioration of existing conditions;
- Public consultation on ESIA;
- Submission of ESIA for validation by Authorised Body;
- Positive Authorities conclusion;
- Provision of support to Stakeholder Engagement Plan implementation (including confirmation of establishment of grievance mechanism and community office);

- Drafting and presentation of RAP (Resettlement Action Plan) for consultation with authorities;
- RAP implementation support;
- Support to ESM System development, including the drafting of ESMP and contractor specifications;
- Development of a Mine Waste Management Plan;
- Provision of support for the acquisition of required permits, including the permits for emission of pollutants into the atmosphere by stationary sources; operations with wastes; the beginning of dangerous activities and/or the start of usage of dangerous/unsafe machinery; and storage and removal of wastes;
- Preparation and submission of the first Annual Mine Environmental and Social Monitoring Report.

21. CAPITAL AND OPERATING COSTS

The Shymanivske Iron Ore Project scope covered in this Study is based on the construction of a facility having a nominal production capacity of 4.0 Mtpa of concentrate in Phase 1 followed by an increase to 8.0 Mtpa via the addition of a second processing line in Phase 2 (construction starting in Year 3 for operation in Year 5). The initial Phase 1 capital cost, expansion Phase 2 capital cost, sustaining capital and operating cost estimates to support mining and mineral processing operations over the 17-year life of mine were estimated by BBA's mining and mineral processing teams based on the mine plan presented in Chapter 16, the process design presented in Chapter 17 and infrastructure design in Chapter 18. These cost estimates were based on those developed by Lycopodium for the 2014 FS. The capital and operating costs were reviewed and updated based on new vendor budget prices for major equipment and, where applicable, adjusted on a factored basis to reflect the new processing strategy and throughput. Adjustments for price escalation and currency exchange rates were also made to reflect more current conditions.

Table 21-1 presents a summary of total estimated capital cost for Phase 1 of the Shymanivske Project.

Table 21-1: Estimated Phase 1 Capital Costs

Estimated Capital Costs	**(M$)**
0000 – Construction Indirects	5.1
1000 – Mine Area	22.2
2000 – Beneficiation Plant	192.0
3000 – Tailings and Waste	11.1
5000 – Project Infrastructure	44.1
Total Direct Costs	**274.5**
Owner's Costs	38.2
Project Indirect Costs	41.2
Contingency	53.7
Total Project Capital Cost	**407.6**
Mine Pre-Stripping (Capitalized from Opex)	13.9
Mining Equipment Leasing Cost (Capitalized)	30.0
Total Pre-production Capital Cost	**451.5**

The total Phase 1 capital cost is estimated to be $407.6M and the total pre-production capital costs at $451.5M. This capital cost estimate is expressed in constant Q4-2017 US Dollars using the following exchange rates:

- 28.00 UHA = 1.00 USD
- 6.55 CNY = 1.00 USD

Table 21-2 presents a summary of total estimated capital cost for Phase 2 of the Shymanivske Project.

Table 21-2: Estimated Phase 2 Capital Costs

Estimated Capital Costs	(M$)
0000 - Construction Indirects	-
1000 - Mine Area	3.3
2000 - Beneficiation Plant	196.4
3000 - Tailings and Waste	3.2
5000 - Project Infrastructure	24.0
Total Direct Costs	**226.9**
Owner's Costs	11.2
Project Indirect Costs	33.6
Contingency	43.7
Total Project Capital Cost	**315.3**
Mining Equipment	49.0
Total Phase 2 Capital Cost	**364.3**

The total Phase 2 capital cost was estimated to be $364.3M.

Direct costs include costs related to transporting purchased equipment to the Project site. The pre-production capital costs include the initial mine pre-stripping costs in the amount of $13.9M. Also included in the costs is the initial mining equipment fleet required for pre-stripping and Year 1 of mining operations, having an estimated value of $94.3M, as well as concentrate loaders required for Phase 1 with an estimated value of $15.5M, which both will be leased. As such, annual lease payments over the life of the leases are included in the operating costs. Lease payments made prior to production start-up amount to $30.0M.

The preceding Phase 1 and Phase 2 estimate tables do not include the following items:

- Sustaining capital costs are estimated at $231.6M and consist of:
  - Mine equipment fleet additions and replacements totalling $119.5M
  - Facilities additions and improvements, and costs related to phasing of the TSF dam construction over the LOM, as described in Chapter 18, totalling $112.1M;
- Costs related to closure and rehabilitation of the mine site, totaling $27.9M, assumed to be disbursed in the final year of operations. These costs consist of costs associated with the closure of the TMF, as estimated by Knight Piesold, as well as costs associated with the restoration of other site infrastructure that were estimated by BBA using factors from similar projects.

Table 21-3 presents a summary of total estimated average, life of mine (LOM) operating costs in $/t of dry concentrate produced.

Table 21-3: Total Estimated Average LOM Operating Cost ($/t Dry Concentrate)

Estimated Average	$/t
Mining	11.47
Mineral Processing	10.17
Site Infrastructure	0.68
General Administration	0.64
Environmental and Tailings Management	0.37
Rail Transportation and Port Services	9.30
Total	**32.63**

The total estimated operating costs are $32.63/t of dry concentrate produced. Operating costs include the estimated costs of leased equipment (equipment cost plus interest) over the life of the leases as well as the salvage value estimated for the concentrate loaders, which will no longer be required in Year 5 of operation and beyond.

Royalties and working capital are not included in the operating cost estimate presented but are treated separately in the Economic Analysis presented in Chapter 22.

21.1 Basis of Capital Cost Estimate and Assumptions

The capital cost estimate presented herewith covers the initial Phase 1 and the expansion Phase 2 of the Project. It includes the initial construction of the mine, crushing plants, concentrator, concentrate handling and infrastructure required to support the initial Phase 1 operations, including the initial TSF dam construction, based on the conceptual site plan presented in Chapter 18. Some of the infrastructure in Phase 1, such as roads and rail facilities, will also serve for Phase 2. BBA developed its capital cost estimate largely based on the Lycopodium 2014 FS capital cost estimate with updated equipment lists and factored engineering quantities aligned to the new scale of the Phase 1 and Phase 2 Project implementation plan.

21.1.1 Type and Accuracy of Estimate

The accuracy of this estimate is qualified as +/-35%, typical for a PEA level study. It is based on an EPCM Project execution strategy.

21.1.2 Estimation Methodology

The Cost Estimation Methodology used by BBA is based on the definition of the Project Work Breakdown Structure (WBS) adopted in the 2014 FS. The WBS captures the different areas of the Project to be considered in the estimate and allows for the definition of the high level Scope of Work.

Table 21-4 shows the structure implemented for this updated PEA, which is consistent with the WBS used previously.

Table 21-4: Project WBS

WBS Code	Description
0000	Construction Indirects
1000	Mine Area Infrastructure
2000	Beneficiation Plant
3000	Tailings and Waste
5000	Site Infrastructure
7000	Project Indirects
8000	Owner's Costs

- **0000 – Construction Indirects:** Includes construction equipment, surveying, safety management, QA/QC and camp operations;
- **1000 – Mine Area Infrastructure:** Includes the mining warehouse, truck shop, infrastructure buildings and general mine support services;
- **2000 – Beneficiation Plant:** Includes all process plant equipment such as crushers, mills, screens, magnetic separators, thickeners, filters and stockpiles. Phase 1 of the Project utilizes a manual reclaim for the concentrate stockpile, which will be upgraded to an automated reclaim system in Phase 2;
- **3000 – Tailings and Waste:** Includes the tailings dam and associated facilities;
- **5000 – Site Infrastructure:** Includes roads, fencing, water supply, sewage, power distribution and railways;
- **7000 – Project Indirects:** Includes engineering, procurement and construction management (EPCM), including vendor representatives, third party consultants, and commissioning;
- **8000 – Owner's Costs:** Includes the Owner's team, railway rolling stock and existing infrastructure relocation cost.

During the previous 2014 FS, the Project scope of work captured in the WBS was analyzed from a constructability point of view and equipment packages were developed accordingly. In most cases the packages defined were developed as Requests for Quotation ("RFQs") and incorporated into a tender process. Budget or firm prices were received from vendors.

For this PEA, the direct costs for the Project areas covered in WBS 0000 to WBS 5000 were estimated based on scaling the Project from 9.9 Mtpa in the 2014 FS to 4.1 Mtpa for Phase 1 of this PEA, using the following methodologies:

- The mechanical equipment list was reviewed in detail, and equipment was removed or modified to match the updated targeted plant output, compared to the 2014 FS;
- Building costs were scaled based on the reduced footprint due to less equipment;
- Stockpiles were resized based on updated process requirements;
- The concentrate reclaim and train loadout scheme from the 2014 FS was changed from an automated system to a manual one using front end loaders;
- Quantities for earthworks, concrete, piping, steelwork, electrical, and instrumentation were typically scaled based on a factor of 0.5;
- All labour quantities were maintained as a ratio of the supply costs. Labour rate adjustments are discussed later in this Chapter.

For the capacity expansion in Phase 2, the following factoring methodology of direct costs was used for this PEA:

- The mechanical equipment list from Phase 1 was essentially doubled, to double the production capacity;
- Quantities for earthworks, concrete, piping, steelwork, electrical, and instrumentation have been increased in line with the mechanical costs;
- The concentrate reclaim and train loadout will become an automated system in Phase 2, replacing the manual operation planned for Phase 1;
- Many infrastructure items are not included in Phase 2, as the Phase 1 items are sufficient for the increased capacity. This includes site roads, fencing, and utilities distribution.

Concerning indirect costs, a factor of 15% of direct costs was used for this PEA, which represents the same proportion of direct costs as in the 2014 FS. This applies for both the Phase 1 and Phase 2 capital cost estimates.

Owner's Costs for this PEA were estimated in collaboration with BKI. For Phase 1, a base factor of 5% of direct costs was used. To this, an amount provided by BKI for the relocation of certain infrastructure, including the relocation of Rudnichnoe village, was added. For Phase 2, Owner's Costs were estimated at 5% of direct costs.

Contingency for both Phase 1 and Phase 2 of the Project was estimated at 17% of the sum of direct and indirect costs.

21.1.3 Construction Labour

Labour rate escalation and adjustments for the UAH to USD exchange rate have been incorporated into this capital cost estimate using the same methodology as was used in the 2014 FS. These rates were obtained from BKI's consultant in Ukraine, familiar with the current labor situation in the Project region. Table 21-5 presents the crew rates used in this PEA. It should be noted that productivity factors were kept the same as those in the 2014 FS.

Table 21-5: Crew Rates ($/h)

Crew	Base + fringes rate ($/h)	Eqpt rental rate per ($/h)	"All-in" rate ($/h)
Architectural	7.0	5.0	12.0
Concrete	5.0	12.0	17.0
Site Development	5.0	10.0	15.0
Piling , Railway	5.0	10.0	15.0
Earthworks	5.0	10.0	15.0
Electrical	7.0	5.0	12.0
Mechanical Eqpt	10.0	10.0	20.0
Mechanical Platework	8.0	9.0	17.0
Piping	8.0	12.0	20.0
Structural Steel	8.0	9.0	17.0
Instrumentation	7.0	5.0	12.0

21.1.4 Assumptions and Exclusions

The following assumptions were made (or maintained from the 2014 FS) for this PEA:

- BKI will proceed with a definition drilling programme, followed by a new Feasibility Study, shortly after the completion of this PEA;
- The Project will be executed in EPCM mode with an estimated schedule of 24 months, as discussed in Chapter 24 of this Report. It is assumed that BKI will obtain all permits, accesses, and agreements required to proceed with construction;
- The workforce will be sourced locally;
- Suitable fabrication shops are available locally.

The following items are excluded from the capital cost estimate:

- Duties, tariffs, sales taxes or VAT's;
- Changes in regulations;
- Financing costs;
- Force Majeure;
- Sunk costs (including costs related to further exploration drilling, laboratory testwork and costs related to executing the Feasibility Study);
- Inflation, escalation and foreign exchange movements.

21.2 Estimated Operating Costs

Average operating costs for the LOM have been estimated at $32.63/t of dry concentrate produced. This cost represents the cost of concentrate production including mining processing, rail and loading into a shipping vessel at the TransInvestServis (TIS) terminal, at port Yuzhny near Odessa. Operating costs include annual lease payments related to initial mining equipment and concentrate loaders, over the life of the leases. Mining costs vary from year to year based on the mine plan.

Operating costs are based on an electricity cost of $0.054/kWh and diesel fuel costs of $0.64/litre.

Operating costs exclude sustaining capital, royalties and working capital, which are treated separately in the Economic Analysis presented in Chapter 22 of this Report.

21.2.1 Mining Operating Costs

Mining operating costs have been developed based on the annual mine plan presented in Chapter 16 of this Report. Pre-stripping quantities of overburden have been estimated in the mine plan and pre-stripping costs have been capitalized, as described earlier in this Chapter. Mining equipment required for pre-production, as well as the first year of operation, has been assumed to be leased. Mining operating costs, averaged over the life of the operation, have been estimated at $11.47/t of dry concentrate or $1.66/t of material mined. These include equipment leasing costs. Table 21-6 presents a breakdown of mining costs.

Table 21-6: Breakdown of the Mining Costs

Category	$/t mined	$/t concentrate
Labour	$0.05	$0.38
Fuel	$0.36	$2.48
Electricity	$0.05	$0.34
Tires	$0.20	$1.36
Parts	$0.73	$5.08
Explosives	$0.13	$0.90
Dewatering	$0.01	$0.07
Grade Control	$0.01	$0.07
Mining Fleet Lease (Major Equipment for PP and Year 1 Leased)	$0.11	$0.79
Total Mine Operating Cost (including leasing costs)	**$1.66**	**$11.47**

Labour

Labour requirements have been estimated to support the mine plan and production schedule developed in this Study. Labour costs were obtained from BKI and are estimated based on regional salary conditions, competitive wages and benefits. Mine labour head counts peak at 345 employees.

Equipment Fuel and Electricity

Diesel fuel is used to operate mine trucks, loaders, dozers and other mine equipment. Fuel consumption was estimated for each year of operation based on equipment specifications and equipment utilization.

Electric power is supplied to the open pit by a power loop and is used to operate the shovels, drills and mine dewatering pumps. Power consumption was estimated for each year of operation based on equipment specifications and equipment utilization.

Tires and Parts

These costs consist mainly of maintenance expenses, which have been estimated by BBA based on experience and historical data on similar projects, as well as Vendor information. Maintenance costs include the costs of repairs, tires, parts, consumables, etc., and are compiled on a maintenance cost per hour of operation basis for each equipment type. It should be noted that equipment maintenance costs exclude the cost of maintenance personnel.

Explosives

Explosives costs for mineralized material and waste rock have been estimated in collaboration with a blasting contractor at $0.46/m^3$.

Dewatering, Grade Control and Miscellaneous

These elements include cost allowances for items such as mine dewatering and stockpile double handling of ROM material.

Equipment Leasing

It is assumed that all mine equipment required for pre-production, as well as for the first year of operation, will be leased by BKI. The value of the equipment to be leased was estimated at $94.3M. Annual lease payments were calculated based on a 7% interest rate and lease duration of seven years. These lease terms have been estimated based on experience on other projects. It has been assumed that at the end of the lease, the equipment will belong to BKI.

21.2.2 Processing Operating Costs

Table 21-7 presents the average mineral processing operating cost for the LOM, which has been estimated at $10.17/t of dry concentrate. This is the average operating cost associated with converting ROM material to final concentrate and loading into railcars for a full year of operation at the nominal concentrate production rate. For Phase 1, mineral processing costs were estimated at $12.06/t and at $9.89/t for Phase 2. The main reason for the decrease, other than the distribution of certain fixed costs over a higher tonnage, is the replacement of loaders by an automated concentrate load-out system in Phase 2.

Table 21-7: Average LOM Processing Operating Cost Estimate

Category	$/t concentrate
Labour	0.24
Electric Power	4.08
Consumables and Reagents	4.40
Maintenance	1.28
Fuel	0.10
Concentrate Loader Lease	0.07
Total Concentrator Operating Costs	**10.17**

Labour

Labour salaries, wages and benefits were obtained from BKI and are estimated based on regional salary conditions with competitive wages and benefits, updated from the 2014 FS to account for escalation and exchange rate adjustments. The 2014 FS employee headcounts were also revised for this PEA in order to reflect the phased implementation of the Project as well as the decreased final capacity of process plant (8 Mtpa in this PEA versus 9.9 Mtpa in the 2014 FS). The labour count, including technical, salaried and hourly personnel, has been estimated at 147 and 219 employees in Phase 1 and Phase 2 respectively.

Consumables and Reagents

The 2014 FS prices for grinding media was validated with BBA's internal cost database and found to be reasonable. Other unit prices and consumption rates were kept the same as the 2014 FS and overall costs were factored for the lower tonnage on a $/t basis.

Fuel and Electricity

Fuel and electricity unit prices were updated to reflect the current local market prices. Fuel and electricity requirements and consumption from the 2014 FS were maintained on a unit per tonne basis, with the exception of the following items:

- Electric power consumption for the crushing circuit was reduced based on the outcome of the front-end optimization of the plant;
- For Phase 1, concentrate loadout electric power consumption was reduced and largely replaced by the addition of diesel fuel consumption, as front end loaders were adopted for loading concentrate into railcars.

Maintenance

Maintenance costs were factored on a $/t basis from the 2014 FS, with an additional maintenance cost added for the concentrate loaders used in the concentrate loadout for Phase 1. These costs include maintenance supplies and materials.

Equipment Leasing

It is assumed that the three front-end loaders required for manual loading of concentrate during Phase 1 will be leased by BKI. The value of the equipment to be leased was estimated at $15.5M. Annual lease payments were calculated based on a 7% interest rate and lease duration of seven years. These lease terms have been estimated based on experience on other projects. It has been assumed that in Year 5, as the automated concentrate loadout is available for Phase 2, the balance of the lease (estimated at $6.6M) will be paid off and the equipment will be sold at a salvage value of $9.9M.

21.2.3 General Site Infrastructure Operating Costs

Infrastructure operating costs averaged for the LOM have been estimated at $0.68/t of dry concentrate. Site infrastructure consists of general site maintenance costs, site development, waste management, railway siding maintenance and power distribution.

- Labour rates attributed to site infrastructure were adjusted for the Project components. Employee head counts were adjusted using the 2014 FS estimates as a basis. It has been estimated that 23 employees will be required in Phase 1 and 31 in Phase 2;
- Power, maintenance and consumable costs were factored from the 2014 FS on a $/t basis;
- An allowance was provided for building heating using natural gas.

21.2.4 Sales, General and Administration

The Sales, General and Administration (SG&A) element of operating costs was estimated at $0.64/t of dry concentrate. This cost estimate includes G&A labour as well as general plant management costs.

- Labour rates were adjusted based upon a salary survey conducted by BKI and employee head counts were updated using the 2014 FS evaluation as a basis. It has been estimated that 59 employees will be required in Phase 1 and 74 in Phase 2;
- Insurance rates were decreased due to the smaller nature of the processing plant in Phase 1 and increased proportionally in Phase 2;
- Catering costs were adjusted to account for the lower number of employees in Phase 1 and readjusted for Phase 2.

21.2.5 Tailings, Waste and Water Management and Environmental

Tailings, waste and water management and environmental operating costs have been estimated at $0.37/t of dry concentrate. These costs include costs related to operating the tailings facilities and various costs related to environmental studies, monitoring, assessments and mitigation measures.

- Labour rates were adjusted as previously described. It has been estimated that 17 employees will be required for both Phase 1 and Phase 2 of the Project;
- Power and maintenance costs were factored from the 2014 FS on a $/t basis;
- An allowance has been made for tailings survey environmental assessments.

21.2.6 Concentrate Rail Transportation, Handling and Ship Loading

Concentrate rail transportation, port terminal services and ship loading costs were provided by BKI based on current rate schedules for such services. This cost amounts to $8.46 per gross tonne (wet) which is equivalent to $9.30/t of dry concentrate.

22. ECONOMIC ANALYSIS

The Economic Analysis for BKI's Shymanivske Project was performed using a discounted cash flow model on both a pre-tax and post-tax basis. The Capital and Operating Cost Estimates presented in Chapter 21 of this Report are based on the mining and processing plan developed in this Study to produce a nominal 4.1 Mtpa of 68% Fe concentrate in Phase 1 (first four years of operation) and 8.1 Mtpa following the Phase 2 expansion starting in Year 5 of the Project.

The IRR on the total investment and the NPV were calculated on a 100% equity financed basis using discounting rates varying between 0% and 12%, resulting from the net cash flow generated by the Project. The Project Base Case NPV was calculated using a discounting rate of 10%, as requested by BKI. The payback period on the initial Phase 1 capital investment, based on the undiscounted annual cash flow of the Project, is also presented. Furthermore, a sensitivity analysis was performed for the pre-tax Base Case to assess the impact of a +/-25% variation of the Project capital cost, annual operating costs and price of iron ore concentrate. A further sensitivity analysis was performed to assess the impact when varying the iron ore 62% Fe benchmark price and the %Fe grade premium. The Economic Analysis was performed with the following assumptions and basis:

- An assumed two-year construction schedule, considering key Project milestones, presented in Chapter 24;
- A LOM of 17 years, based on the subset of mineral resources within the open pit design estimated in Chapter 16;
- The price of concentrate loaded on the ship (FOB) at the TIS Port Terminal assumed in this Economic Analysis is $97.19/dmt. This price was derived based on the methodology presented in Chapter 19 and considers the following:
  - The benchmark reference price is the Platts IODEX 62% Fe, CFR North China. The 36-month trailing average price of $61.88/dmt;
  - An Fe premium of $43.28/dmt is used for the Shymanivske concentrate grading 68% Fe. This was based on the November 10, 2017, 3-month trailing average price of $90.24/dmt for the benchmark Platts IODEX 65% Fe, CFR North China;
  - A $3.57/dmt net premium is applied in consideration of product quality parameters (%SiO_2, %Al_2O_3 and %P) for the Shymanivske concentrate;
  - Shipping cost from the TIS Port Terminal to the Chinese port is estimated at $11.54/dmt, calculated based on a rate of $10.50 per gross tonne and adjusted for 9% humidity in the concentrate. This estimate was provided by TIS based on rates currently being charged to their other iron ore customers;
- All of the concentrate is sold in the same year as it is produced;
- All costs and sales estimates are in constant Q4-2017 dollars;

- The Economic Analysis includes working capital;
- All sunk costs are not considered in this Economic Analysis;
- An 8% royalty on net selling price payable to Ukraine's Federal Government.

Table 22-1 presents the undiscounted, pre-tax cash flow projection for the Project. BBA assumed that both the initial Phase 1 capital cost and the expansion Phase 2 capital cost disbursements are distributed 25% - 60% - 15%, starting two years before production for each phase.

Table 22-1: Undiscounted Cash Flow

Year	Unit	PP-2	PP-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
Concentrate Production	**M dmt**			**3.04**	**4.05**	**4.05**	**4.05**	**7.60**	**8.46**	**7.96**	**7.80**	**7.59**	**8.18**	**8.32**	**8.46**	**8.32**	**7.86**	**8.72**	**7.60**	**4.75**				**116.3**
Concentrate Selling Price	**$/dmt**			**97.19**	**97.19**	**97.19**	**97.19**	**97.19**	**97.19**	**97.19**	**97.19**	**97.19**	**97.19**	**97.19**	**97.19**	**97.19**	**97.19**	**97.19**	**97.19**	**97.19**				**97.19**
Gross Revenue from Sales	**M$**			**$295.5**	**$393.9**	**$393.9**	**$393.9**	**$738.4**	**$821.8**	**$773.7**	**$758.0**	**$737.3**	**$794.6**	**$808.4**	**$821.7**	**$808.4**	**$763.7**	**$803.5**	**$738.5**	**$461.6**				**$11,307**
Operating Costs	**M$**			139.96	160.64	163.80	165.37	248.25	256.26	247.38	242.17	245.82	242.56	250.04	263.61	271.63	259.69	253.00	234.09	151.78				3,796.1
Royalties	**M$**			18.6	24.8	24.8	24.8	43.3	49.0	52.6	49.8	46.4	46.2	46.7	49.6	50.6	51.5	48.8	48.4	49.3				710.6
Capital Costs	**M$**	12.5	439.0	9.5	44.5	8.6	318.3	57.9	10.3	14.6	1.2	8.4	2.7	39.7	40.1	33.8	1.7	1.6	3.0	0				1,047.4
Rehabilitation and Closure Costs	**M$**																			27.9				27.9
Cash Flow (Undiscounted)																								
Total Operating Expenses + Royalties	**M$**	-	-	158.5	185.4	188.6	190.1	294.7	307.9	296.0	289.8	292.2	292.5	300.9	315.3	322.4	307.7	303.5	280.5	180.8				4,506.7
CAPEX Disbursement Incl. Rehab	**M$**	114.4	275.9	70.7	44.5	87.4	192.1	105.2	10.3	14.6	1.2	8.4	2.7	39.7	40.1	33.8	1.7	1.6	3	27.9				1,075.3
Working Capital	**M$**			11.7	1.7		0.4	6.9												(20.7)				-
Annual Cash Flow	**M$**	(114.4)	(275.9)	54.7	162.2	118.0	11.2	331.6	503.7	463.1	467.0	436.8	499.4	467.9	466.4	452.2	454.3	498.3	455.0	273.6				5,725.0
Cumulative Cash Flow	**M$**	(114.4)	(390.4)	(335.7)	(173.5)	(55.5)	(44.2)	287.4	791.0	1,254.1	1,721.1	2,157.8	2,657.2	3,125.1	3,591.5	4,043.7	4,498.0	4,996.4	5,451.4	5,725.0				-

A discount rate is applied to the cash flow to derive the NPV for each discount rate. The payback period is presented for the undiscounted cumulative NPV and represents the period required to recover the initial Phase 1 capital investment. The NPV calculation was done at discount rates of 0%, 8%, 10% and 12%. The Base Case NPV uses a 10% discount rate, as per discussions with BKI. Table 22-2 presents the results of the Economic Analysis for the Project, based on the assumptions and cash flow projections presented previously.

Table 22-2: Pre-Tax (Unlevered) Economic Analysis Results

IRR = 40.5% Payback = 2.9 years	NPV (M$)
Discounting Rate	
0%	5,725
8%	2,295
10%	1,852
12%	1,501

22.1 Taxation

The Project is subject to two levels of taxation that are material to the financial performance of the Project:

- Corporate tax applied at a rate of 18% on taxable income;
- Value Added Tax (VAT) applied at a 20% rate on all taxable purchases of goods and services. In practice, the VAT is not expected to be refunded until the Project is operational. After operations commence, the VAT is expected to be refunded with a one-year delay after being incurred.

Table 22-3 presents the results of the post-tax financial analysis. Annual taxation amounts were provided by BKI.

Table 22-3: Post Tax (Unlevered) Economic Analysis Results

IRR = 34.4% Payback = 3.3 years	NPV (M$)
Discounting Rate	
0%	4,642
8%	1,807
10%	1,442
12%	1,152

22.2 Sensitivity Analysis

A sensitivity analysis was performed whereby the initial capital cost, annual operating costs and product selling price were individually varied between +/-25% to determine the impact on the Project NPV at a 10% discount rate and for the IRR. The sensitivity analysis was performed on a pre-tax basis only. Results are presented graphically in Figure 22-1 and Figure 22-2.

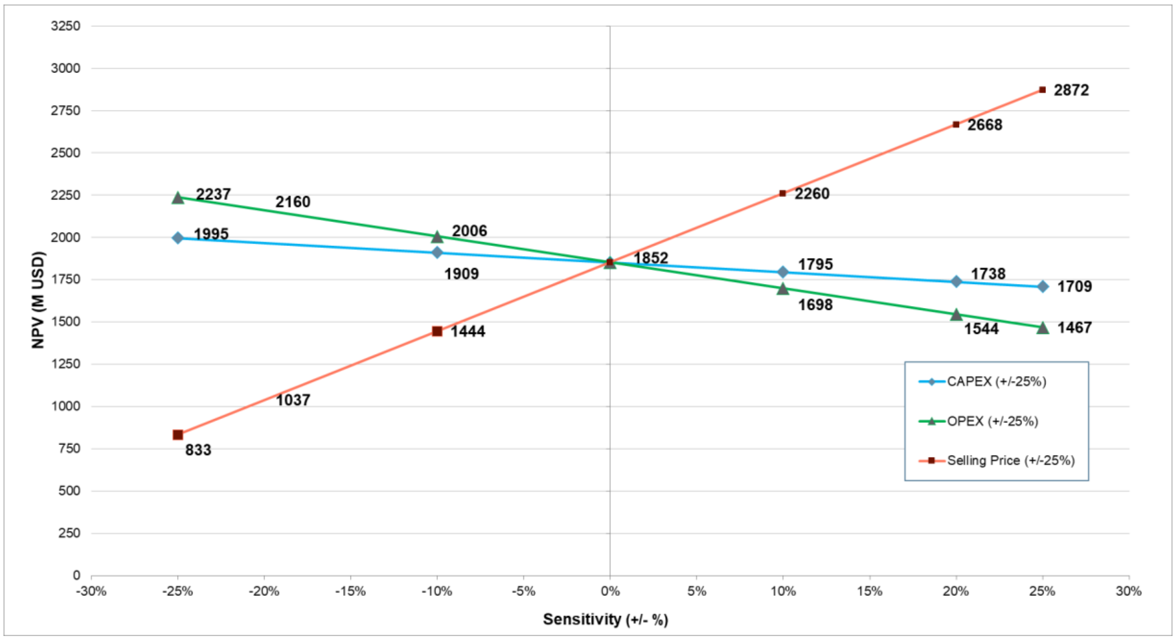


Figure 22-1: Sensitivity Analysis Graph for NPV

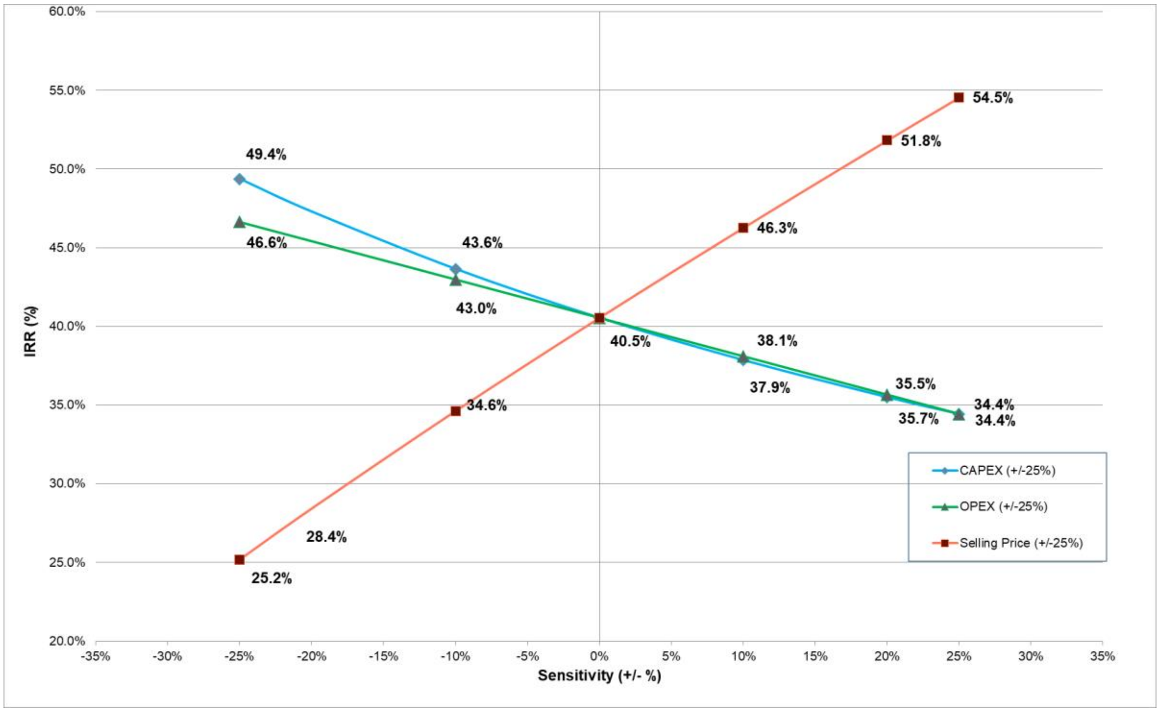


Figure 22-2: Sensitivity Analysis Graph for IRR

A further analysis was conducted to assess the sensitivity of the Project IRR and NPV at a 10% discount rate to variations in the 62% Fe benchmark price and to the %Fe grade premiums for Fe content above 62% Fe. The benchmark price was varied from $50/dmt to $90/dmt and the %Fe grade premium was varied from $4/dmt per 1% Fe to $9/dmt per 1% Fe. It should be recalled that the Shymanivske concentrate grade is 68% Fe, therefore the unit %Fe premium is multiplied by six in order to adjust from the 62% Fe benchmark to the 68% Fe concentrate grade being produced.

The results of this analysis are presented in Table 22-4. The base case conditions (62% Fe benchmark price of $61.88/dmt and a %Fe grade premium of $7.21/dmt per 1% Fe increment) are highlighted. Conditions considered to be extreme (combinations of low and high 62% benchmark price and %Fe grade premium) are also highlighted and are considered unlikely to occur.

Table 22-4: NPV and IRR Sensitivity Analysis to Benchmark 62% Fe price and Fe Grade Premium

Pre-Tax IRR and NPV at 10% Discount Rate Sensitivity to Base 62% Fe CFR and %Fe Grade Premium							
62% Fe $/dmt		Fe Premium ($/dmt per 1% Fe)					
		$4.00	$5.00	$6.00	$7.21	$8.00	$9.00
$50.00	IRR	20.4%	24.6%	28.6%	33.3%	36.2%	39.9%
	$NPV_{10\%}$	$545 M	$797 M	$1 049 M	$1 354 M	$1 553 M	$1 805 M
$61.88	IRR	28.5%	32.4%	36.1%	**40.5%**	43.4%	46.9%
	$NPV_{10\%}$	$1 044 M	$1 296 M	$1 547 M	**$1 852 M**	$2 051 M	$2 303 M
$70.00	IRR	33.7%	37.4%	41.1%	45.3%	48.1%	51.5%
	$NPV_{10\%}$	$1 384 M	$1 636 M	$1 888 M	$2 193 M	$2 392 M	$2 644 M
$80.00	IRR	39.9%	43.4%	46.9%	51.1%	53.7%	57.1%
	$NPV_{10\%}$	$1 804 M	$2 056 M	$2 308 M	$2 613 M	$2 811 M	$3 063 M
$90.00	IRR	45.8%	49.2%	52.6%	56.7%	59.3%	62.5%
	$NPV_{10\%}$	$2 224 M	$2 476 M	$2 727 M	$3 032 M	$3 231 M	$3 483 M

23. ADJACENT PROPERTIES

The Shymanivske, Kryvyi Rih, iron ore deposit is part of the major regional iron ore formation of KrivBass, represented by linear north-south trending metamorphosed sedimentary rocks, hosting a siliceous-banded iron formation (BIF) over a length of 300 km.

The Shymanivske deposit is located at the central part of the iron ore district, situated in a valley surrounded by operating mines. Presently, there are five operating open pit iron ore mines and beneficiation plants in the area:

- Arcelor Mittal's mine and beneficiation plant is located 1 km northeast of the Property. It has been in production since 1959 and the current plant capacities are as follows: 24.2 Mtpa of ore mined from two active open pits; 9.9 Mtpa of concentrate produced, with 65.4% iron content;
- YuGOK (southern mining and beneficiation plant) is located 1 km east of the Property. It has been in production since 1955 and the current plant capacity is 9.0 Mtpa of concentrate production with 65% iron content;
- InGOK (Inhulets mining and beneficiation plant) is located 12 km south of the Property. This is the largest iron ore concentrate producing plant in Ukraine and it has been in operation since 1965. The current plant capacity is 15.0 Mtpa of iron ore concentrate. The plant produces two types of concentrate: high grade 67.5% iron content (6.8 Mtpa) and low grade 63.7% iron content (8.2 Mtpa);
- CGOK (central mining and beneficiation plant) is located 15 km north of the Property. The current plant capacities are as follows: iron ore concentrate output of 6.0 Mtpa with iron content of 65% and 68.2%; Pellets: output of 2.2 Mtpa with 63.9% of iron content;
- SevGOK (northern mining and beneficiation plant) is located 32 km north of the Property. The current plant capacities are as follows: Iron ore concentrate output 14.2 Mtpa with Fe content of 66%; Pellets: output 11.8 Mtpa with iron content of 63.5%.

The above information is available to the public and is not necessarily indicative of the quality or quantity of the mineralization on the Shymanivske Property.

24. OTHER RELEVANT DATA AND INFORMATION

24.1 Project Execution Plan

This Chapter provides a high-level general description of the Project execution plan and provides a list of key Project milestones covering major activities to be planned following the completion of this PEA Study. This PEA assumes that BKI will adopt an EPCM construction strategy but in the next Study phase other options should also be evaluated. The EPCM contractor will provide overall management for the Project as BKI will limit the size of its Owner's team. The EPCM Contractor will need to work in collaboration with the relevant Ukrainian Design Institutes (UDIs), which will provide local expertise, site-specific knowledge and some degree of technical capability as consulting engineers. UDIs also have a regulatory authority function in Ukraine and they represent the only real channel for obtaining local validation of engineering design as well as controlling the permitting procedure and ultimate approval for Project permits.

Following this PEA Study, BKI has indicated that it will proceed with an infill drilling programme with the objective of better defining the Inferred Resources that lie within the open pit designed for the PEA. This will likely lead to a revised Resource Estimate to be included in the new FS planned for the re-scoped Project as defined in this PEA Study. Ahead of construction, BKI will need to mobilize its Project team and select its EPCM contractor. In parallel, project permitting needs to be undertaken. Construction will begin once detailed engineering and procurement are advanced enough. The Project Schedule presented in Table 24-1 is based on duration and key milestones relative to the date whereby all required permits are obtained. Project execution is based on a construction period lasting a total of 24 months. Seasonal factors need to be considered when planning. Site preparation will include mine pre-stripping and initial construction of the TSF.

Table 24-1: Key Project Milestones

Major Milestones	Month
Complete Exploration Drilling and Update Mineral Resource Estimate	M -21
Start New FS on Re-Scoped, Phased Project	M -21
Complete New FS on Re-Scoped, Phased Project	M -12
Assemble Owner's Team	M -12
Award EPCM Contract and Start EP	M -9
Permit to Start Construction Available	**M 0**
Start Construction (Site Preparation)	M 0
Construction Completed	M 24
Cold Commissioning Completed	M 25
Hot Commissioning and Handover to Operations	M 28

Employment conditions in Ukraine are generally governed by the Labour Code, which was enacted when Ukraine was still part of the Soviet Union. The Code still contains many Soviet concepts, including a strong sense of the employee's right to work, and many protections for employees. Although employers can enter into individual labour contracts with employees, the terms of those agreements may not be worse than conditions guaranteed under the Labour Code. If employers are aware of and respect the statutory rights of employees, labour should not cause any significant issues for employers in Ukraine.

Unions have a visible place in the labour market. There is a specific law for Trade Unions. They are easy to establish, and the law grants certain benefits to unions. The largest trade union confederation in Ukraine, the Federation of Trade Unions of Ukraine (FPU), claims to unite more than 10 million trade union members. The Labour Code recognizes collective agreements and employers must accept collective agreements, if demanded by employees.

25. INTERPRETATION AND CONCLUSIONS

This PEA Study is based on the mining and mineral processing methods developed for the Shymanivske mineral deposit. The NI 43-101 guidelines require that interpretations and conclusions related to the Study, including an outline of key Project risks identified, be discussed.

25.1 Mineral Resource Estimates

WGM believes that the current block model resource estimate and its classification are to NI 43-101 and CIM standards and definitions and adequately represent the mineralization in the Shymanivske deposit.

The present Mineral Resource estimate was completed by using all historical drilling and information from Black Iron's Twin Drill hole and definition-drilling programs. The results for all non-oxidized horizons are summarized in Table 25-1 below.

Table 25-1: Mineral Resource Estimate for the Shymanivske Iron Ore Deposit (Cut-off Grade of 10% Fe_{mag})

Category	Tonnes (Million)*	Fe_{tot} %	Fe_{mag} %
Measured	355.1	32.0	19.5
Indicated	290.7	31.1	17.9
Total M&I	**645.8**	**31.6**	**18.8**
Inferred	188.3	30.1	18.4

* Tonnage and grade numbers rounded to the first decimal

Mineral Resources that are not Mineral Reserves do not have a demonstrated economic viability. Given the uncertainty that may be attached to Inferred Mineral Resources, it cannot be assumed that continued exploration will lead to the upgrading of all or any part of an Inferred Mineral Resource to an Indicated or Measured Mineral Resource.

In WGM's opinion, the Fe_{tot} grades in the Mineral Resource estimate should not be relied upon as a basis for evaluating the deposit. Given the considerable Fe-silicate component of the iron mineralization, WGM is of the opinion that these assays and averages do not represent a truly meaningful measure of the deposit, and that only the Fe_{mag} should be used to economically assess this deposit. However, the Fe_{tot} assays are included in this Study for comparison purposes with previous Shymanivske mineral resource estimates and with similar global iron deposits.

25.2 Subset of Mineral Resources with the Open Pit Design

Using the aforementioned mineral resource estimate and associated geological block model, a pit optimization analysis was conducted to determine the cut-off grade and to what extent the deposit can be mined profitably. This was done using the 3D Lerchs-Grossman algorithm in MineSight with inputs such as mining and processing costs, revenue per block and operational parameters such as the Fe recovery, pit slopes and other imposed constraints. The subset of Mineral Resources within the open pit designed for the Shymanivske deposit, inclusive of mining dilution and mining recovery are presented in Table 25-2.

Table 25-2: Subset of Mineral Resources within the Open Pit Design (Above 13% Fe_{mag} Cut-off)

Material	Tonnage (Mt)	Fe_{tot} (%)	Fe_{mag} (%)
Measured	283	31.4	19.4
Indicated	106	31.2	19.0
Total Measured & Indicated	**389**	**31.4**	**19.3**
Inferred	22	31.2	19.6
Overburden	108	-	-
Waste Rock	286	-	-
Total Stripping	**394**	-	-
Strip Ratio	**1.0**	-	-

25.3 Metallurgy and Processing

Metallurgical laboratory and pilot testwork were conducted during the 2012 and 2014 BFS in order to establish the process flowsheet developed in this PEA Study. The testwork campaigns achieved the desired quality of concentrate and demonstrated that by using the proposed process and flowsheet, it is possible to economically recover magnetite from the Shymanivske mineralization. Results from the testwork were used to determine process performance parameters such as throughput, Fe and weight recoveries, final concentrate grade (including key elements such as Fe, SiO_2, Al_2O_3 and P) and product particle size. These results were also used for determining final equipment sizing.

In order to produce concentrate with the desired specification, the mined material will be processed through two-stage crushing, one-stage HPGR, low-intensity magnetic separation and sulphide flotation. Although the process flowsheet and metallurgical performance are deemed to be robust and well supported by the metallurgical testwork, the sulphide flotation circuit requires further testwork to confirm retention times and final sizing prior to purchase.

25.4 Infrastructure

The Shymanivske Project area is serviced by existing rail and port infrastructure. The required utilities such as power, process water and natural gas are available in the vicinity of the Project. As such, the Project integrates well with other adjacent iron ore projects.

25.5 Environmental and Permitting

Prior to May 2017, the Ukrainian Environmental Impact Assessment, or the Otsinka Vplyvu na Navkolyshne Seredovysce (OVNS), was required by law to be approved by a State Environment Review (SER) prior to commencement of Project development activities. As of December 18, 2017, organizations planning any activity that has the potential to significantly impact the environment are required to perform an Environmental Impact Assessment (EIA) subject to the requirements imposed by Law No. 2059-VIII regarding Environment Impact Assessment adopted on May 23, 2017. Article 3 of the law lists activities that are capable of having significant impact on the environment and includes extraction of minerals and processing of minerals.

Considering that the Shymanivske Project will be located in an area where iron ore mining operations have been taking place for a number of years, the Project will further contribute to the environmental footprint of the area, namely with respect to air, water, soil and noise. These will need to be addressed during the permitting process and adequate mitigation will need to be planned. Also, the new regulations need to be well understood and the environmental permitting schedule will need to be integrated within the overall Project development schedule.

25.6 Project Economics

The results of the unlevered pre-tax and post-tax Economic Analysis are presented in Table 25-3 and Table 25-4 respectively.

Table 25-3: Pre-Tax (Unlevered) Economic Analysis Results

IRR = 40.5% Payback = 2.9 years Discounting Rate	NPV (M$)
0%	5,725
8%	2,295
10%	1,852
12%	1,501

Table 25-4: Post Tax (Unlevered) Economic Analysis Results

IRR = 34.4% Payback = 3.3 years Discounting Rate	NPV (M$)
0%	4,642
8%	1,807
10%	1,442
12%	1,152

25.7 Conclusions

The re-scoped Shymanivske Project demonstrates a significant benefit in executing the Project in two phases, namely by providing a significant reduction of initial capital required. The concentrate produced by the Project is of high Fe grade (68%) and is low in deleterious elements such as alumina and phosphorus. This attracts significant price premiums when compared to the benchmark 62% Fe fines. This is driven primarily by Chinese steelmakers trying to increase efficiency, reduce overall costs and most importantly reduce their greenhouse gas emissions. Furthermore, the Shymanivske concentrate is of fine particle size making it readily usable for any pelletizing operation as pellet feed.

The ongoing political instability in Ukraine remains an important risk to the development of the Project. Some legal issues related to the relocation of villages as well as to the new environmental permitting law should also be pointed out. Technical risks are mainly related to tailings dam design water management as related to extreme waterfall events. These risks can be mitigated firstly through proper design and secondly through proper operations. Processing risks are mainly associated with adequate equipment sizing, especially in the flotation circuit, based on the mineral characterization performed during the extensive metallurgical testwork that was done during the past studies.

26. RECOMMENDATIONS

Based on the information available and the degree of development of the Project as of the effective date of this Report, BBA is of the opinion that the Project is technically and financially sufficiently robust to warrant proceeding to a feasibility study (FS) for the re-scoped Project.

As a first step, BKI should proceed with an in-fill drilling program in order to better define the inferred resources within the optimized pit shell. This should be followed by an update of the mineral resource estimate and these should be incorporated into the recommended FS.

The FS should develop in more detail the two phase approach for Project execution as well as optimize the equipment selection and layout for each 4.1 Mtpa line.

The TMF design and tailings deposition plan have been developed at a conceptual level in this PEA. This should be developed at a more detailed level during the FS.

BKI should proceed with initiating environmental permitting activities in parallel with the FS.

26.1 Mineral Resource Estimates

Most of the previous drilling, including the Twin drill hole program, was vertical or sub-vertical. During the subsequent definition-drilling program, WGM proposed flatter angles to give more information about the location and orientation of faulted blocks and the existence of several projected faults within the deposit from south to north. This program partially achieved its goals in delineating some structural elements within the deposit. However, in the steeply dipping areas close to the west and east limbs of the main anticline structure, some proposed holes were cancelled because of the position of collars on old waste dumps that belong to the neighbouring mines. Completion of the remainder of these holes, either as originally planned or from in-pit once production has commenced, would give more structural information. This would aid in understanding the controls and boundaries of the Oxide Zone and the magnetite-bearing quartzite, thereby improving the quality of the Mineral Resource estimate and helping to achieve better mine planning and scheduling at the boundaries of the Oxide Zone. WGM recommends that, for any future work, the Saksagan stratigraphic member codes be applied more circumspectly.

26.2 Mineral Processing and Metallurgical Testwork

In the 2014 FS, the tower mills were sized based on testwork results and manufacturer recommendations gained from experience with similar operations. It is however recommended that some pilot scale testwork be performed, either for the FS or prior to final design, to properly size tower mills' requirements.

The flotation circuit design should be confirmed with further testwork. The use of flotation columns or other advanced cell designs could be considered. This can improve flotation performance and optimize capital and operating costs. Flotation reagent selection should also be optimized prior to final design.

Prior to final design, thickening and rheology testwork should be undertaken with equipment vendors in order to establish final equipment sizing.

26.3 Geotechnical

Geotechnical and hydro geological investigations are required in the pit area to confirm the assumed pit slope angles and dewatering requirements for the mine. These investigations must be completed prior to final design.

Site wide geotechnical studies will be required prior to final design.

26.4 Environmental

BKI should initiate the permitting process based on the new requirements brought about by regulations recently introduced. This work should be integrated into the overall Project development schedule to ensure that permitting does not become the critical step in starting construction.

26.5 Next Steps

BBA recommends that BKI proceed with the undertaking of a targeted infill drilling program and a Feasibility Study for the Shymanivske re-scoped Project. In parallel, BKI should proceed with initiating the permitting process. This, as well as recent encouraging iron ore market conditions, will facilitate Project financing and BKI can then transition into the EPCM phase of the Project. The costs for the next Study phase have been estimated and are outlined in Table 26-1.

Table 26-1: Next Study Phase Cost Estimate

Study Phase	Cost Estimate M US $
In-fill drilling program	$2.1
Feasibility Study	$1.0
Initiation of EIS (Allowance)	$ 0.5
Total	**$ 3.6 M**

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