A COMPETENT PERSONS REPORT ON THE MINERAL ASSETS OF JSC KAZCHROME, KAZAKHSTAN

Prepared For

Eurasian Resources Group Sarl

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A COMPETENT PERSONS REPORT ON THE MINERAL ASSETS OF JSC KAZCHROME, KAZAKHSTAN

1 INTRODUCTION

1.1 Background

SRK Consulting (UK) Limited ("SRK") is an associate company of the international group holding company, SRK Consulting (Global) Limited (the "SRK Group"). SRK has been requested by the Eurasian Resources Group Sarl ("ERG", hereinafter also referred to as the "Client" or the "Company") to prepare a Competent Persons' Report ("CPR") on the Mineral Assets of JSC Kazchrome, located in the Republic of Kazakhstan ("Kazakhstan").

JSC Kazchrome, a 100% owned subsidiary of the Company, consists of the following:

- Donskoy Mining and Processing Combine ("Donskoy GOK", or "Donskoy"):
  - 2 underground chrome mines and 1 open pit;
  - 2 processing plants producing chrome concentrates;
- Aksu ferro-alloy plant: Smelter producing ferro-alloys;
- Aktobe ferro-alloy plant: Smelter producing ferro-alloys;
- Aktobe Power Generation: turbines and thermal power plant, incorporated within the Aktobe Smelter; and
- Kazmarganets: Tur manganese mine and processing plant.

This CPR presents the following key Technical Information as at the Effective Dates (defined below):

- Mineral Resource and Ore Reserve statements reported in accordance with the terms and definitions of the JORC Code (defined below, section 1.2);
- an opinion on the reasonableness of the technical-economic inputs into the life of mine plan ("LoMp"), specifically: saleable production, operating expenditure and capital expenditure (hereinafter the "Technical Economic Parameters" or "TEPs");
- an opinion on the reasonableness of the environmental liabilities; and
- a summary of the key technical risks and opportunities.

Certain units of measurements, abbreviations and technical terms are defined in the glossary at the end of this CPR. Unless otherwise explicitly stated all quantitative data as reported in this CPR are reported on a 100% basis.

1.2 Reporting Standard and Reliance

1.2.1 Reporting Standard

The Reporting Standard adopted for reporting of the recent Mineral Resource and Ore Reserve Statements for the Mineral Assets in this CPR is that defined by the terms and definitions given in *"The 2012 Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves as published by the Joint Ore Reserves Committee of the Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and Minerals Council of Australia"* (the "JORC Code"). SRK confirms that the JORC Code (2012) has been aligned with the Committee for Mineral Reserves International Reporting Standards ("CRIRSCO") reporting template.

1.2.2 Reliance on SRK

The CPR is addressed to and may be relied upon by the Directors of the Company and the Financial Advisors, specifically in respect of compliance with the Reporting Standard.

SRK declares that it has taken all reasonable care to ensure that the information contained in the CPR is, to the best of its knowledge, in accordance with the facts and contains no omission likely to affect its import.

SRK believes that its opinion must be considered as a whole and that selecting portions of the analysis or factors considered by it, without considering all factors and analyses together, could create a misleading view of the process underlying the opinions presented in this CPR. The preparation of a CPR is a complex process and does not lend itself to partial analysis or summary.

SRK has no obligation or undertaking to advise any person of any development in relation to the Mineral Assets which comes to its attention after the date of this CPR or to review, revise or update the CPR or opinion in respect of any such development occurring after the date of this CPR.

1.3 Base Technical Information Date and Effective Date

The base technical information date, and the effective date of the CPR is 1 January 2018 (the "Effective Date"). The Mineral Resource and Ore Reserve Statements and the Technical Information have been prepared as at the Effective Date in reliance on:

- the Mineral Resource statement as prepared by SRK with a base date of 1 January 2018;
- the Ore Reserve statement as prepared by SRK with a base date of 1 January 2018;
- the LoMp as developed by the Company as at 1 January 2018; and
- the Environmental Liabilities.

1.4 Verification and Validation

SRK has conducted a review (which specifically excludes independent verification by means of re-calculation) and assessment of all material technical issues likely to influence the Technical Information included in the LoMp and the associated TEPs, which included the following:

- Limited inspection visits to Kazchrome's mining and processing facilities and associated infrastructure undertaken by four consultants during November-December 2017. Other consultants had visited the Donskoy site recently as part of a separate mandate.
- Enquiry of key project and head office personnel during Q4 2017/Q1 2018 in respect of the Mineral Assets, the LoMp and the associated TEPs and other related matters.
- An examination of historical information for the financial reporting periods ended 31 December 2014 through to 31 December 2017.
- An examination, review and where appropriate identification of the key technical risks and opportunities as they relate to the Technical Information reported herein.

The Company has provided technical data to SRK for the purpose of this review and inclusion in the CPR. SRK confirms that it has performed all necessary validation and verification procedures deemed necessary and/or appropriate by SRK in order to place an appropriate level of reliance on such technical information.

In presenting the Mineral Resource and Ore Reserve Statements, TEPs and other technical information as reported in this CPR the following apply:

- Measured and Indicated Mineral Resources are inclusive of those Mineral Resources modified to produce Ore Reserves; that is, they are reported on an 'inclusive basis'; and
- commodity long-term price assumptions as included in the LoMp and reported in the Company's Financial Model.

1.5 Limitations, Reliance on Information, Declaration, Consent and Cautionary Statements

1.5.1 Limitations

Ore Reserve estimates are based on many factors and are derived from estimates of future technical factors, operating and capital expenditures, product prices and the exchange rate between various currencies and the United States Dollar ("USD"). The Ore Reserve estimates contained in this report should not be interpreted as assurances of the economic life of the Mineral Assets. As Ore Reserves are only estimates based on the factors and assumptions described herein, future Ore Reserve estimates may need to be revised. For example, if production costs increase or product prices decrease, a portion of the current Mineral Resources, from which the Ore Reserves are derived, may become uneconomical to recover and would therefore result in lower estimated Ore Reserves. Furthermore, should any of the assumed factors change, the Mineral Resource and Ore Reserve Statements, the TEPs and the Technical Information as reported herein may need to be revised and may well result in lower estimates.

The Mineral Resource and Ore Reserve Statements, the TEPs, and the Technical Information rely on assumptions regarding certain forward-looking statements. These forward-looking statements are estimates and involve a number of risks and uncertainties that could cause actual results to differ materially.

The achievability of the projections of TEPs as included in this CPR and incorporated into the LoMp for the Mineral Assets are neither warranted nor guaranteed by SRK. The projections as presented and discussed herein have been proposed by the Company's management and cannot be assured; they are necessarily based on economic assumptions, many of which are beyond the control of the Company.

Future cashflows and profits derived from such forecasts are inherently uncertain and actual results may be significantly more or less favourable.

Unless otherwise expressly stated all the opinions and conclusions expressed in this CPR are those of SRK.

1.5.2 Reliance on Information

SRK has relied upon the accuracy and completeness of technical, financial and legal information and data furnished by or through the Company.

The Company has confirmed to SRK that, to its knowledge, the information provided by it (when provided) was complete and not incorrect or misleading in any material respect. SRK has no reason to believe that any material facts have been withheld.

Whilst SRK has exercised all due care in reviewing the supplied information, SRK does not accept responsibility for finding any errors or omissions contained therein and disclaims liability for any consequences of such errors or omissions.

SRK's assessment of Kazchrome's Mineral Resources and Ore Reserves, TEPs and the LoMp for the Mineral Assets is based on information provided by the Company throughout the course of SRK's investigations, which in turn reflect various technical and economic conditions prevailing at the date of this report. In particular, the Ore Reserves, the TEPs and the LoMp are based on expectations regarding the commodity prices and exchange rates prevailing at the Effective Date of this CPR. These TEPs can change significantly over relatively short periods of time. Should these change materially the TEPs could be materially different in these changed circumstances.

This CPR specifically excludes all aspects of legal issues, marketing, commercial and financing matters, insurance, land titles and usage agreements, and any other agreements and/or contracts the Company may have entered into.

This CPR includes technical information, which requires subsequent calculations to derive subtotals, totals and weighted averages. Such calculations may involve a degree of rounding and consequently introduce an error. Where such errors occur, SRK does not consider them to be material.

1.5.3 Declaration

SRK will receive a fee for the preparation of this report in accordance with normal professional consulting practices. This fee is not dependent on the findings of this CPR and SRK will receive no other benefit for the preparation of this CPR. SRK does not have any pecuniary or other interests that could reasonably be regarded as capable of affecting its ability to provide an unbiased opinion in relation to the Ore Reserves, the TEPs, and the LoMp for the Mineral Assets, opined upon by SRK and reported herein.

Neither SRK nor the Competent Persons (as identified under Section 1.7, below) who are responsible for authoring this CPR, nor any Directors of SRK have at the date of this report, nor have had within the previous two years, any shareholding in the Company, the Mineral Assets or the Financial Advisors of the Company, or any other economic or beneficial interest (present or contingent) in any of the assets being reported on. SRK is not a group, holding or associated company of the Company. None of SRK's partners or officers are officers or proposed officers of any group, holding or associated company of the Company.

Further, no Competent Person involved in the preparation of this CPR is an officer, employee or proposed officer of the Company or any group, holding or associated company of the Company.

Consequently, SRK, the Competent Persons and the Directors of SRK consider themselves to be independent of the Company, its directors, senior management and Financial Advisor.

In this CPR, SRK provides assurances to the Board of Directors of the Company, in compliance with the Reporting Standard that the Ore Reserves, the TEPs, including production profiles, operating expenditures and capital expenditures of the Mineral Assets as provided to SRK by the Company and reviewed and, where appropriate, modified by SRK are reasonable, given the information currently available.

1.5.4 Disclaimers and Cautionary Statements for US Investors

This CPR uses the terms *"Mineral Resource"*, *"Measured Mineral Resource"*, *"Indicated Mineral Resource"* and *"Inferred Mineral Resource"*. U.S. investors and shareholders in the Company are advised that while such terms are recognised and permitted under JORC Code (2012) and the Requirements, the U.S. Securities and Exchange Commission ("SEC") does not recognise them and strictly prohibits companies from including such terms in SEC filings.

Accordingly, U.S. investors and shareholders in the Company are cautioned not to assume that any unmodified part of the Mineral Resources in these categories will ever be converted into Ore Reserves as such term is used in this CPR.

1.6 Indemnities provided by the Company

The Company has provided the following indemnity to SRK:

- In order to assist SRK in the preparation of this CPR the Company may be required to receive and process information or documents containing personal information in relation to SRK's project personnel. The Company has agreed to comply strictly with the provisions of the Data Protection Act 1998 of the United Kingdom ("DPA 1998") and all regulations and statutory instruments arising from the DPA 1998, and the Company will indemnify and keep indemnified SRK in respect of all and any claims and costs caused by breaches of the DPA 1998.

1.7 Qualifications of Consultants and Competent Persons

The SRK Group comprises over 1,400 staff, offering expertise in a wide range of resource engineering disciplines with 45 offices located on 6 continents. The SRK Group prides itself on its independence and objectivity in providing clients with resources and advice to assist them in making crucial judgment decisions. For SRK this is assured by the fact that it holds no equity in either client companies/subsidiaries or mineral assets.

SRK has a demonstrated track record in undertaking independent assessments of resources and reserves, project evaluations and audits, Competent Persons' Reports, Mineral Resource and Ore Reserve Compliance Audits, Independent Valuation Reports and independent feasibility evaluations to bankable standards on behalf of exploration and mining companies and financial institutions worldwide. SRK has also worked with a large number of major international mining companies and their projects, providing mining industry consultancy service inputs. SRK also has specific experience in commissions of this nature.

This CPR has been prepared based on a technical and economic review by a team of consultants sourced from SRK's offices in the United Kingdom. These consultants have extensive experience in the mining and metals sector and are members in good standing of appropriate professional institutions. The consultants comprise specialists in the fields of: geology and resource estimation; mining engineering and ore reserves; mining geotechnical engineering; waste and tailings engineering; mineral processing; smelting; environmental and social; and financial evaluation (hereinafter the "Technical Disciplines").

The Competent Person who has reviewed the Mineral Resources as reported by the Company is Dr Lucy Roberts, a Competent Person who is a Member of The Australasian Institute of Mining and Metallurgy. Dr Roberts is a Principal Consultant (Resource Geology) and a full-time employee of SRK. Dr Roberts has sufficient experience that is relevant to the style of mineralisation and type of deposit under consideration and to the activity being undertaken to qualify as a Competent Person as defined in the 2012 Edition of the JORC Code. Dr Roberts consents to the inclusion in the report of the matters based on her information in the form and context in which it appears.

The Competent Person who has reviewed the Ore Reserves and the LoMp as reported by the Company is Jurgen Fuykschot, a Competent Person who is a Member of The Australasian Institute of Mining and Metallurgy. Mr Fuykschot is a Principal Consultant (Mining) and a full-time employee of SRK. Mr Fuykschot has sufficient experience that is relevant to the style of mineralisation and type of deposit under consideration and to the activity being undertaken to qualify as a Competent Person as defined in the 2012 Edition of the JORC Code. Mr Fuykschot consents to the inclusion in the report of the matters based on his information in the form and context in which it appears.

The Competent Person who has overall responsibility for the CPR is Mr Richard Oldcorn, who is a Corporate Consultant and Managing Director of SRK. He is a Fellow of the Geological Society of London and a Chartered Geologist, a ROPO. Mr Oldcorn has 27 years' experience in the mining and metals industry and also has been involved in the preparation of Competent Persons' Reports comprising technical evaluations of various mineral assets internationally during the past five years, which is relevant to the activity which he is undertaking to qualify as a Competent Person as defined in the JORC Code (2012).

Table 1-1 provides a summary of the designated Competent Persons and other key contributors for completion of this CPR.

Neither SRK nor the authors of this report are qualified to provide comment on any legal issues associated with the Mineral Assets. Assessment of these aspects has relied on information provided by the Company and its advisors, and has not been independently verified by the authors.

Table 1-1: Competent Persons and Other Experts

List of Competent Persons					
Competent Person	**Position / Company**	**Responsibility**	**Independent Kazchrome**	**Date of Last Site Visit**	**Professional Designation**
Dr Lucy Roberts	Principal Consultant (Resource Geology), SRK Consulting (UK) Ltd	Geology, Mineral Resources	Yes	November 2017	BSc, MSc, PhD, MAusIMM(CP)
Jurgen Fuykschot	Principal Consultant (Mining), SRK Consulting (UK) Ltd	Mining, Ore Reserves	Yes	July 2017	MSc, MBA, MAusIMM(CP)
Richard Oldcorn	Corporate Consultant (Due Diligence), SRK Consulting (UK) Ltd	Overall CPR	Yes	none	BSc, MSc, CGeol
Other Experts who assisted the Competent Persons					
Expert	**Position / Company**	**Responsibility**	**Independent of Kazchrome**	**Date of Last Site Visit**	**Professional Designation**
Dr David Pattinson	Corporate Consultant (Minerals Processing & Metallurgy), SRK Consulting (UK) Ltd	Mineral Processing Review	Yes	July 2017	PhD, CEng, MIMMM, BSc
Trevor Silverton	Principal Consultant (Geotechnical), SRK Consulting (UK) Ltd	Geotechnical Review	Yes	July 2017	BSc(Hons), FIMMM CEng
Johan Basson	Associate Consultant (Smelting), Pyrotek Consulting	Smelter Review	Yes	November/ December 2017	MEng, ECSA PrEng
Fiona Cessford	Corporate Consultant (Environment), SRK Consulting (UK) Ltd	Environmental & Social Review	Yes	November 2017	BSc, MSc, Pr.Sci.Nat.
Dr Paul Mitchell	Associate Consultant (Environment), Green Horizons Environmental Consultants Ltd	Environmental & Social Review	Yes	December 2017	BEng, PhD
Sabine Anderson	Principal Consultant (Due Diligence), SRK Consulting (UK) Ltd	Financial Model Review	Yes	February 2016	MEng, CEng, MIMMM
Inge Moors	Senior Consultant (Due Diligence), SRK Consulting (UK) Ltd	Project Manager	Yes	none	MSc, MAusIMM

2 JSC KAZCHROME

2.1 Introduction

Kazchrome's ferroalloy assets, comprise a variety of mines, concentrator plants and ferroalloy smelters. These are all located in Kazakhstan. Kazchrome employs some 18,300 people across its assets.

The Kazchrome assets are summarised in Table 2-1 and the locations are shown in Figure 2-1.

Table 2-1: Summary of Kazchrome Assets

Asset	Infrastructure
Donskoy Mining and Processing Combine	Two underground and one open pit mine Two processing plants
Aksu ferroalloy plant	Smelter producing ferroalloys
Aktobe ferroalloy plant	Smelter producing ferroalloys
Aktobe Power Generation	Turbines and thermal power plant
Kazmarganets	Manganese mine and process plant

Figure 2-1: Location of Kazchrome Assets

2.1.1 Donskoy GOK

The chromite mines of Donskoy are situated around the town of Khromtau in north-west Kazakhstan, 90 km east of Aktobe, the provincial capital. The operation currently consists of two producing underground mines, an operating open pit mine, two beneficiation plants, two pelletiser plants, and a fine tailings treatment plant:

- 10th Anniversary of Kazakhstan Independence underground mine (commonly referred to as “DNK”);
- Molodezhnaya underground mine;
- Yuzhny (20th Anniversary of Kazakh SSR) open pit mine;
- Plant No 1 (DOF-1);
- Plant No 2 (FOOR);
- fines beneficiation plants designated OMK-1 and OMK-2;
- Pelletiser plant No 1 (UPO-1);
- Pelletiser plant No 2 (UPO-2); and
- Tailings treatment plant No1.

The chromite deposits were discovered in the 1930s, and production from the Donskoy open pit started in 1938. Annual output exceeded 1 Mt in 1959 and 3 Mt in 1973. Mining from the underground Molodezhnaya mine started in 1982, and the DNK mine was commissioned in 1999. A total of 24 open pits have been worked since the first production in 1938. Of these, the Yuzhny pit is still in production and scheduled to close in 2022. In 1995, the Donskoy mining and concentration facilities were merged with the Aktobe and Aksu ferroalloy plants to form Kazchrome.

Donskoy is serviced by a sealed road and railway lines west to Aktobe and east to Astana and the Aksu ferroalloy plant. Electricity is supplied from the Kazakh power grid. The topography of the whole central to northern area of Kazakhstan is essentially flat, tree-less open steppe.

Based on present Ore Reserves and forecast production rates, Donskoy is projected to continue until 2051.

The Donskoy products consist of concentrates of various grades and sizes, pellets, briquettes and high grade ore. The high grade ore is only crushed and sized without further processing.

2.1.2 Aktobe Ferroalloy Plant and Power Station

The Aktobe ferroalloy plant is located near Aktobe City, occupying a large industrial estate in the outskirts of the city.

The first furnace was commissioned in 1943, followed by frequent additions and changes to the plant to produce a wide variety of alloys and metals over its history. The three current smelting complexes were built in the 1940s to 1970s.

The plant produced 524 kt of ferroalloy products in 2017.

Aktobe currently produces:

- high-carbon ferrochrome (“HCFeCr”) including four grades;
- medium-carbon ferrochrome (“MCFeCR”) including two grades;
- low-carbon ferrochrome (“LCFeCr”) including three grades; and
- ferrosilicon (“FeSi”).

The Aktobe power plant produces some 150 MW, from the gas and steam turbine, and the thermoelectric power station. The current smelter demand is about 450 MW. The smelters are therefore also connected to the grid to make up for any shortfalls and ensure continued power supply.

The staff complement for the overall Aktobe facility is currently almost 5,000.

2.1.3 Aksu Ferroalloy Plant

The Aksu ferroalloy plant is located 6 km north of the town of Aksu, approximately 25 km to the south of the regional centre Pavlodar. The smelting facility at Aksu consists of four smelting complexes. Construction commenced in 1960 and operations in 1968. Over the past 20 years, the plant output has steadily increased through expansions and productivity improvements. The workshops were initially designed to produce ferrosilicon and subsequently converted to produce ferrochrome and ferrosilicomanganese. Today, Aksu is one of the world’s largest ferroalloy plants and in 2017 produced 1,088 kt of ferroalloy products. Aksu currently produces:

- high-carbon ferrochrome (“HCFeCr”) including six grades;
- ferrosilicochrome (“FeSiCr”) including two grades;
- ferrosilicomanganese (“FeSiMn”) including two grades; and
- ferrosilicon (“FeSi”).

The staff complement is currently about 6,400.

2.1.4 Kazmarganets

Kazmarganets Mining Enterprise (“Kazmarganets”) operates the Tur mine, located in Central Kazakhstan, some 200 km north east of Zhezkazgan. Kazmarganets’s head office is in the city of Karaganda. The concentrate is sized and transported to Kazchrome’s Aksu ferroalloy plant.

The Tur deposit was discovered in 1986 with help of regional-scale geophysics. The GKZ resource statement was approved in the 1998 and trial mining started in the same year.

Previously, the Vostochny Kamys operation was also part of Kazmarganets. Since depletion of the deposit and ceasing of mining operations in 2013, the site has been successfully rehabilitated and returned to the Government of Kazakhstan.

During 2017, the Tur mine produced 0.4 Mt of manganese ore grading 27.1% Mn.

2.2 Licences

2.2.1 Donskoy GOK

The Donskoy mines are operated according to the terms and conditions of the contract MG No. 110 issued on 3 March 1997 and valid to 21 March 2041.

Kazchrome has confirmed that the licences encompass the area of the Mineral Resource and Ore Reserves, and the associated development for the underground mines and pit limit for the open pit.

Table 2-2: Ferroalloy Division — Summary of Mining Exploration Contracts for Donskoy

Asset	Licence/ Contract No	Status	Asset Type	Contract Expiry Date	Last Year of Ore Reserve	Contract Area (ha)
Donskoy Mining Contract	110	Production	-	21/03/2041	-	260
DNK	110	Production	underground	21/03/2041	2051	260
Molodezhnaya	110	Production	underground	21/03/2041	2023	240
Yuzhny	110	Production	open pit	21/03/2041	2022	23

In the case of the DNK and Molodezhnaya mines, where the life of the mine exceeds the duration of the contract, SRK has assumed that Kazchrome will successfully apply and be granted one renewal of the contract. In this case, the extended duration will exceed the life of the mine and hence be suitable for the reporting of Mineral Resources and Ore Reserves.

Kazchrome has advised SRK that it owns the surface rights for the Donskoy areas required to operate through to transport of product, and disposal of the waste for each site.

2.2.2 Kazmarganets

Mining operations at Tur operate under the terms and conditions of sub-soil contract No. 380. The details of the contract are presented in Table 2-3.

Kazchrome has advised SRK that it owns the surface rights for the Kazmarganets areas required to operate through to transport of product, and dispose of the waste for each site.

Table 2-3: Ferroalloy Division — Summary of Mining Exploration Contracts at Kazmarganets

Asset	Licence/ Contract No.	Status	Asset Type	Contract Expiry Date	Last Year of Ore Reserve	Contract Area (ha)
Tur	380	Production	open pit	07/10/2021	2020	46

2.3 Climate

All Kazchrome sites are subject to a central continental climate with hot dry summers with temperatures peaking over 40°C and winters with temperatures dropping below -40°C. The temperature is on average below 0°C for some 200 days of the year, although no permafrost exists. The sites are semi-arid with a mean annual precipitation of 350 mm, most of which occurs in autumn and winter. Thunderstorms can result in peak rainfall events with more than 50 mm of precipitation during the event.

2.4 Previous work by SRK and SRK Site Visits for the CPR

SRK has been involved with Kazchrome's assets since preparing an independent mineral experts' report on all of (then) ENRC's mining, processing, smelting and power generating assets in connection with its admission to trading on the London Stock Exchange in December 2007.

From 2008 onwards, SRK has reviewed and restated the statements for the assets as per the first of January, in line with now ERG's reporting requirements. Whilst the statements are not published in the public domain, they are still a requirement for internal reporting of the Company's accounts.

Most recent site visits undertaken to Kazchrome included a mining engineer, geotechnical engineer, and processing engineer in July 2017 as part of the "Kazchrome 2.0" project and the information obtained during this visit is considered recent enough to be used in the CPR. A geologist visited site as part of the CPR process in November 2017, followed by environmental and smelters specialists in December 2017.

3 DONSKOY GEOLOGY

3.1 Regional Geology

The chromite deposits at Khromtau are located at the southern fringe of the Ural mountain chain, in the Kempirsai Massif, a Varscian ophiolite complex which extends for over 2,000 km^2. There are several chromite deposits within the Kempirsai Massif, with the deposits near Khromtau being the largest and of the highest grade. The Donskoy chromite deposits, which occur in the main field, are found over an area measuring some 22 km in length and 7 km in width.

3.2 Deposit Geology

The chromite pods within the Donskoy deposits consist of dense to massive chromite ($(Fe,Mg)(Cr,Al,Fe)_2O_4$), which is a chromium-rich mineral. The pods are typically elongated and continuous for several hundred metres along plunge and have variable thicknesses, averaging approximately 50 m.

The contact between the chromite pods and the host serpentinite is typically either very sharp or gradational over 1 to 2 m, which is marked by fine disseminations of chromite. Most of the mineralisation is classified as ‘Massive’, which represents over 90% of the chromite. The grain size is typically between 2 and 20 mm. Two further mineralisation types are present, namely ‘disseminated’ and ‘porphyry’, which are currently excluded from the GKZ estimates due to the typically low grade. The main distinguishing feature between the disseminated and porphyry types is the grain size, with porphyry mineralisation typically having chromite agglomerations of between 0.5 to 10 cm diameters, with individual 1 mm size chromite grains. A number of south-dipping normal faults offset the pods by as much as 300 m vertically and 80 m laterally.

Six deposits are included in the current declaration of Mineral Resources. The deposits in the region are shown in Figure 3-1 and are as follows:

- **Molodezhnaya**: The deposit lies 15 km north-northeast of Khromtau and consists of 25 pods, three of which contain or contained a significant tonnage. The No 22 deposit is the largest, is located at a depth of between 420 and 600 m below surface and is currently being mined by underground mining methods. The pod has a strike length of approximately 1,500 m, a maximum width of over 300 m, and a maximum thickness of 140 m. The average thickness is approximately 50 m. The dip of the pod is approximately 40° towards the southwest. The average in situ grade is greater than 51% Cr_2O_3.
- Within Molodezhnaya, additional exploration within the Dubersai area has resulted in this deposit being added to the Mineral Resources. Dubersai lies below the Molodezhnaya open pit, and will be accessed from there. The mineralisation is approximately 300 m long, 100 m vertical thickness, and lies close to surface.
- **Almaz-Zhemchuzhina**: The deposit is located 2 km southwest of Khromtau and comprises 15 individual pods, four of which contain significant tonnages. The depth of the pods varies from 140 m in the north to over 1,350 m in the south. The lenses are relatively thick, being typically between 25 to 100 m, and extend down-plunge for considerable distances (up to 1.6 km). Numerous faults divide the pods, which can make the shape more difficult to mine. The grades of the larger lenses are typically greater than 50% Cr_2O_3.

- **Millionoye**: The deposit consists of two north-south striking lenses with a strike length of 760 m and 540 m respectively. The average width of the lenses is 180 m, with a thickness of between 25 to 75 m. These lenses have been explored to a depth of 1,000 m, and the deposit is open at depth.
- **Pervomaiskoye**: The deposit consists of four lenses with comparatively complex shapes, which have also been intersected by a number of significant faults. The average in situ grade of the main lens is 45% Cr_2O_3.
- **No 21:** This deposit is located some 4 km east of the Millionoye pit and consists of 11 lenses. Two lenses are substantial, although thin compared with those in the other deposits, being between 8 and 50 m thick. Where several lenses are stacked together and create a mineable unit, the average in situ grade of 46.8% Cr_2O_3 is diluted by the waste interburden. The stacked lenses are described as complicated in form and variable in orientation.
- **Zapadny:** Further to the four main DNK mine deposits, additional exploration in the Western area (Zapadny) has now been completed. This has resulted in this deposit being added to the Balance Reserves. The deposit lies approximately 0.5 km from Millionoye. The deposit is relatively fragmented, forming small discrete pods of mineralisation over a vertical height of approximately 150 m. The true thicknesses of the pods are between 2 and 50 m. Mineralisation has been drilled over a strike length of approximately 250 m. The average in situ grade is approximately 44% Cr_2O_3.
- **Yuzhny**: The deposit lies 12 km north-northeast of Khromtau and is mined by open pit methods. The deposit consists of several chromite pods, which have a generally shallow dip. The pods vary in size from a few metres up to 15 m in thickness. The average in situ grade is approximately 48% Cr_2O_3, although recent exploration has identified some higher grade mineralisation, increasing the mean grade of the deposit to 51.7%.

The Almaz-Zhemchuzhina, Millionoye, Pervomaiskoye, No 21 and Zapadny deposits form the resource base of the DNK mine.

Figure 3-2 shows the plan of the surface exploration drillholes. Figure 3-3 and Figure 3-4 show long-sections of the Molodezhnaya and DNK mines.

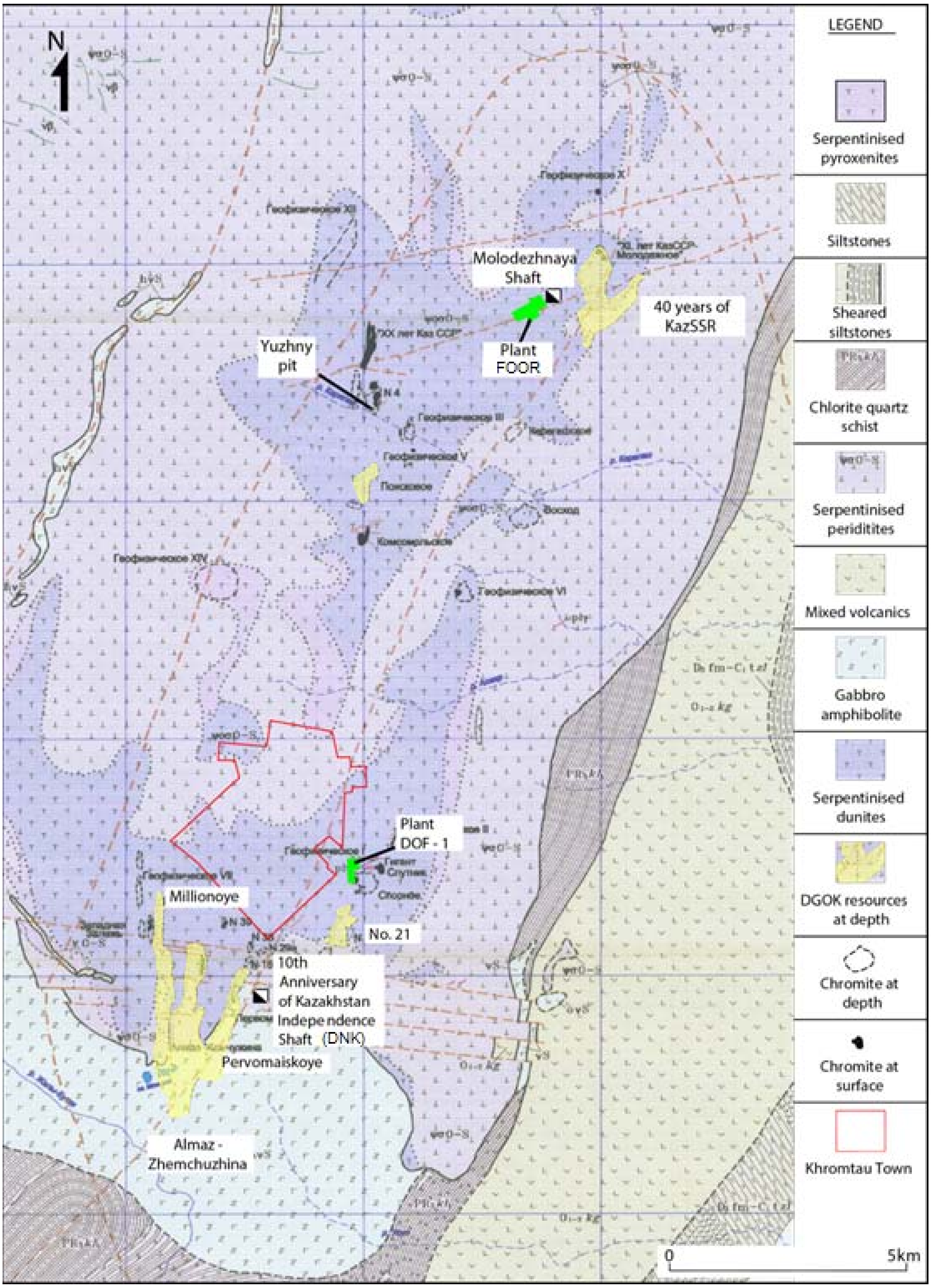


Figure 3-1: Geological map showing the extent of the main ore field in the context of the Donskoy mines and significant infrastructure

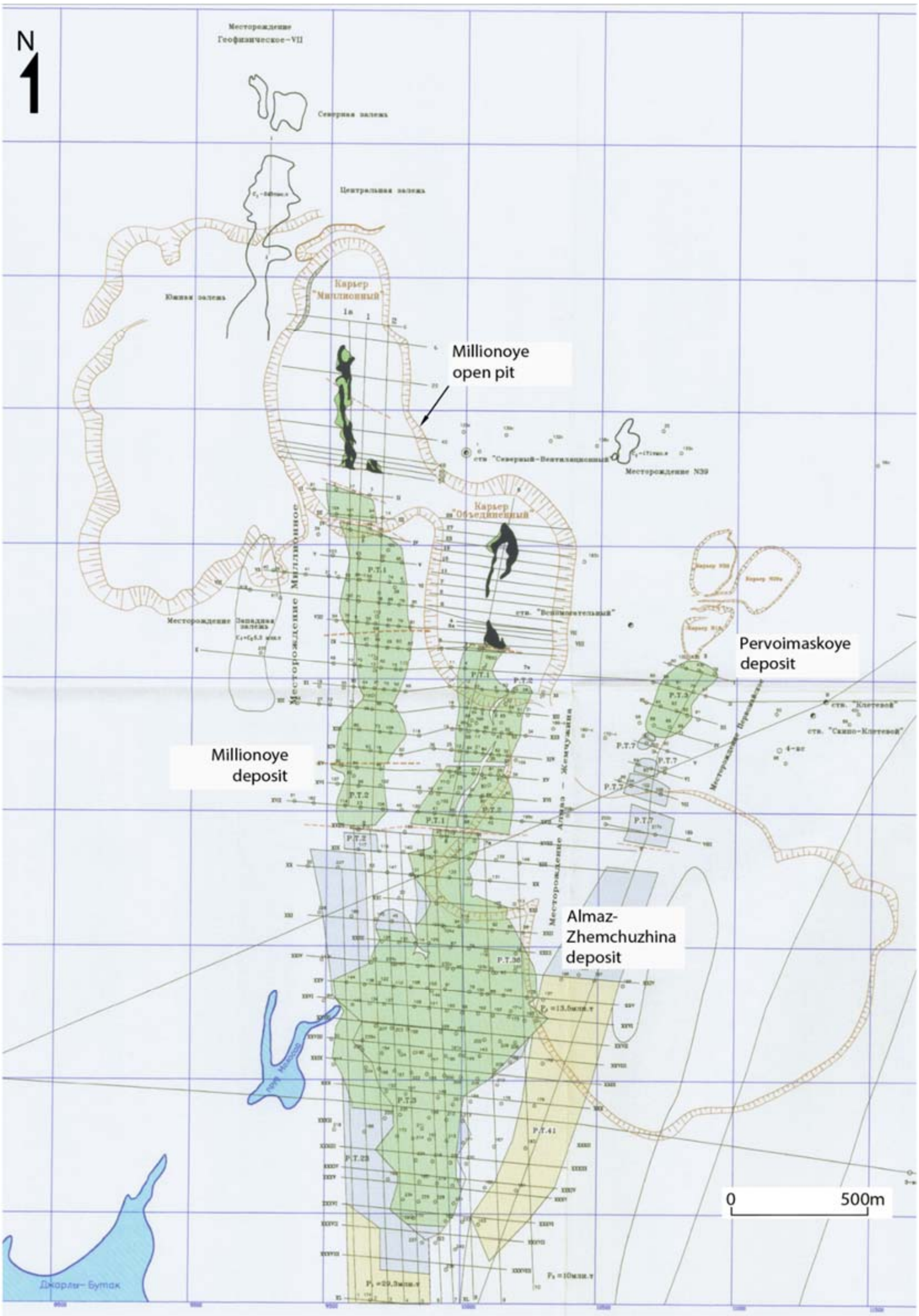


Figure 3-2: Plan of surface exploration hole locations at the DNK Mine

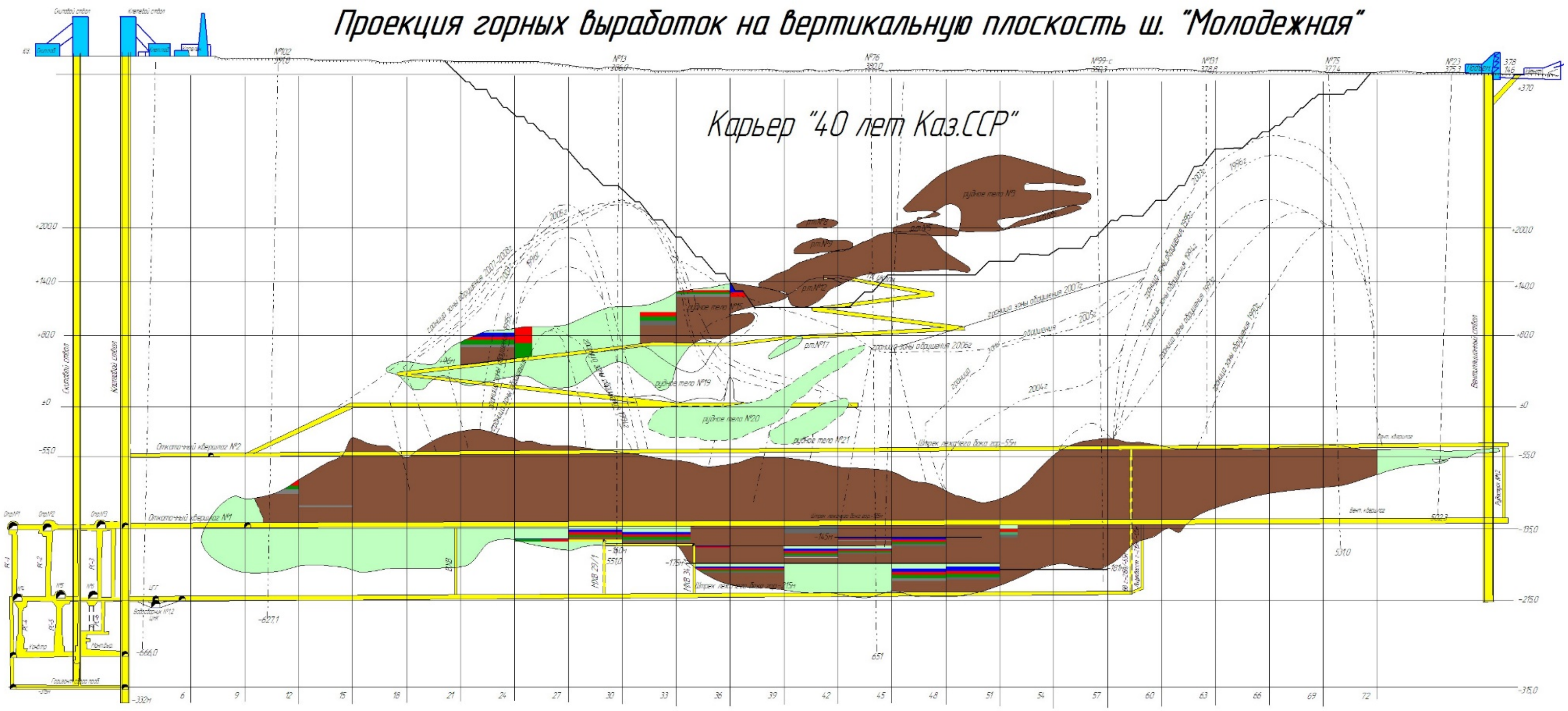


Figure 3-3: Long section of the Molodezhnaya Mine

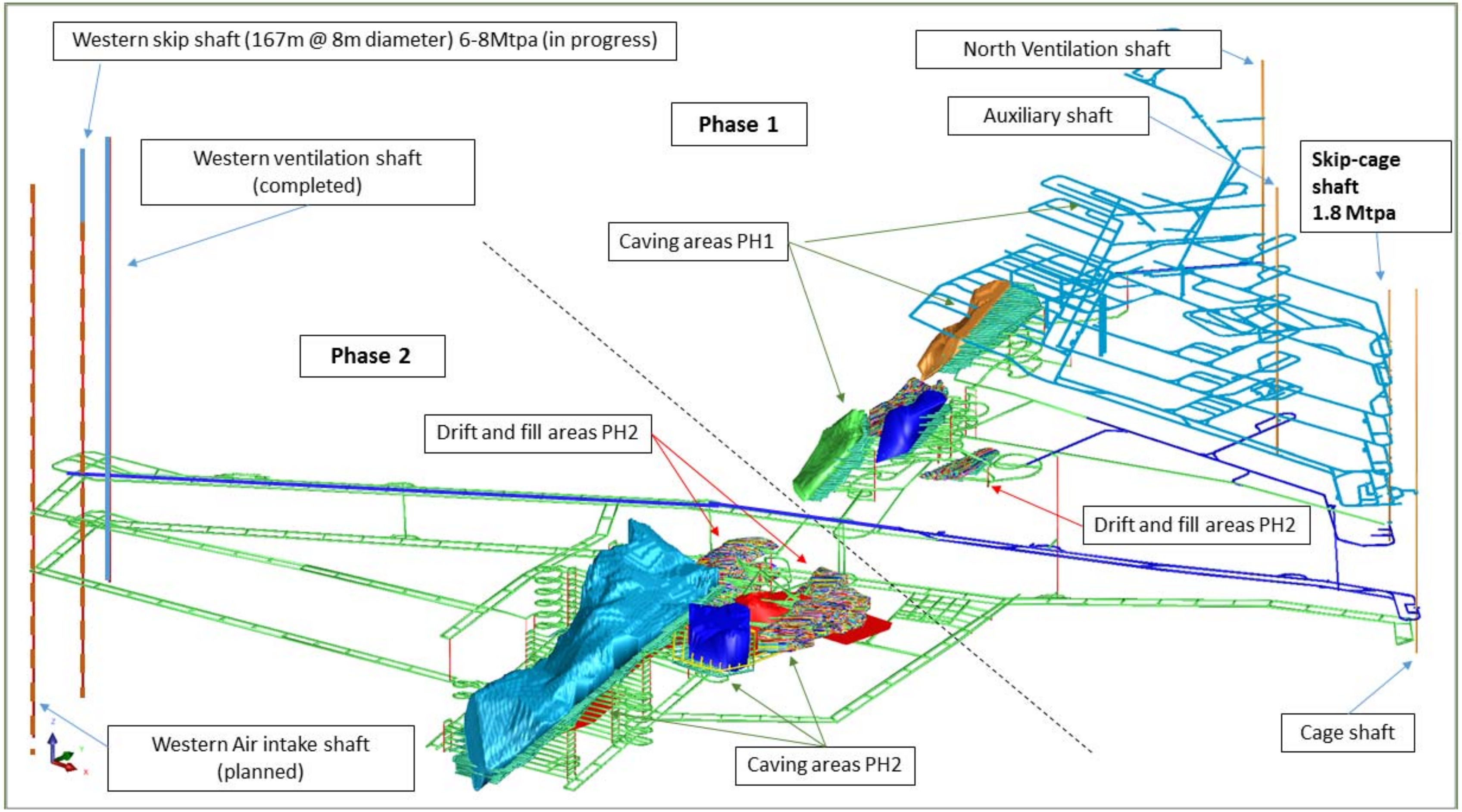


Figure 3-4: Long section of the DNK Mine

3.3 Data Quantity and Quality

3.3.1 Quality Assurance and Quality Control Procedures

An internal Department of Standards is responsible for quality control and monitors quality statistics from the surface stockpiles through beneficiation to saleable products. On a monthly basis, mineralisation grades from each source are reported and these are used to correct grade data gathered by each mining centre, and ultimately the loss and dilution records for each caving block.

The central laboratory operates 24 hours per day, processing 30,000 samples per month. Half of the pulp is kept as a duplicate record and the other half is submitted to chemical assay. Splits of the assay sample are assayed for Cr_2O_3, Fe_2O_3, SiO_2, CaO, MgO and the main deleterious elements, sulphur and phosphorus. As Donskoy is fully ISO 9000 accredited, so is the central laboratory.

There is a five yearly external check on the laboratory, although comparisons with customer assays provide more frequent checks.

3.3.2 Data for Resource Estimation

Over 125 km of surface exploration drilling has been completed, providing a total of 7,780 cored intersections. The diameter of the core was either 93 or 76 mm. The drillholes were surveyed downhole at regular intervals. Significant drillhole deviation was noted in deeper holes. Whilst the core recovery was only 80%, SRK considers that the losses are not material given the massive nature of the mineralisation.

The drill core was sampled at 2 and 5 m intervals depending on the mineralisation type. Little, if any, core was kept for reference purposes.

The grade of the samples was assayed at the Eastern Urals Geological Exploration Mission Laboratory ("EUGEML"). Internal control checks on chromium oxide grades at the laboratory indicated that the error was on average less than 0.7%. External control assays were undertaken at the Central Laboratory of Western Kazakhstan and the results were within 2% relative of the EUGEML results. SRK considers that this difference is not material for the type of mineralisation.

Density and moisture content determinations were undertaken on 23% of the samples and standard formulae have been developed to determine density from Cr_2O_3 grade.

4 DONSKOY MINERAL RESOURCE ESTIMATION

4.1 Tonnage and Grade Estimates

The Donskoy deposits were classified as having a geological complexity rating of 2 according to GKZ standards. This is typically for large and generally continuous deposits. Consequently, C2 is defined by a grid spacing of 80 x 120 m, whilst C1, and B in the central thicker parts of the larger deposits, are defined by a grid spacing of 80 x 60 m.

At the end of the exploration drilling stage, estimates of deposit tonnage and grades were made based on methods stipulated by the GKZ for large podiform chromite deposits. Mine plans and the cut-off grade were developed by appropriate technical institutes. The estimates were checked and adopted by the GKZ and the mineral inventory at each deposit was recorded on the State Balance, categorised by geological confidence. Low-grade and difficult areas to mine, usually at the fringes of the lenses, or otherwise non-viable parts of the deposits were recorded as ‘off-balance’.

The GKZ reserves were estimated from cross-sections. Geological cross-sections were drawn showing drillholes, sample grades, and the interpretation of the geological boundaries and features. Separate outlines were made for very low grade (off-balance), average grade, and high-grade (balance) resources, according to the following GKZ estimation criteria:

- minimum grade for ’off-balance’ resource 10% Cr_2O_3;
- minimum grade for ’balance’ resource 30% Cr_2O_3;
- minimum grade for ’high-grade balance’ resource 45% Cr_2O_3;
- minimum thickness 2.5 m; and
- minimum thickness of ‘off-balance’ or waste interburden 4 m.

The area of each grade category and classification category was calculated on each section and the volume of mineralised material between two sections for each mineralisation type was calculated by multiplying the average of the area of each ore-type for the two sections by the distance between the two sections.

The Cr_2O_3 and other grades of each resource block were determined by taking a length weighted average of the sample values within that block. The tonnage of each resource block was estimated by multiplying the volume by the specific gravity which was based on the Cr_2O_3 grade using a regression formula derived from the Cr_2O_3 grades in the density samples. The density of the mineralised material averages 3.6 t/m^3.

SRK conducted spot checks on the calculations and is satisfied that this approach was applied as described. SRK considers that the density of drilling, given the large and generally continuous nature of the deposits and regular drill pattern, is generally appropriate for defining the mineralisation outline. SRK notes that the deposit outline is only slightly modified by subsequent ’operational planning’ infill drilling results; however, SRK notes that some geological information, such as faulted discontinuities, or other structural breaks, are not well reflected using this method, meaning that the geological continuity is overstated. SRK also considers the grade distribution in each of the outlined parts of the deposit to be reasonably simple, making the use of a length weighted average an acceptable approach to estimating average grades.

4.2 Mineral Resource Classification

In determining how to reclassify the GKZ resource estimates using the guidelines of the JORC Code, SRK assessed the continuity of mineralisation and the data spacing as defined by each of the B, C1, and C2 categories. Having reviewed these areas, although noting that the interpretation overstates the geological continuity at DNK mine, SRK considers the B category in the larger, thicker deposits to be equivalent to Measured Mineral Resources and the C1 category to be equivalent to Indicated Mineral Resources. The C2 category applies to extensions and smaller lenses with very few sample borehole intersections resulting in low confidence estimates, which SRK considers to be appropriate for Inferred Mineral Resources. At Molodezhnaya, the C2 material is classified as Indicated Mineral Resources as the later infill drilling has given confidence to the tonnage and grade estimates.

4.3 GKZ Balance Reserve Estimates

According to the supplied Form 8 statement for Donskoy for 2017, the total GKZ approved Balance Reserves, as of 1 January 2018 are as shown in Table 4-1.

Total resource depletion for 2017 at Donskoy was 4,343 kt with 732 kt losses. This is detailed in Table 4-2.

Table 4-1: Donskoy – GKZ approved Balance Reserves, as of 1 January 2018

Deposit	Category	Tonnes (kt)	Grade (% Cr_2O_3)	Contained Metal (kt Cr_2O_3)
DNK	B	56,061	50.8	28,492
	C1	163,595	50.5	82,589
	C2	90,155	48.7	43,930
Molodezhnaya	B	6,929	51.0	3,534
	C1	285	51.0	145
	C2	2,244	51.0	1,144
Yuzhny	C1	2,523	51.7	1,304
Geophysical VII	C1	245	41.2	101
Zapadny	C1	1,550	43.7	677
Dubersai	C1	321	43.8	141
Total		323,907	50.0	162,057

Table 4-2: Donskoy – Form 8 stated depletions and changes for 2017

Deposit	Category	Extraction (kt)	Losses (kt)	Changes (kt)	Total (kt)
DNK	B	552	95		647
	C1	1,174	221		1,395
	C2				
	Total	**1,727**	**316**	**0**	**2,042**
Molodezhnaya	B	782	165		948
	C1	768	162		930
	C2	349	74		423
	Total	**1,900**	**401**	**0**	**2,301**
Yuzhny	B				
	C1	717	15	1,853	2,585
	C2				
	Total	**717**	**15**	**1,853**	**2,585**
Zapadny	B				
	C1			-513	-513
	C2			-3,382	-3,382
	Total	**0**	**0**	**-3,895**	**-3,895**
Total		**4,343**	**732**	**-2,043**	**3,032**

4.4 Recent and Additional Exploration

ERG has recently completed a surface near mine exploration programme at Dubersai and Zapadny. This has resulted in these deposits being added to the Balance Reserves. In addition to these areas, ERG is currently undertaking a more regional exploration programme. The exploration programme includes drilling in the Geophysical region, which covers an area of approximately 500 km^2, approximately 100 km north of Molodezhnya. Exploration in this area is aiming to test some geophysical anomalies identified during the Soviet era of exploration. All drilling is being completed by contractors, namely Kazgeology, and as at November 2017, approximately 10% of the drilling had been completed. The drilling operations were then on hold, as metallurgical testwork was being finished. If this proves positive, the exploration drilling will continue.

Several deposits had been identified in the first phase of drilling, but these were typically either small, or occasionally larger, but typically low grade. The area was proving prospective for chromite mineralisation, but the deposits being found are thought to be uneconomic, until the metallurgical testwork proves otherwise. The mineralisation identified to date is typically low grade (5 to 17% Cr_2O_3), and at depths of up to 300 m deep, with generally steep dips, and thin morphologies.

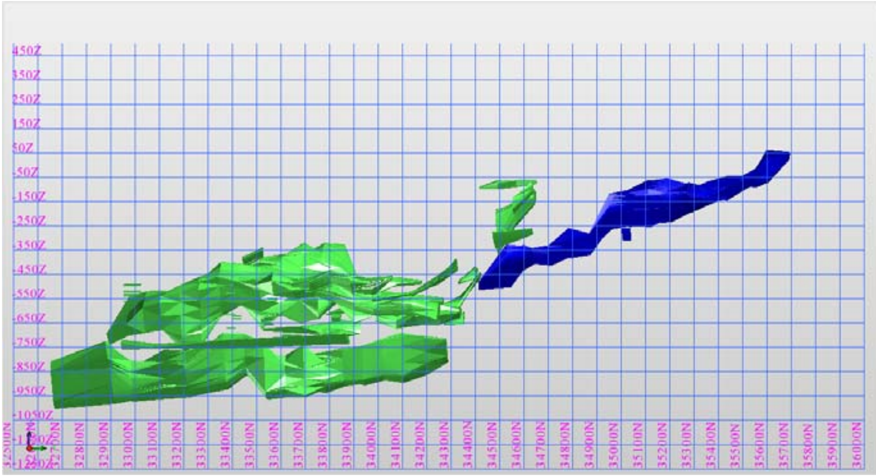
At Geophysical 7, the exploration conducted to date has delineated 245 kt of material, which is classified at C1. The mean grade of the mineralisation is estimated as 41.2% Cr_2O_3. This deposit has been included on the Form 8, and so also in the Mineral Resources. Further deposits in the region, which have not yet been added to the Balance Reserves are June, Geophysical 12, and Geophysical 9. It is anticipated that all exploration will have been completed by 2021. The Company has shown to be successful in both near mine and regional exploration, with new deposits being identified. Exploration success is never guaranteed but Kazchrome looks to be undertaking the necessary size of exploration programme to find the next economic orebody in what is clearly a prospective region.

4.5 SRK Adjustments to generate Mineral Resources

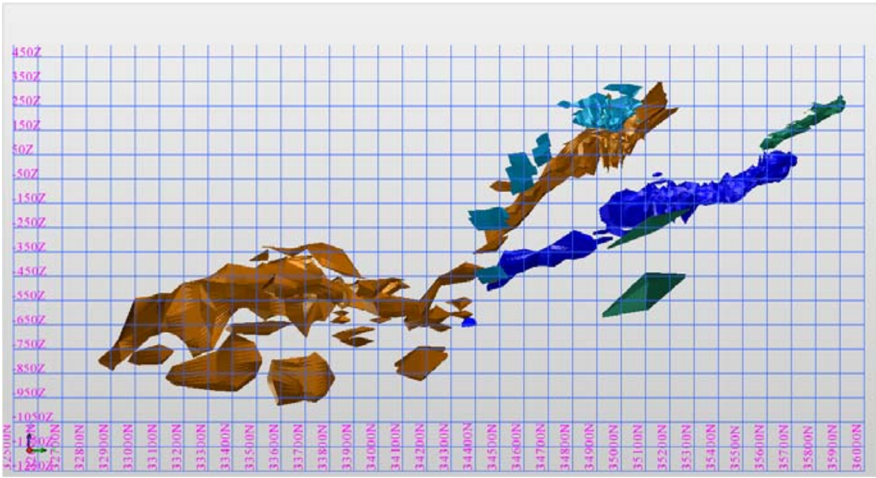
4.5.1 DNK

During the review of the DNK Mineral Resources, SRK has briefly reviewed a 3D geological model as developed by IMC Montan, now part of the DMT Group ("DMT"). The model was produced during 2014, with the reporting dated January 2015. The 3D geological model was based on a digitised version of the database generated during the Soviet era exploration. The geological and grade models produced by DMT were not intended for use in directly estimating and reporting the Mineral Resources.

The DMT wireframes were based on the grade data, with some minor geological interpretation to guide the manual wireframing process. The digitised database only contained grade data. SRK has compared the resultant wireframes to the GKZ estimates. Wireframes of the GKZ outlines were generated by SRK in 2014 as part of a different mandate, and so can be directly compared. The GKZ wireframes are based on the interpreted sections as defined during the exploration phase. A comparison between the geological model produced by DMT, and the GKZ outlines (as digitised by SRK) is given in Figure 4-1.



Wireframes generated from GKZ estimate



Wireframes generated by DMT

Figure 4-1: Comparison of DMT wireframes with digitised GKZ outlines

The GKZ outlines, which formed the basis for the GKZ Balance Reserves, reflect a level of geological and grade continuity which SRK considers to be unlikely to be realistic. The DMT model also has some shortcomings, for example the lack of implicitly modelled geological information (for example, faults) which has been used to derive the 3D wireframes, and the shapes of the wireframes which do not reflect the geology of the deposit. The 3D shapes derived by DMT, however, do reflect some of the faulting and perceived offsets between the mineralised units, which are not included in the GKZ outlines.

SRK considers that the currently declared GKZ Balance Reserves are overstating the in situ tonnage due to the unrealistic assumptions regarding the geological continuity. Due to the errors identified in the DMT database, SRK does not consider that the DMT model is suitable to be used to report Mineral Resources directly. To reflect the strengths and weaknesses of the two models, SRK has used a factoring approach, based on the DMT model, to reduce the tonnages of the GKZ estimate, whilst leaving the grades unchanged.

The tonnage factor was based on a comparison of the volume of DMT wireframes to the volume of the GKZ estimates, on a mining phase basis. The average factors per phase were then applied to the GKZ Balance Reserves, to derive an audited Mineral Resource Statement. SRK considers this a valid approach as SRK acknowledges the quality of the work completed during the derivation of the GKZ estimates, but also cautions that tonnages are probably overstated due to the assumptions of geological continuity.

The factors derived, and applied to the Measured and Indicated Mineral Resources, are stated in Table 4-3. A factor of 0% means no change, whereas 100% means all material is excluded. For Phase 4 (which corresponds to Level -880 and below), a 100% factor has been applied, as SRK considers material at this depth to not meet the requirements for having *"…reasonable prospects for eventual extraction"* as required by the JORC Code. This is because this material lies at significant depths, and it is uncertain whether a suitable mining method exists which would lead to the successful mining of this material.

SRK has applied more optimistic factors to the Inferred Mineral Resources to reflect the uncertainty regarding the geological continuity in the wider spaced drilling areas. These factors are derived from the DMT model, and are included in Table 4-4.

Table 4-3: Tonnage factors for reporting Measured and Indicated Mineral Resources

Deposit	Phase 1	Phase 2	Phase 3	Phase 4
Millionoye	0%	18.8%	-	-
Almaz-Zhemchuzhina	0%	18.8%	31.6%	100.0%
Pervomaiskoye	11.2%	-	-	-
No 21	0%	-	-	-

Table 4-4: Tonnage factors for reporting Inferred Mineral Resources

Deposit	Phase 1	Phase 2	Phase 3	Phase 4
Millionoye	-	-	-	100.0%
Almaz-Zhemchuzhina	0.0%	18.0%	30.0%	100.0%
Pervomaiskoye	-	20.0%	20.0%	100.0%
No 21	0.0%	50.0%	50.0%	-

4.5.2 Molodezhnaya

DMT also produced a 3D model of the Molodezhnaya deposit in 2014, reported in January 2015. The database used also contained errors, but overall, the geological continuity as modelled by DMT generally reflects the current understanding of the deposit. The deposit is less faulted than DNK, and the fault offsets are generally smaller in scale. As such, SRK does not consider that the DMT model for Molodezhnaya is significantly different to the reported GKZ Balance Reserves and so has not made any further adjustments to the tonnages and grades reported as Mineral Resources.

4.5.3 Smaller deposits

No 3D modelling has been completed for the small deposits. To date, the mining of the deposits has not identified any significant geological features which need to be reflected. As such, SRK has not made any adjustments to the tonnages and grades reported as Mineral Resources.

5 DONSKOY MINING

5.1 Introduction

Donskoy operates two underground mines and one open pit mine. The Molodezhnaya underground mine is near the end of its life, with six years of mining remaining. The Yuzhny open pit has around five years of mining remaining. The DNK underground mine has 34 years of mining remaining, according to the LoMp, and consists of the following deposits: Millionoye, Almaz-Zhemchuzhina, Pervomaiskoye, No 21, and Zapadny.

The underground mines currently apply the gravity caving mining method utilising a scraper drive layout and rail transport to the hoisting shafts. DNK and Molodezhnaya are each producing 1.8 Mtpa of ore through their shafts, supplemented by production through declines from surface. The ore streams are split into high-grade (48% Cr_2O_3) and low-grade (36% Cr_2O_3) streams.

The deeper levels of the DNK mine, containing the Almaz-Zhemchuzhina and Millionoye deposits, located between Levels -400 and -640 (800 to 1,040 m below surface), form the largest Mineral Resources at the DNK mine and are planned to be developed in the next several years; these levels are designated as Phase 2. Phase 2 is currently scheduled to start producing ore during 2023 and 2024 for Almaz-Zhemchuzhina and Millionoye, respectively.

ERG plans to transition the DNK mine from a gravity scraper caving operation, currently operating in Phase 1, to a mainly mechanised block caving operation in Phase 2. A pre-feasibility study is underway and an early implementation is planned to be undertaken from Q3 2018, probably located in one of the isolated zones of the Phase 1 orebodies.

In making this change to a new mining method, a programme of drilling to quantify the geotechnical properties of the ore and host rock is planned. The data from this drilling programme, plus experience in the first caving area will confirm the design parameters for the new mining method across the whole operation.

In parallel, the current underground development programme will be aligned with the requirements of the new mining method, which requires different access, reinforcement and equipment.

5.2 Geotechnical Characterisation

Drilling and mapping information containing geotechnical data stored in digital form is essentially non-existent for the Molodezhnaya, Almaz-Zhemchuzhina and Millionoye deposits. Only four geotechnical drillholes at the future shaft locations adjacent to the Almaz-Zhemchuzhina and Millionoye deposits provide meaningful geotechnical information on the host rock.

Ore units and waste rock and have been grouped into four geotechnical domains:

- gabbro-amphibolite;
- above-ore (hanging wall);
- ore zone; and
- under-ore (footwall).

The deposits of the Molodezhnaya and DNK underground mines comprise an altered serpentine rock mass which has been described previously as an "extremely unstable rock mass". More recent analyses by SRK have made use of the intact rock strength (unconfined compressive strength, "UCS") combined with joint characteristics, including frequency, persistence and surface condition, to determine the Rock Mass Rating ("RMR") for these orebodies ranging between 14 and 30 corresponding to Class 5A (Very Poor) and 4B (Poor). When these ratings are adjusted for weathering, orientation, stress, and blasting according to the Mining RMR system, the adjusted MRMR is likely to be in the range 9 -18. This impacts on stand-up times and support requirements.

Empirical relationships have been developed that are used to determine stand-up time and support requirements. The relationship of RMR to stand-up time is shown in Figure 5-1 with the range of RMR assumed for DNK and Molodezhnaya. This shows the limited stand-up time applicable to the orebody and demonstrates why support needs to be installed immediately in ore drive development to avert collapse. The performance here is reflected in development and support practices at Molodezhnaya and DNK underground mines where support (comprising steel arches and in places shuttered concrete) is installed immediately behind development.

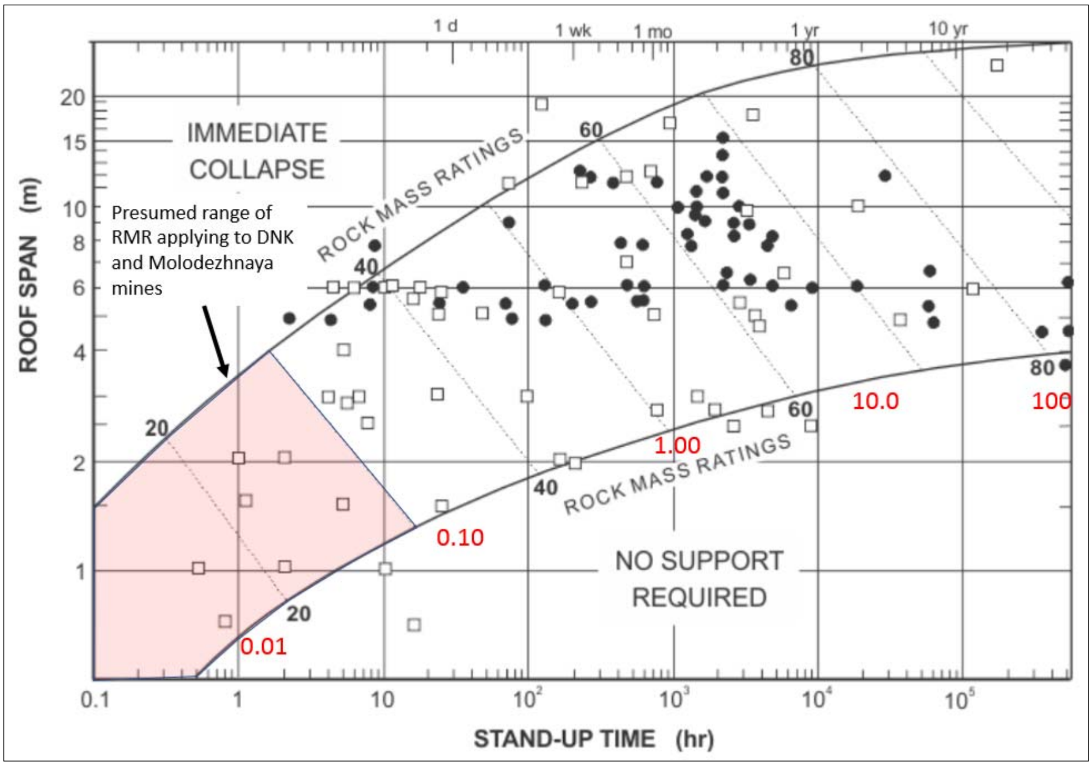


Figure 5-1: RMR Classification of rock masses and KZC orebody (Bienawski, 1989)

Equivalent Q values are also shown in Figure 5-1 (in red) which show that Q-values are likely to be in the range 0.01 – 0.09. This range has been applied in another empirical relationship reported by Barton and the Norwegian Geotechnical Institute (NGI, 2014) for tunnel support. According to this, ore development would require closely spaced (1.0-1.3 m) bolts and Type II reinforced ribs of 12 cm thick shotcrete. This type of support is being installed by Thyssen Schachtbau (albeit in footwall development) to good effect. This approach is akin to the New Austrian Tunnelling Method ("NATM") which is a relatively modern concept of development and support for Kazchrome and is currently only in use by these contractors on Level -480.

The use of active support is now a widespread practice in mining as it mobilises the inherent strength of the rock mass rather than only mobilising support resistances after the rock mass has yielded thereby carrying the deadweight in a strain-softened environment. At DNK however, passive support is installed involving steel sets and it is relatively common practice for closely spaced steel sets to be installed within previously installed sets separated by timber lagging and in extreme cases (where abutment stresses have induced significant displacements) for rehabilitation of de-stressed tunnels to involve systematic stripping of sets and re-installation. This is because mining induced stresses are causing deformation of the rail drives crosscutting the orebodies. This rehabilitation increases operating costs, and the transport of steel arches (deformed and new ones) takes up hoisting capacity in the cage shaft.

A conspicuous feature of the orebody rock mass strength is that it is driven by serpentine alteration and structural damage where the latter degrades the intact rock strength as well as the rock mass strength. Highly fractured zones are present within the orebody and immediate hanging wall and the degree of fracturing has been used in a classification scheme. Wide fault corridors are also present; most notably in the Almaz-Zhemchuzhina deposit. This gives rise to considerable variability.

The immediate footwall domain is of higher rock mass quality than the orebody and hanging wall and this is significant in view of the requirement for the bulk of development to support most methods of mining being positioned in the footwall. In this domain, the UCS of massive serpentenised dunite and peridotite may reach 126 MPa, whereas the ore zone where associated with secondary fractures, may be as low as 6 MPa.

The differing rock mass properties present both challenges and opportunities. It is clear that the orebody is eminently caveable and that gravity caving is viable although the current arrangements are considered to be high cost and low productivity and the mine is recognising that there may be opportunities to improve on both aspects with carefully designed development and appropriate active support. Alternatives under consideration are discussed in Section 5.3.

5.3 Mining Methods

5.3.1 Present Mining Methods

The following mining methods are presently applied at Donskoy:

- open pit mining: Yuzhny (Section 5.3.3);
- caving:
  - gravity caving using scraper drives with rail haulage to hoisting shafts, including gravity caving from intermediate levels: Molodezhnaya (Level -215) and Phase 1 at DNK, consisting of Almaz-Zhemchuzhina, Millionoye, and Zapadny (Section 5.3.4);
  - gravity caving using scraper drives with truck haulage through a decline: No.21 at DNK and “Under-pit resources” at Molodezhnaya (Section 5.3.4); and
- underhand drift and fill mining with truck haulage through a decline: Pervomaiskoye at DNK (Section 5.3.5).

5.3.2 Phase 2 Mining Methods

The Almaz-Zhemchuzhina deposit represents the largest quantum of mineral resources in the mine plan, the bulk of which is located at a depth of 700 m to 960 m below surface. At this depth, the generally poor ground conditions combined with high mining-induced stresses lead to challenging mining conditions. Whilst studies are underway for an alternative mining method, the current mine plan incorporates mining part of the deeper part of the deposit by a form of block caving, which SRK refers to as “reinforced level block caving”. The principle behind this method is described in Section 5.3.6.

In summary, the following mining methods are currently planned to be applied during Phase 2 at DNK to mine the material included in the Ore Reserves:

- drift cut and fill: in the parts of Almaz-Zhemchuzhina underneath and near critical capital access drives; and
- caving: the remainder of Phase 2 is to be mined using the gravity caving method as applied in Phase 1, or by reinforced level block caving. Alternatively, upon the successful outcome of technical studies, mechanised block caving will be implemented. A preliminary description of the mechanised block caving is presented in Section 5.3.7.

5.3.3 Open Pit Mining

Yuzhny open pit is a conventional truck and shovel operation. Ore and waste are blasted and loaded into dump trucks using rope shovels. All of the mining equipment has been sourced from CIS suppliers and is fully maintained by Donskoy’s own maintenance department.

The deposit is mined from 10 m benches, split into sub benches as necessary to maximise recovery of ore and/or minimise dilution. The pits are mined to an overall slope angle of around 42°. Additional resources have led to an extension of the pit bottom, with a low strip ratio of 0.89 t_{waste}/t_{ore}.

5.3.4 Gravity Caving – Phase 1

The underground mining method currently used for the Phase 1 at DNK mine is gravity caving using scraper drives. Footwall and hanging wall drives are connected at intervals of 40 to 60 m by collection or haulage drives. The drives are connected by cross drives at intervals of approximately 40 to 60 m. Scraper drifts are developed from the hanging wall of the cross drives every 12 m. Draw-points approximately 1.8 m wide and 2.2 m deep are developed at 8 m centres along the scraper drift.

The basic underground support system is the three-part, yielding steel arch set. The spacing, capacity and design of the support system for a specific area depend on rock mass conditions and the level of stress anticipated. The Kazakhstan scientific institutes have developed a set of standard underground support design criteria for the country’s mining industry which are based on rock support interaction algorithms. The scientific institutes work in conjunction with mine technical personnel to develop site specific modifying factors for the standard design criteria. The scientific institutes have also developed criteria to assess the position and magnitude of the stress zone ahead of the cave face. Mine support is therefore designed using a combination of these criteria.

The most widely used support system comprises arch sets spaced at intervals of between 0.3 and 0.5 m. Weld mesh is placed between and behind the arches and the void is packed with waste rock blocks to improve support pressures. Double arch support with interspaced timber lagging, shotcrete applied between arches, additional concrete layers up to 0.6 m thick and using heavier steel sections are techniques that are used to increase support capacity where required.

The number of scraper drifts in operation at any time is restricted to control stress distribution and minimise damage caused by abutment stress.

When the base of the orebody lies above an extraction level, intermediate levels are developed to access the orebody. Figure 5-2 shows the layout of the gravity cave in longitudinal and plan view, with the intermediate levels shown in orange.

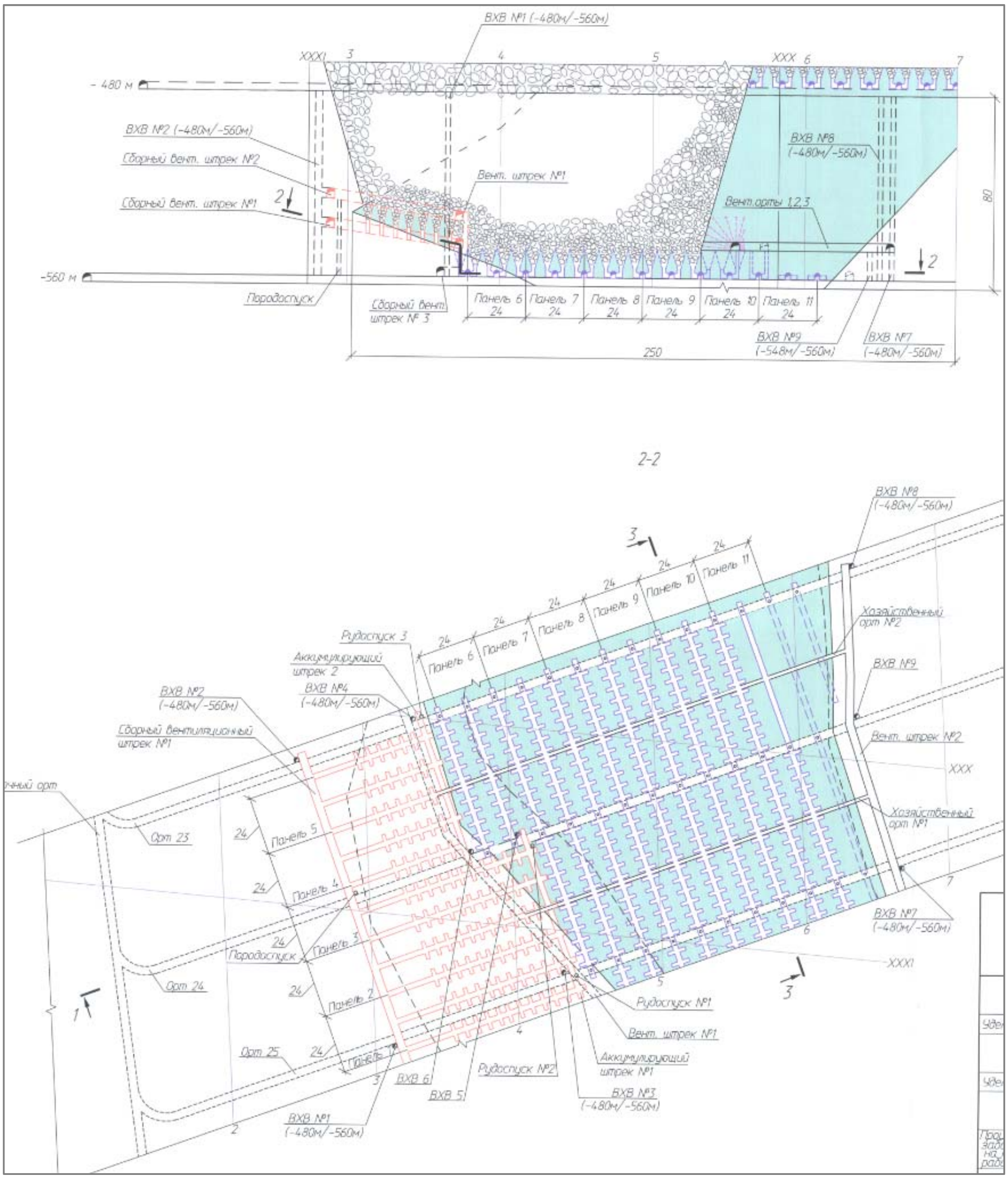


Figure 5-2: Longitudinal and plan views of gravity caving method using scrapers

5.3.5 Drift and Fill

The underhand drift and fill method is planned to be applied in areas where the thickness and morphology is unsuitable for caving, and, more importantly, in those areas located underneath and near capital development, such as the northern part of the Phase 2 resources.

Tunnels are developed within the ore and filled with cemented backfill. Pending the size of the orebody, several tunnels can be developed at the same time. After filling these tunnels, the neighbouring tunnels can be developed. Once the whole level is finished, the next level below is mined underneath the backfill. A schematic is shown in Figure 5-3.

The method has the following advantages: it is very suitable for poor ground, very little subsidence is created, and the dilution and losses are low. The disadvantages are the higher costs and lower productivity.

This method is being trialled at present at Pervomaiskoye, with a tunnel size of 4 by 4 m. The trackless equipment is operated by a mining contractor, who also operates the backfill plant.

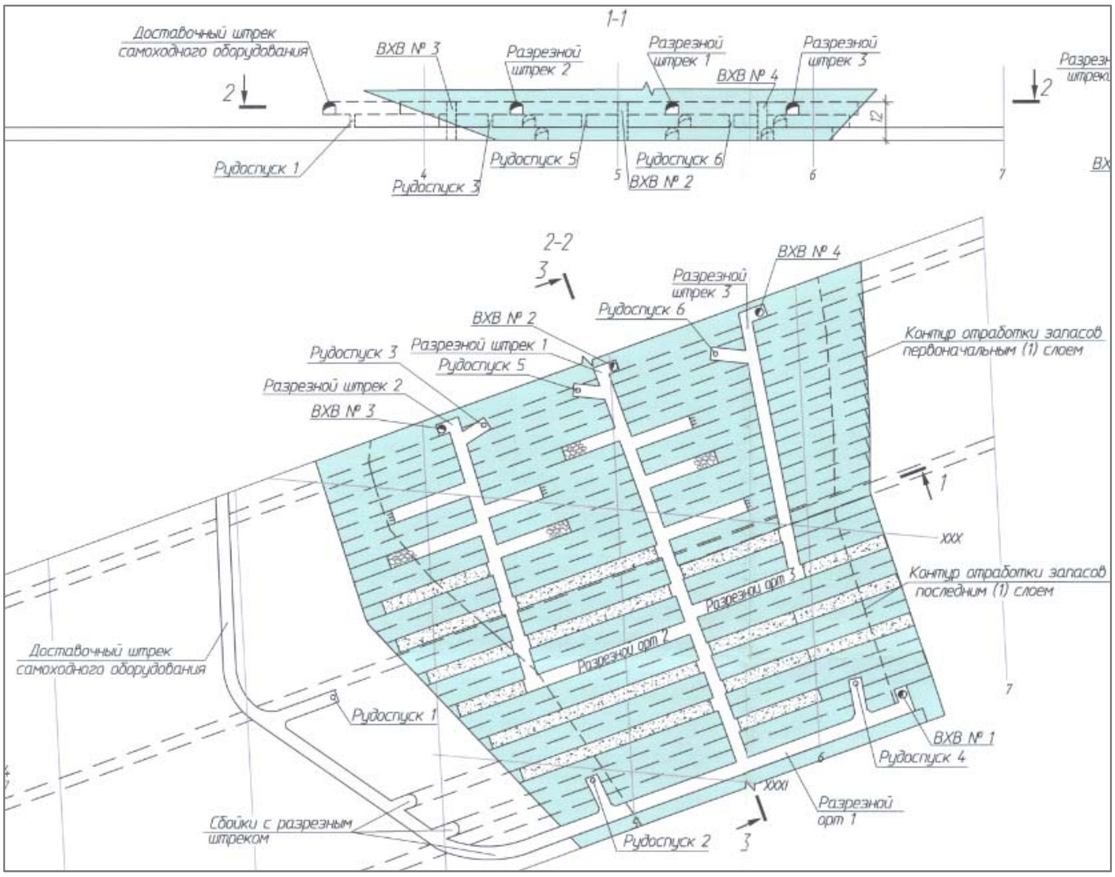


Figure 5-3: Longitudinal and plan views of drift and fill method

5.3.6 Reinforced Level Block Caving

In the reinforced level block caving ("RLBC") method the space between the drawbells is constructed out of concrete and steel. Drives are developed, supported by steel arches, and entirely filled with concrete (Figure 5-4). The space between these solid "beams" is then taken out as the drawbell. This method is supposed to deal with the higher stresses when going deeper and reduce the amount of surface rehabilitation required.

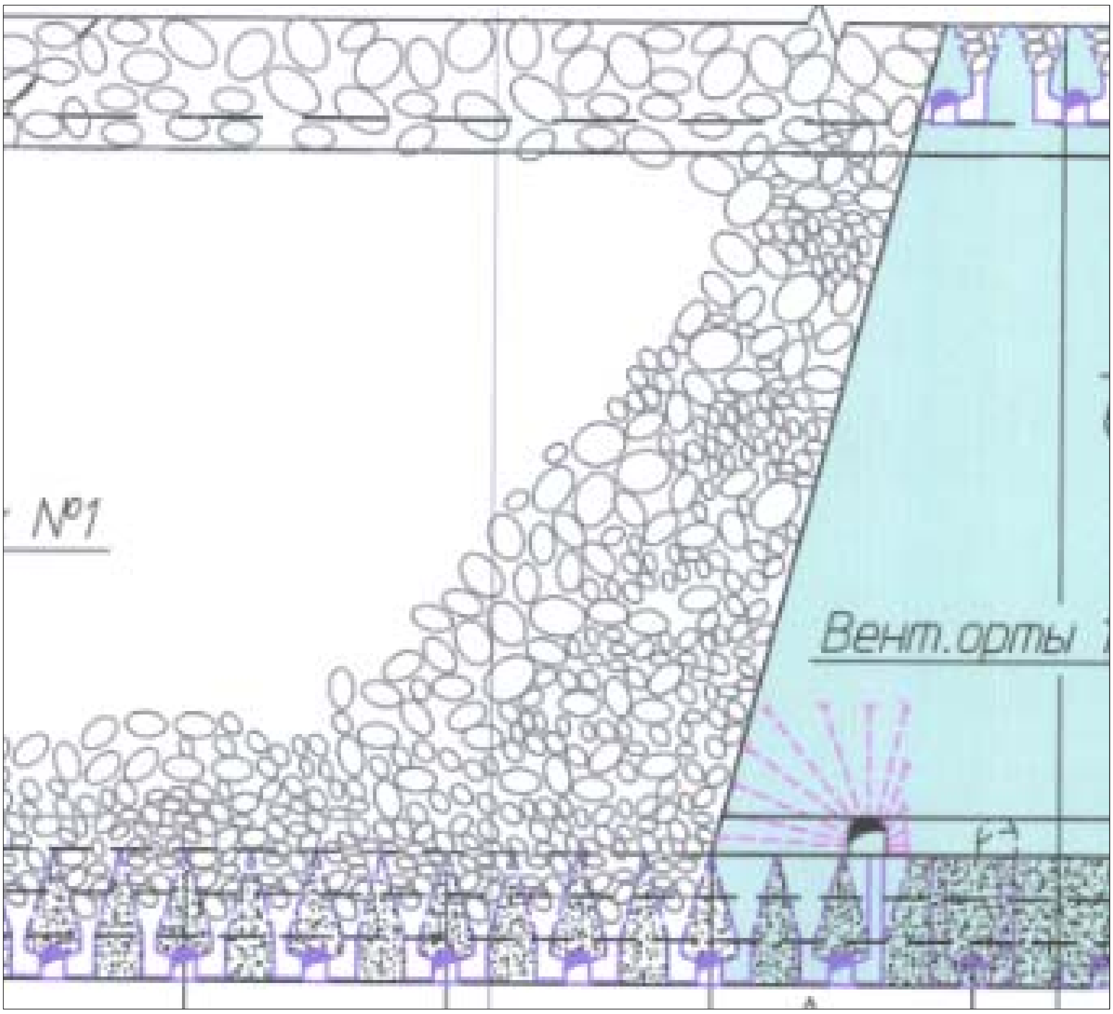


Figure 5-4: Longitudinal detailed view of reinforced level block caving method (concrete level in dark grey).

SRK Comments on RLBC method

There are a number of issues with the RLBC method which intends to create a concrete steel reinforced production level, using drift and fill methods:

- SRK understands that the RLBC method has never been applied on any mine. It was developed by the local mining institute for DNK to deal with the higher in situ stresses of going deeper (1,000-1,250 m below surface) and the swelling effects of the serpentinites within the rock mass. It is meant to reduce/eliminate the need for rehabilitation of the ground support which is presently taking up a lot of time, materials, and personnel efforts in the upper levels. SRK is of the opinion the method is conceptually viable, but the construction requires advanced technical knowledge, and maintaining a stable and sufficient production rate will be difficult.
- The RLBC method is still a manual method, based on scrapers. In effect, it is still a gravity caving method.
- The RLBC target of 4.8 Mtpa is deemed aggressive due to the column height dimensions.
- The success of RLBC would depend on proper application of the New Austrian Tunnelling Method for the access drives.

- The construction and preparation time prior to the commencement of ore mining is long; this, in turn, will have a significant cost implication.

SRK perceives that there is a downside (risk) to the RLBC method, which has led to the use of mobile equipment in the upcoming pre-feasibility study (“PFS”) and a proposed early implementation of the alternative mechanised caving method using mobile equipment.

5.3.7 Mechanised Block Caving

SRK understands that ERG is now planning to implement mechanised block caving at DNK for the Phase 2 resources. A PFS is underway, and early implementation is to be undertaken from Q4 2018, possibly located in the Phase 1 area at Level -240. A new geological model is being developed, incorporating the lithological and structural information available to update the geological wireframes. This will lead to a more reliable mining plan.

The PFS is due be completed at the end of June 2018, after which the design will be updated during a Feasibility Study (“FS”) based on the new geological model. At the same time, geotechnical drilling is to be undertaken to confirm the caving parameters. During the drilling campaign, development of the early caving area is to start.

The main deliverables of the PFS are an evaluation of the present methods for Phase 2, and development designs and schedules and associated production schedules for all mechanised caving areas. Particular attention will be paid to the early caving area and the main area, supplemented by higher level designs and schedules for the smaller orebodies.

The advantages of the mechanised caving method are as follows:

- high productivity, allowing the planned production level at Phase 2 to be reached;
- lower operating cost than the current gravity caving method;
- mechanised block caving is used in more than 30 major underground mines around the world, including operations of Rio Tinto, BHP, Codelco, Freeport and Newcrest, so benchmarking and site visits are possible;
- lower operational risk than the currently proposed reinforced level block caving, which has never been implemented anywhere; and
- the higher block height should allow a reduction in the number of access levels, reducing the development metres compared with the current design.

The disadvantages of a change of this magnitude are:

- new mining method for DNK and external assistance for the implementation and operation will be required in the form of advisors and mining contractors;
- the haulage methods are to change from scrapers and trains to diesel powered loaders and trucks with long distance haulage by conveyors; this is a step change for the operational management;
- the method requires a full implementation of active support methods;
- limited time is available for the implementation; and
- these factors combined mean that the early cave implementation will be a test case for both management, and the applicability of the mechanised caving method.

5.4 Development

Development of main Phase 2 level access is behind plan, which has in past years impacted on achieving planned production levels. The present development is being undertaken by an external contractor, Schachtbau. This contractor implemented active support systems and introduced trackless diesel jumbos. The result was a vast increase in development rate in the long single headings, compared with the application of airlegs and passive support.

Sinking of the Western skip shaft is currently planned to be completed in 2021. This is required for the commencement of Phase 2 production. A new contractor started work in September 2017. Sinking works have already fallen behind schedule as development proceeds through a number of aquifers. Productivity should improve when the shaft bottom advances past these aquifers and proceeds in solid host rock.

The mine capital works continue for Phase 2 production at the deeper levels of DNK, down to the Level -560. Also included in the plans are early capital works for production from the Level -640. The Phase 2 capital development is being undertaken currently and production from the Level -480 is expected to start in 2023.

5.5 Underground Access

Access to the underground mines is primarily via shafts.

The deeper deposits at DNK are currently accessed by two cage shafts, one skip shaft, and one ventilation shaft. Access required for Phase 2 will include a ventilation shaft which has been completed, the skip shaft which is being developed, and construction of a new ventilation intake shaft is still to be commenced. The DNK deposits of Pervomaiskoye and No 21 are being accessed by decline development, which emerges into the old open pit. The maximum hoisting capacity is 2.5 Mtpa, which is to be achieved by increasing the hoisting speed.

The Molodezhnaya mine has access via one skip shaft, one cage shaft and one ventilation shaft. The under pit reserves are accessed via decline from a worked out open pit. The maximum hoisting capacity is 1.8 Mtpa. Donskoy operates at this production rate.

5.6 Materials Handling

Ore is transferred from the scraper drives into wagons. The ore is railed to the shaft, transferred through ore passes via several levels to a central crusher on Level -160, from where it is hoisted to surface. Ore is split into low and high grade at the shaft, based on XRF analysis.

5.7 Ventilation

Ventilation practices are deemed satisfactory at the underground operations. Donskoy reports that they conform to the required national regulations. SRK considers that these are considered strict by international standards.

5.8 Historical Production

The actual production information for each of the main ore sources for the operation over the last five years is presented in Table 5-1.

Table 5-2 shows planned vs actual historical production for the last three years. Production has increased from DNK, as planned; however, it was slightly below budget for 2017. Production at

Molodezhnaya has remained fairly steady.

Table 5-1: Donskoy – Historical Mining Production

Mining	Units	2013	2014	2015	2016	2017
DNK u/g						
Tonnage	(Mt)	1.78	1.77	1.81	2.14	2.38
Grade	(%Cr_2O_3)	38.9	39.6	37.5	38.5	37.3
Molodezhnaya u/g						
Tonnage	(Mt)	2.36	2.30	2.32	2.30	2.38
Grade	(%Cr_2O_3)	40.2	40.9	39.8	40.3	37.1
Yuzhny o/p						
Tonnage	(Mt)	0.34	0.34	0.29	0.33	0.82
Grade	(%Cr_2O_3)	40.8	44.3	43.3	43.9	44.2
Total						
Tonnage	**(Mt)**	**4.48**	**4.41**	**4.42**	**4.77**	**5.59**
Grade	**(%Cr_2O_3)**	**39.7**	**40.6**	**39.1**	**39.7**	**38.2**

Table 5-2: Donskoy – Actual vs Planned Mining Production

Mining	Units	2015			2016			2017		
		Plan	Actual	±	Plan	Actual	±	Plan	Actual	±
DNK u/g										
Tonnage	(Mt)	1.80	1.81	0.6%	2.12	2.14	1.1%	2.50	2.38	-4.7%
Grade	(%Cr_2O_3)	42.2	37.5	-11.1%	39.1	38.5	-1.5%	38.1	37.3	-2.0%
Molodezhnaya u/g										
Tonnage	(Mt)	2.00	2.32	16.0%	2.30	2.30	-	2.30	2.38	3.7%
Grade	(%Cr_2O_3)	40.5	39.8	-1.7%	39.8	40.3	1.3%	37.1	37.1	0.0%
Yuzhny o/p										
Tonnage	(Mt)	0.30	0.29	-3.3%	0.30	0.33	8.7%	0.60	0.82	37.4%
Grade	(%Cr_2O_3)	42.4	43.3	2.2%	42.6	43.9	3.1%	43.3	44.2	2.1%
Total										
Tonnage	**(Mt)**	**4.10**	**4.42**	**7.8%**	**4.72**	**4.77**	**1.0%**	**5.40**	**5.59**	**3.6%**
Grade	**(%Cr_2O_3)**	**41.4**	**39.1**	**-5.5%**	**39.7**	**39.7**	**0.2%**	**38.2**	**38.2**	**0.0%**

5.9 Production Schedule

5.9.1 Cut-off Strategy

The effective reserve cut-off grade is 30% Cr_2O_3 for all deposits. Individual drawpoints are shut off when the grade drops to 15% Cr_2O_3.

5.9.2 Modifying Factors

Table 5-3 presents the modifying (losses and dilution) factors split by mine and deposit and the current mining methods applied. These factors have been determined by the Kazgiprotsvetmet Institute during the mine design. SRK understands that no reconciliation has been undertaken to confirm or update these factors.

Table 5-3: Donskoy – Summary overall modifying factors by method

Mine/Deposit	Method	Losses	Dilution
Molodezhnaya	Gravity caving	17%	19%
DNK Phase 1 and 2	Gravity caving	16%	19%
DNK Phase 2	Drift and fill	4.8%	7.3%
Zapadny	Gravity caving	16%	19%
No 21	Gravity caving	16%	17%
Pervomaiskoye	Drift and fill	4.8%	7.3%
Yuzhny	Open pit	2%	13%

5.9.3 Mining Schedule

Between 2018 and 2023, prior to production from DNK Phase 2, the bulk of the production is formed by Molodezhnaya, DNK Phase 1, Yuzhny open pit, and No.21. With Molodezhnaya and Yuzhny being completed between 2021 and 2024, the total production is lowered to below 4 Mtpa until the DNK Phase 2 production level ramps up. Production from Phase 1 Almaz-Zhemchuzhina is continuing until 2045. The Zapadny area is being occasionally mined at around 200 ktpa.

The drift and fill mining at Pervomaiskoye is reaching the targeted 300 ktpa in 2020, continuing until 2027.

From 2030, all the Donskoy production is sourced from DNK, with the bulk from Phase 2.

The production schedules are shown in Table 5-4 and Figure 5-5.

Table 5-4: Mining Production Schedule

		10 Year Total	LoM Total	2018	2019	2020	2021	2022	2023
Tonnage									
Molodezhnaya	(kt)	**10,120**	**10,120**	2,200	2,200	2,200	1,880	1,210	430
Yuzhny	(kt)	**2,324**	**2,324**	600	600	470	390	264	-
DNK									
Millionoye – Phase 1	(kt)	**11,437**	**13,123**	1,065	940	1,173	1,488	1,480	1,400
Millionoye – Phase 2	(kt)	**1,049**	**8,897**	-	-	-	-	-	-
Almaz-Z – Phase 1	(kt)	**9,755**	**18,129**	812	1,090	1,017	1,050	1,100	920
Almaz-Z – Phase 2	(kt)	**7,951**	**117,796**	-	-	-	-	-	300
Pervomaiskoye	(kt)	**2,647**	**2,647**	215	270	300	300	300	300
No 21	(kt)	**5,032**	**5,418**	700	700	700	700	550	422
Zapadny	(kt)	**1,290**	**1,490**	-	200	140	-	-	50
Total	**(kt)**	**51,606**	**179,946**	**5,592**	**6,000**	**6,000**	**5,808**	**4,904**	**3,822**
Grade									
Molodezhnaya	(% Cr_2O_3)	**40.5**	**40.5**	40.4	40.5	40.5	40.5	40.3	41.2
Yuzhny	(% Cr_2O_3)	**43.2**	**43.2**	43.6	43.8	42.9	42.7	42.2	-
DNK									
Millionoye – Phase 1	(% Cr_2O_3)	**38.1**	**38.2**	38.2	39.5	38.4	38.4	38.3	38.1
Millionoye – Phase 2	(% Cr_2O_3)	**48.1**	**42.7**	-	-	-	-	-	-
Almaz-Z – Phase 1	(% Cr_2O_3)	**40.9**	**41.0**	36.4	39.8	41.1	41.6	41.5	41.4
Almaz-Z – Phase 2	(% Cr_2O_3)	**42.3**	**42.9**	-	-	-	-	-	40.7
Pervomaiskoye	(% Cr_2O_3)	**40.7**	**40.7**	39.4	39.8	41.4	40.9	40.9	40.9
No 21	(% Cr_2O_3)	**38.7**	**38.7**	39.9	38.4	38.2	38.5	38.5	38.9
Zapadny	(% Cr_2O_3)	**35.4**	**35.4**	-	35.7	35.7	-	-	35.2
Total	**(% Cr_2O_3)**	**40.3**	**42.0**	**39.7**	**40.1**	**40.1**	**40.1**	**39.9**	**39.7**

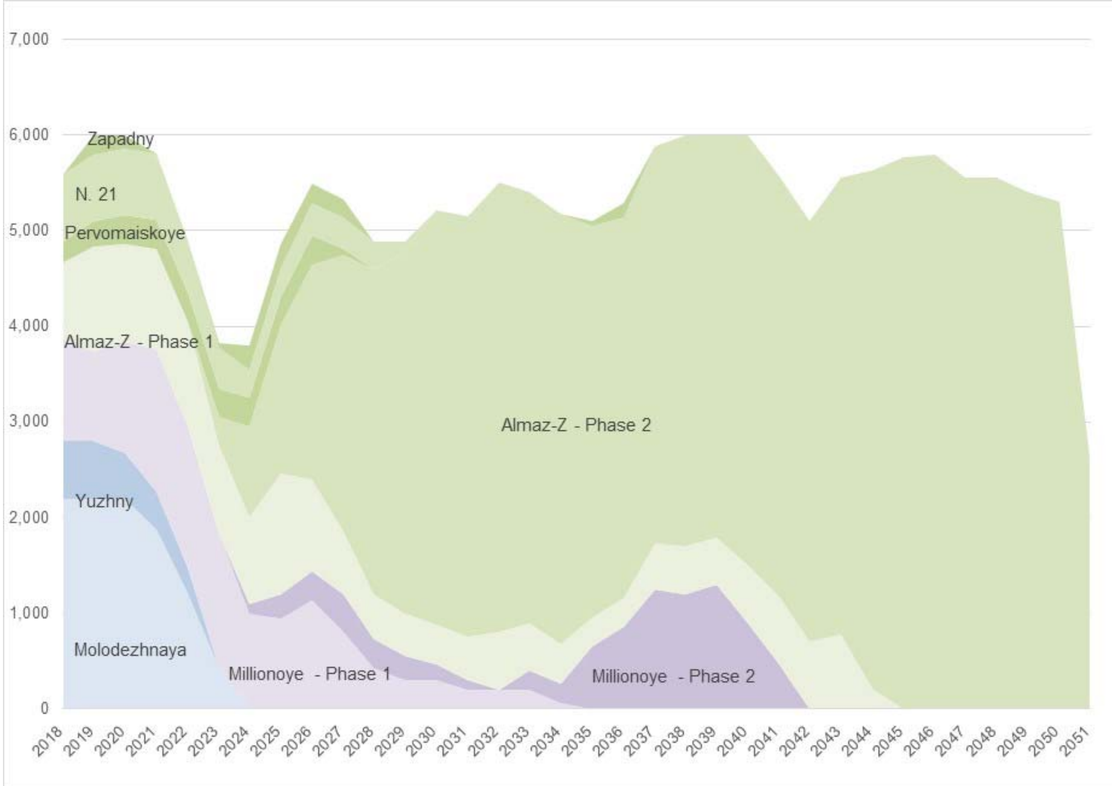


Figure 5-5: Mining Schedule Tonnage (kt)

5.10 SRK Comments on Studies Undertaken and Planned

5.10.1 Reinforced Level Block Caving

The original study on the reinforced level block caving method, which was already completed in 2007, was expanded with a costing section in early 2017.

At present, there is no detailed design available for the RLBC method. It is therefore difficult to assess the risk in this mining method for construction and/or operation at the Level -480 and below. SRK has been informed that a detailed design is being prepared, but details have not been provided as of the delivery date.

5.10.2 Phase 2

The development schedule for Phase 2 has been updated as the sinking of the Western skip shaft was suspended in 2015. A new contractor started development in October 2017, but is already behind on schedule (which is set at 60 m/month) as only 30 m was developed in 4 months due to slow progress through the aquifer layers. There are still 9 aquifers to be encountered during the sinking of the remainder of the shaft (8 aquifers have already been dealt with, of which one was by the new contractor).

SRK understands that the Phase 2 budget is being revised with the updated schedule, capital and operating costs to be available 30 March 2018. At that time, the budget will be updated to account for the latest cost and schedule estimates.

5.10.3 KZ 2.0 Business Improvement Studies

Between July and September 2017, ERG undertook the "KZ 2.0 Concept Study" managed by McKinsey, with input from Hatch, Tenova, Peter Gash, and SRK. The aim was to understand the value available to ERG by increasing the capacity of Kazchrome and the best mechanisms to achieve this capacity growth. This included testing by increasing the mining capacity through new mining methods, and subsequent increases in processing and smelting capacity for which several options were proposed. SRK understands that as a result of this Concept study, two PFS have been initiated, including the Block Caving PFS to increase the robustness of the mining method and schedule in Phase 2.

5.10.4 Operational Improvement Studies - Phase 1

In parallel with the KZ 2.0 Concept Study, a range of operational improvements were identified in H2 2017 by combined ERG and McKinsey teams. The outcomes relevant to mining at DNK Phase 1 are reportedly:

- possible increase of shaft hoisting capacity of the existing skip shaft at DNK from 1.8 to 2.5 Mtpa; and
- possible production increase from the shaft hoisted tonnages at DNK from 1.8 to 2.2 Mtpa.

Some of the actions to be implemented at DNK are:

- improved organisation and schedules for transport of personnel, ore, materials, and tools;
- reduction of production losses in preparation for blasting operations;
- drilling of development headings with two airlegs;
- automation of opening and closing of ventilation doors;
- automation of the skip loading system;
- improving the ventilation of development headings; and
- increasing the speed of the shaft platform handling systems of the delivery of materials and rocks.

SRK considers each action to be appropriate for Kazchrome and the estimate of the capacity increase available to Kazchrome is a fair reflection of the technical potential in mining. ERG has committed to these improvements and the associated capital and operational costs in order to achieve at least 50 Mt of ore production in the first 10 years (2018-2027). SRK sees no significant technical risk in this programme, while the continuing involvement of McKinsey on site is an appropriate approach to managing the change and minimising the organisational risk.

5.10.5 Mechanised Block Caving

A key outcome of the KZ 2.0 process is the possibility of replacing the proposed RLBC method and the current gravity scraper caving by the mechanised block caving in Phase 2. This change in method allows an increase in production capacity, lower costs, and should improve the capability of the mine to deal with the ground conditions and induced stresses.

A PFS is to be undertaken in the first half of 2018 on the implementation of block caving and to determine a design and schedule for a block caving trial ("BCT"). Development of a trial area is to start March 2018; footprint development is to take place from November 2018, with first production tonnes to be produced from June 2019. The trial is to take 18 months after which the evaluation stage will provide confirmation or updates of the block cave design parameters.

5.10.6 Software Implementation

Until 2017, the only software in which mine designs and schedules were created was Geomix. This is a Russian based programme which has limited export capabilities to other mining software. In 2017, ERG acquired licences for Gemcom and PCBC for the modelling of the caving process and Surpac/MineSched for design and scheduling. This is considered by SRK to be a positive development as Kazchrome continues to improve its mine planning and operating practices.

5.10.7 G4 Resource Model Update

SRK understands that ERG is in the process of updating the geological model for DNK. The paper logs from the original drilling programme are still available and have already been partly digitised. This process is being undertaken by Viogem and DMT and the expected delivery is Q3 2018.

SRK has recommended this in previous reports and welcomes this initiative as another development for Kazchrome as it improves performance. SRK recommends that this process is accelerated, but only if it can be achieved without compromising data quality, so that improved information is available for mine planning of Phase 2. Further drilling is planned and the budget approved, as the present drillhole database is based on assay information, while geotechnical information is also required for the mine design parameters. The drilling programme is to be created based on the updated geological model.

ERG is proposing to speed up the process and to undertake drilling during H1 2018, and to create an updated resource model and CPR in the middle of 2018. The objective of this is to not only to increase the confidence in the Mineral Resources, but possibly increase them, as well as ensuring the required information for a change in mining method is available.

5.11 Risks

SRK has identified the following main risks at DNK with the present level of information available, and the present operations and planning systems/workflows and procedures.

No major risks for the Molodezhnaya and Yuzhny mines have been identified.

5.11.1 Geological Model for DNK

The DMT model has certain limitations, such as the lack of implicitly modelled geological information (notably faults), and the quality of the underlying database. The 3D wireframes derived by DMT, however, do reflect the faulting and perceived offsets between the mineralised units, which are not included in the GKZ outlines. As such, the DMT model provides a better reflection of the geological continuity than the GKZ interpretation.

SRK considers that until geological modelling includes fault structures, any geological model will have limitations. This prevents the creation of optimum mine designs and production schedules. SRK believes that the planned work, as discussed in Section 5.10.7, is an appropriate path forward to manage this risk.

5.11.2 Underground development crossing fault structures

Due to the lack of structural data in the geological model, the main Phase 2 haulage drives have been designed in straight lines between the existing shafts and the new shafts in the west of DNK. This has the following consequences:

- The drives cross the main faults between Phase 1 and 2 at a very acute angle. This will require increased ground support over a longer distance than is necessary.
- As the drives are located above and near the Phase 2 resources, parts of these resources will be sterilized unless the drift and fill mining method is used. This will increase costs and lower the production rate.

Both issues would result in increased development time, decreased mining production rate, and increased capital and operating costs relative to the optimum mine design, but they are not considered fatal flaws.

5.11.3 Hydrogeology

The new skip, ventilation, and air-intake shafts are located near a surface water reservoir in a streambed. The shafts cross 17 aquifers, which has slowed down shaft development and increased sinking costs. The impact from Phase 2 mining operations on the aquifers and subsidence zone should be assessed. The reservoir is partly located within the future subsidence zone and will have to be moved. SRK understands that plans and capital cost estimate of USD60m for this relocation exist, and that ERG will provide SRK with an update on the proposed timing relating to this project in 2018.

It is understood that significant groundwater flows occur close to the footwall and hanging wall of orebody contacts. The presence of groundwater within the orebody may result in the development of ‘sticky’ ore, making draw difficult reducing productivity and production rates.

SRK recommends that a hydrogeological model be created, to allow for the estimation of expected water inflows and associated issues which SRK has been able to determine to date. Based on this hydrogeological model, a detailed plan to move the reservoir is to be developed, budgeted and implemented.

5.11.4 Project delays

Delays in shaft and surface infrastructure construction are delaying the start of Phase 2 production and causing indirect financial losses. The reduction in overall production tonnages in the period 2021 to 2025 from previous plans is a direct result of the low development rates on the Level -480 and the slow progress in sinking the Western Skip shaft during the last five years. Attention is required to the current development and sinking rates to prevent further delays in the Phase 2 project. Employing an experienced Underground Development Project Team would help reduce this risk.

5.11.5 Improvements in mining capacity in Phase 1

The increased production at Millionoye and Almaz-Zhemchuzhina Phase 1 is based on the implementation of operational improvements. These are yet to be implemented and must be achieved to increase production from 46.5 Mt to at least 50 Mt over 10 years, as ERG has committed to SRK.

5.11.6 Present Phase 2 methods

SRK considers that the mining methods presently proposed for Phase 2 are associated with the following risks:

- The reinforced level caving mining method is considered highly risky:
  - The design is new and has never been implemented anywhere in the world.
  - No detailed design has yet been created.
  - The level construction is depending on proper application of drift and fill mining. The present level of experience within Kazchrome and associated contractors is low.
  - No trials have been undertaken or are currently planned for the reinforced level caving method.
  - Reinforced level caving is a modified version of the present caving method. As such, Kazchrome has estimated that 64 scraper drives would be required for 4.8 Mtpa. SRK considers this to be unrealistic.

  To mitigate these risks, the Company has made significant commitments to a PFS based on a mechanised mining method, which includes trial mining.

- Part of the Phase 2 resources are to be mined by drift and fill due to the close proximity to present infrastructure. The drift and fill mining trial at Pervomaiskoye is presently not operating at the technical, safety, development rate, and production rate level required for 1.2 Mtpa production rate from the drift and fill method in Phase 2. There are very few global examples of achieving this targeted production rate.

5.12 Recommendations

SRK has the following recommendations for improvements at DNK.

5.12.1 Geotechnical data gathering

SRK understands that, at present, no geotechnical data are being gathered at DNK, which is preventing a well-informed decision on the best way to develop and schedule the Phase 2 resources.

SRK strongly recommends immediate implementation of geotechnical data gathering using the following methods:

- stress measurements to determine the in-situ and mining induced stresses;
- logging of historical core based on hardcopy core photos;
- caving-specific geotechnical logging of any future exploration core;
- face mapping, including estimation of fracture frequency, microdefect intensity, alteration style and intensity; and
- logging of damage zones (bad ground) to determine a correlation with the main faults intersecting and displacing the deposit zones.

These data should be gathered in a geo-referenced database which then can be used to create additional attributes in the geological block model and allow it to be used for geotechnical purposes as well. SRK understands that some but not all of these actions are underway and expects Kazchrome to report on progress as part of the next Competent Persons Report.

5.12.2 Geotechnical monitoring

SRK recommends the following methods of monitoring to be undertaken to determine the effectiveness of ground support of mine development and the way the present cave is propagating.

- ground support monitoring;
- cave monitoring;
- Direct Displacement Measurements (long term stability of development); and
- open hole monitoring.

SRK has had no quantitative data provided on any of these issues and expects that operations would be tracking these issues qualitatively. SRK recommends that quantitative measures be undertaken for each to ensure appropriate risk management.

5.12.3 Numerical modelling

The complexities of developing new mining methods within of a highly variable and generally weak rock mass subject to increasing levels of field and induced stress warrant analysis by means of numerical modelling for which the following approach is recommended.

Develop a large scale linear elastic model

This should be conducted for the life of the proposed mechanised block cave using the Map3D computer software package that will utilise the measured in situ stress values. This should give a good indication of the future stress patterns that can be expected around the mechanised block cave operations and will impact on the undercut and loading levels, which will be used to guide strategies such as advanced, pre- or post-undercutting.

Develop small-scale inelastic model

Whilst potential regions of such damaging stress states can be identified in a linear elastic model, the actual processes of damage and failure cannot be represented in such a model. In order to better understand the rock mass behaviour in response to such damage and failure, more local scale non-linear, inelastic modelling of key areas (such as the extraction level) will be required. This will allow an analysis of damage and should involve the use of FLAC3D once boundary conditions have been ascertained and used as the base boundary loading conditions for the non-linear, inelastic model.

The power of this approach lies in its ability to model scenarios and sequences and to model support which will be key to maintaining serviceability of the extraction level and maximising drawbell stability and drawpoint life.

5.12.4 Design and planning systems

The current mine design and planning systems are based on Geomix software, which does not allow the export of design data into any other software. This leads to a lack of visualisation and immediate feedback on technical and financial consequences of actual versus planned development rates.

SRK understands that ERG is in the process of introducing Surpac (mine design), MineSched (mine scheduling), and PCBC (block caving software). The advantage should be better design and scheduling capabilities for the mining department; however, SRK recommends that this change is combined with an integration between the production and financial planning as well as alignment of personnel capabilities between ERG, Kazchrome, and Donskoy.

6 MINERAL PROCESSING

6.1 Ore Sources and Processing Facilities

Donskoy has two main crushing and beneficiation plants, DOF-1 and FOOR, producing coarse, high grade lump and a number of different sized, slightly lower grade concentrates via beneficiation. The fines beneficiation plants are designated OMK-1 and OMK-2. Two pelletisers, one for each plant, designated UPO-1 and UPO-2, process fine concentrates to produce hard chromite pellets for ongoing treatment in the smelters at Aksu and Aktobe.

High grade and low grade ores are received separately by conveyor from the DNK shaft and by rail cars from the Yuzhny open pit. These ores are fed to DOF-1.

Run of mine (“RoM”) low grade ore is received for processing at FOOR from the Molodezhnaya shaft, the Yuzhnyi open pit, the DNK shaft and minor volumes from historic tailings. High grade ore from the Molodezhnaya underground mine is processed in the FOOR crushing and screening circuit.

Historically, the high grade and low grade plants have processed a combined feed of up to 6.9 Mtpa of high grade ore, low grade ore, stockpiled material and old tailings. Up to 5.2 Mtpa of RoM ore (high grade and low grade) has been processed. The combined plants have the capacity to process higher amounts of RoM.

6.2 Process Description

6.2.1 DOF-1

Coarse, high grade RoM ore, typically 48-50% Cr_2O_3, does not need beneficiation and is crushed and screened to produce -160+10 mm and -10+0 mm final products, typically split 40:60 by mass, respectively.

Lower grade ore, typically 32-36% Cr_2O_3, is crushed to produce different sized concentrates that are shipped to the smelters or used to produce pellets. The coarser separation occurs in DOF-1.

The fines separation occurs in OMK-1 described in Section 6.2.3.

The crushing section of the plant has historically processed in excess of 1.8 Mtpa of combined high grade and low grade ore. Capacity of this section is not seen as an issue at the current level of production. Historically, the DOF-1 dense media plant has processed up to 1.4 Mtpa.

Historically, a small amount of fine concentrate was used to produce briquettes. SRK has been advised that this plant was shut down in 2017, but does not rule out future occasional operation; however, no sustained production is planned. In addition to processing RoM ore, historical tailings are also re-processed. These materials are relatively low grade.

In DOF-1, lower grade ore is crushed and screened at 160 mm and 10 mm to produce two sized fractions. The -160+10 mm coarse fraction is concentrated by heavy media separation ("HMS") using dense media drums and the coarse concentrate, or heavies, is -160+10 mm final product with a grade of 48-49% Cr_2O_3. The light fraction from the HMS is rejects, grading 3 to 5% Cr_2O_3, and is sent to dump.

6.2.2 FOOR

In FOOR, RoM ores can be routed through the high-grade crushing and screening plant or the low-grade FOOR beneficiation plant.

High-grade ore from the mine is crushed and screened at 160 mm and 10 mm to produce two products, -160 +10 mm and -10 +0 mm. Any +160 mm oversize is low grade and is re-crushed and sent for further processing.

Low-grade ore is crushed and screened at 160 mm and 10 mm into two size fractions, -160 +10 mm and -10 +0 mm. The -160 +10 mm fraction is processed by HMS in FOOR by a drum separator and the -160 +10 mm concentrate is final product, typically 47% Cr_2O_3. The HMS rejects, 1.8-5.2% Cr_2O_3, are sent to the tailings dump.

The fines separation occurs in OMK-2 described in Section 6.2.3.

Historically, the FOOR dense media plant has processed almost 2 Mtpa.

6.2.3 OMK-1 and OMK-2 (fines beneficiation)

OMK-1 and OMK-2 treat the -10 mm material removed by the screening prior to treatment of the +10 mm fraction in DOF-1 and DOF-2. The feed for OMK-1 is from DOF-1 feed pre-screening and for OMK-2 from FOOR feed pre-screening. In the metallurgical accounting, both feed streams to OMK-1 and OMK-2 are included in the FOOR feed streams.

Stockpiled fine material is also processed in OMK-1 and OMK-2 using spirals; the concentrate is sent to the pelletiser.

OMK-1

The OMK-1 fines plant is rated at 100 tph or 600 ktpa of feed.

The -10 mm fraction from DOF-1 feed pre-screening is further screened at 3 mm and the -10 +3 mm fraction is concentrated in a number of jigs producing concentrate, middlings and rejects. The concentrate from the jigs is -10 +3 mm final product. The -10 +3 mm rejects from the jigs are sent to dump. The -3 mm screen undersize is further screened at 0.5 mm. The -3 +0.5 mm fraction is classified to remove fines and the coarse solids are processed in additional jigs to produce a -3 +0.5 mm final concentrate product.

The -10 +3 mm middlings and the -3 +0.5 mm jig tailings are combined and milled and then further processed in spiral concentrators together with the -0.5 +0 mm fraction to produce a -0.5 mm spiral concentrate.

The spiral tailings are further processed through centrifugal concentrators to recover fine chromite, and the centrifugal concentrator tailings are deslimed at 20 μm, then classified in a multistage hydrosizer prior to further concentration at defined size fractions on shaking tables. The tailings from the tables and the slimes are discharged to the wet tailings dam. Typically, the tailings grade is 16-19% Cr_2O_3.

The -3+0.5 mm concentrate from the jigs, the -0.5 mm spiral concentrate and the table concentrates are combined and sent to the pelletiser.

OMK-2

The OMK-2 fines plant is rated at 1 Mtpa.

The -10 +0 mm fraction is screened at 2 mm prior to further beneficiation in OMK-2. The - 10 +2 mm fine fraction is deslimed in classifiers and the coarser fraction concentrated in jigs. The jig product is screened at 10 and 5 mm. Relatively small amounts of +10 mm oversize is low grade and is discarded to dump. The -10 +5 mm fraction is final product, typically 46 to 47% Cr_2O_3. The -5 +2 mm jig fraction is used as pellet plant feed. The -2 +0 mm fine fraction is deslimed and upgraded using three stages of spirals. Concentrate from the spirals is dewatered by disc filter and is used as pellet plant feed.

Rejects from the spirals are deslimed by hydrocyclone and then further processed in centrifugal concentrators and any concentrate is also dewatered and sent to the pelletiser.

Historical tailings and externally sourced “ores” are also processed in OMK-2 if excess capacity is available due to insufficient RoM feed. The ore is crushed in a jaw crusher and slurried and screened in a combination of a log washer and trommel screen. The fine material is processed in the three-stage spiral plant.

6.2.4 Pellet Plants (UPO-1 and UPO-2)

The two Outotec pellet plants have similar flowsheets and equipment. Both plants are rated to produce 700 ktpa of dry, 7 to 13 mm pellet product, typically containing 50.5% Cr_2O_3. UPO-1 was commissioned in 2005 and UPO-2 in 2009. Historically, the plants have not operated at the rated performance due to lower than expected equipment availability. Typically, pellet production from each plant has been 500 to 600 ktpa. UPO-1 is associated with DOF-1 and OMK-1 and UPO-2 with FOOR and OMK-2.

In each pelletiser, -10 mm concentrate products from beneficiation are stockpiled separately inside the pelletiser buildings and are blended to achieve the correct feed grade to the pellet preparation area. The blended concentrate is wet milled with around 2% by mass of coke to 80% -71 μm, and dewatered to nominally 10% moisture using five ceramic disc filters. The wet filter cake is mixed with a measured quantity of bentonite clay, typically 0.8% by mass, recycled dust, and recycled, broken green pellets and fed to the balling drum to produce green pellets. Green pellets are screened to 8 to 13 mm to remove fines before feeding to the hot pelletiser. Any fines from pellet screening are recirculated back to the balling drum. The gas fuelled, hot pelletiser incorporates a moving metal grate that passes through a number of different temperature controlled sections. The green pellets are dried, heat treated at around 1,320ºC and then cooled to around 120ºC prior to discharge. Hot gases are recirculated to the drying section to improve thermal efficiency, prior to discharge to atmosphere via off-gas treatment.

The cooled, 7 to 13 mm pellets are transferred to loadout by metal conveyors and the products are transported to Aksu and Aktobe by rail. Most of the products are used internally in the Aksu and Aktobe smelters with minimal external sales.

6.2.5 Ancillary facilities

There are no capacity or reliability issues with the power supply to the plants. There are no water supply issues. All other support facilities are satisfactory to maintain production at the current level.

6.2.6 Historical Production

Production has increased moderately over the last three years as a result of upgrades to the plants. The production statistics for 2015 to 2017 are presented in Table 6-1. The plant feed includes the retreated tailings.

Historically, the overall mass yield of concentrates from low grade ores has been 60% with a metal recovery of 79 to 81%; however, 2017 showed a significant improvement to 85%.

Table 6-1: Donskoy – 3 Year Processing History

Parameter	Units	2015	2016	2017
Plant Feed				
Ore Tonnage	(Mt)	5.86	5.79	5.60
Ore Grade	(%Cr_2O_3)	37.2	37.9	39.4
Recovery				
Cr_2O_3 Recovery	(%)	79.1	81.0	85.2[1)]
Total Product				
Tonnage	(Mt)	3.56	3.67	3.95
Average Grade	(%Cr_2O_3)	48.5	48.5	47.6
Product Split				
Crushed product	(Mt)	1.45	1.58	1.6
Concentrate	(Mt)	1.08	1.16	1.2
Briquettes	(Mt)	0.19	0.19	0.2
Pellets	(Mt)	0.84	0.75	0.9

1) as provided by the Company

6.3 Proposed Plant Modifications

The main plant modification is the currently planned expansion of the final fines treatment plant associated with OMK-1. An additional hydrosizer and shaking tables will be installed to double the overall capacity. This modification will allow all the fine tailings to be processed. The modification is planned for 2018.

6.4 Ongoing Projects

During 2017, Kazchrome implemented an evaluation of mining, beneficiation and pelletiser plants, and the smelters to assess the potential for operational improvements and cost optimisation. This evaluation has included potential improvements in extraction efficiency, potential increases in capacity, and the reduction of the unit cost of production. This work is currently ongoing.

6.5 SRK Summary Comments

Overall, SRK considers that the crushing and beneficiation plants are in a reasonable condition, considering the age of the facilities. A high degree of maintenance is required to maintain operations at the current level. Over the last few years additional or new equipment has been installed to improve the concentrate yield and metal recovery and, consequently, the layout of equipment in some areas is very cramped. The fabric of the buildings is old and in some areas required remedial works, but this does not appear to adversely affect operations at this time.

The two pelletisers are relatively new and the equipment utilised is of a high standard. Alternative grate designs and some modifications to the hot pelletiser section in recent years have improved the overall utilisation of the equipment. Overall, the fabric of the two pelletiser buildings is good.

7 AKTOBE SMELTER

7.1 Introduction

Aktobe Ferroalloy Plant ("AZF") is located in the town of Aktobe. The process site is situated in the industrial estate in the outskirts of Aktobe city and occupies a considerable area of approximately 369 ha. The first furnace was commissioned in 1943 and thereafter frequent additions and changes were made to the plant to produce a wide variety of alloys and metals over its history. The plant presently employs almost 5,000 personnel, including more than 600 contractors.

7.2 Plant details

7.2.1 Utilities

Electric power is supplied from three sources:

- the plant's own Akturbo gas and steam turbine facilities, with an installed capacity of 135 MW (operating at approximately 123-147 MW);
- Aktobe TEC thermoelectric power station, which supplies between 10 and 15 MW; and
- the national power grid, which usually supplies up to 300 MW as the balance of requirements.

In case of problems with on-site power generation or interruption of the supply from Aktobe TEC, electric power can be imported from the local division of the national power grid or from Russia. The plant used to enjoy almost self-sufficiency in electricity supply from its Akturbo gas and steam power generation facility. The capacity of the gas turbine varies between 85 MW (summer) and 110 MW (winter). The steam turbine capacity of 37 MW gives a total capability of 123 to 147 MW. The present plant requirement is about 450 MW, so the remaining electrical requirements are sourced from the other two mentioned sources.

Potable water is supplied to the plant from the plant's own artesian wells (depth of approximately 20 m). The cooling water requirement is pumped from the Ilek River and from local boreholes. Plant process water circulation is about 3,000 m^3/h and about 50 m^3/h is required for make-up.

7.2.2 Furnace Configuration

AZF comprises three production shops and an alloy recovery plant, with associated maintenance workshops, laboratory and other services. The smelting shops consist of the following:

- **Smelting Shop 1**, equipped with seven open submerged-arc furnaces, producing high carbon ferrochrome (HCFeCr). There are also two small pilot-scale furnaces, F39 and F71, that produce intermittently. F71 produces FeSi15 primarily through a melting operation, whilst F39 remelts HCFeCr concentrate. Although they are not physically inside Shop 1, they are administratively included under Shop 1.
- **Smelting Shop 2**, equipped with seven open-arc tiltable furnaces, producing low carbon and medium carbon ferrochrome (LCFeCr and MCFeCr). These furnaces can also produce HCFeCr if required.
- **Smelting Shop 4,** with four closed DC arc furnaces, producing HCFeCr.
- **Alloy recovery plant**, with crushing, screening, and jigging equipment, yielding saleable HCFeCr, metal concentrate (90% alloy) that is remelted in Shop No 1 (F39) and middling (50% ferrochrome, 50% slag) that are recycled to Shop No 2.

A variety of grades per product are produced. The barren slag product only contains 0.3-0.4% alloy and is saleable.

The processes employed in Shops 1 and 2 are all conventional processes used for production of the respective alloys. It is SRK's observation that, within the constraints of the limitations of raw material quality, furnace configuration, and product handling, the operating results are reasonable and within acceptable parameters. It must be noted that the furnace design for the majority of furnaces (open type) is typical for the period that they were installed. These furnaces do not have the benefits of closed furnaces (such as production of CO gas and reduction of hexavalent chromium), but have benefits in terms of accessibility to the furnace interior. Due to the fact that the physical quality of the raw materials is not optimised (excessive fines entering the furnaces), manual rabbling of the furnaces next to the electrodes is still required.

The furnaces in Shops 1 and 2 are of a standard Giprostal design: the hearth insulated with a thick lining of refractory bricks and magnesite as the working lining. The furnace hoods are high and all maintenance on the electrode components has to be carried out inside the furnace. The electrode holder components (especially contact shoes and pressure rings) are poorly protected from flame and hot gas/dust impingement. Water-cooling of these critical components is sub-optimal. The electrodes in Shop 1 use Söderberg electrode paste, whilst the furnaces on Shop 2 use either electrode paste or pre-baked graphite electrodes. The large furnaces in Shop 4 are ultra-modern, utilising the most recent technology for cutting edge direct current ("DC") smelting technology.

7.2.3 Raw material supply

Chrome ore is supplied by Donskoy situated approximately 150 km to the east of Aktobe. The reductants for the smelting of ferro alloys comprise coal, coke, and anthracite supplied by mines in Kazakhstan, Russia, and China. Delivery of chrome ore, coal, coke, quartzite, limestone, and other materials is by means of open railway trucks. Raw materials are offloaded from the trucks into one of two designated storage areas in large centralized buildings. The raw materials are generally reclaimed from the storage areas by means of grab cranes or are offloaded from the sides of the railway trucks.

7.2.4 Product handling

The bulk of the output is produced in Shops 1 and 4. Generally, each one of the two older shops consists of electric ore-smelting furnaces of open type, some of which (the HCFeCr furnaces) are stationary, and some (the LCFeCr and MCFeCr furnaces) are equipped with a furnace tilting mechanism. Shops 1 and 2 are capable of switching from the production of one grade of ferrochrome to another, if required.

The tapping process is conventional and slag and alloy are tapped together from a common taphole into a ladle, with slag overflowing into shallow slag pots. The alloy is tapped by bottom teeming from the tapping ladle into casting billets. The slag pots are removed from the tapping bay by rail and emptied at the slag processing plant. The alloy billets are removed from the tapping bay and transported to the alloy crushing and screening plant by rail.

The slag is processed in the alloy recovery plant by crushing, followed by density separation. The plant produces a saleable product (approximately 15 ktpa), as well as two metal concentrate fractions, which are recycled to Shop 1 (F39) and Shop 2. The alloy is classified in accordance with its composition and crushed and screened, followed by stockpiling in final product bunkers.

In the new Shop 4 (start-up mid-2014) tapping takes place from separate slag and alloy tapholes, which ensures that slag is largely alloy-free and alloy largely slag-free. Each furnace has five tapholes (two for slag, two for alloy, and one emergency draining taphole). In ideal tapping conditions, very little, if any, tapping scrap will be generated and the slag should not require processing to recover alloy. Alloy is tapped directly into casting moulds, which ensures a ladle free operation, whilst slag is tapped into slag ladles.

7.3 Operational Details

7.3.1 Raw materials

The main raw materials used for the different processes are shown in Table 7-1. A number of raw materials are transported over considerable distances, primarily to ensure that speciality products with the required analyses can be produced. This requirement will be substantially simplified when Shop 4 is the only remaining shop in future, which will directly impact on the supply of briquettes and pellets from Donskoy, which will no longer be required.

Table 7-1: Typical raw material analyses

Type	Source	Analysis (%)					
		Cr_2O_3	FeO	SiO_2		P	S
Lumpy ore	Donskoy	45.6	11.5	9.7		0.008	0.020
Pellets	Donskoy	51.1	12.7	8.0		0.003	0.008
Briquettes	Donskoy	48.2	11.9	8.7		0.003	0.018
		Moisture	**Ash**	**Volatiles**	**C**	**P**	**S**
Coke	Russia	16.7	12.9	2.3	~84	0.039	0.600
Coke	China	4.1	12.0	2.3	~85	0.007	0.270
Coke (special)	Shubarkul	18.0	7.9	7.3	~84	0.014	0.270
Coal	Karaganda	5.0	34.2	24.4	~40	0.010	0.420
		Cr		**Si**	**C**	**P**	
FeSi45		35.0		45.0	0.05	0.035	
FeSiCr48	Aksu	31.5		49.5	0.05	0.025	

7.3.2 Process description

Although sections of the plant are at various ages, with the oldest section spanning back to the 1940s, the plant is in a generally good condition. The plant housekeeping is commendable and all operating areas are well laid out for the general plant logistics. The equipment also seems well maintained and few signs of serious deterioration were observed. Regardless, the plant has embarked on an extensive programme of replacing existing assets with modern smelting technology.

The furnace operations are not ideal driven by orebody geology: the furnace feeds contain excessive amounts of fines and the sizing of some ingredients varies over a wide range. This is particularly evident for the chrome ores, which were noted to contain excessively large lumps as well as a considerable proportion of fine material. This is also the case with briquettes from Donskoy, which arrive on site with excessive fines. Donskoy has decommissioned its briquettes production line in 2017. The ore feed quality compares unfavourable with the feed quality at the Aksu Ferroalloy Plant ("AFP"), which reflects in inferior operating efficiencies compared to AFP.

The processes can be summarised as follows:

- HCFeCr: Conventional carbothermic reduction of chromite ores with suitable reductants in submerged arc furnaces in Shop 1. Combined process of remelting of metal concentrate, together with carbothermic reduction of ores and other waste materials in F39. Under particular circumstances, HCFeCr also takes place in Shop 2. In Shop 4, carbothermic reduction of fine chromite ores takes place in large, closed DC furnaces.
- LCFeCr and MCFeCr: Slightly unconventional combined process of ore-lime melting and silicothermic reduction of the ore with FeSiCr and FeSi in open arc AC furnaces in Shop 2. This process has limitations in terms of the final product qualities obtainable. It was previously anticipated that MCFeCr will be produced in future with different technology, but this plan seems to have been postponed. This facility may be established in AFP in future.
- FeSi 15: Primarily a melting process where higher grades of FeSi are melted with steel scrap in a small AC furnace (F71), after which the product is atomised by air in a section of Shop 1. The product is for utilisation in heavy medium separation at Donskoy.

- Cr metal: This plant only operates when required and appears not to have been operated for some time. The process incorporates an aluminothermic process and is situated in Shop 1.

Smelting Shop 4

AZF has made a large investment on the installation of Shop 4, (+USD800m) in cutting edge technology. There were risks for Kazchrome in adopting a leading edge technology, due to a slow learning curve and large costs to render the technology fully functional. Full functionality is critical in order to achieve the competitive benefits inherent to the technology, such as reduced raw material costs, improved metallurgical efficiencies and environmental benefits. It is clear that the learning curve was considerably longer than anticipated and the costs to render the plant fully functional considerably higher. Three years since commissioning, the point of full functionality has not yet been reached, with two more years and another USD65m of capital planned to reach this objective.

Briefly summarised, the core issues with Shop 4 are as follows:

- The complexity and importance of the raw material feed system was underestimated and are causing delays in the ramp up.
- Some serious refractory lining issues (including a furnace breakout) were experienced with the first furnace, to the extent that the furnace had to be taken out of production and rebuilt with a redesigned refractory lining. This caused the delay of the commissioning of the second furnace, together with modifications to its lining to address the issues experienced on the first furnace.
- Gas cleaning plants on the furnaces have some capacity issues which are planned to be resolved in the current capital programme.
- Scheduled maintenance is higher than originally planned, which reduces capacity.
- Off-setting these problems, the thermal efficiency of the furnaces (measured as MWh/t) is better than contracted, so that full capacity does not require the planned 288 MW to achieve the 440 ktpa design capacity.

The chosen technology has proven long-term benefits, but the optimisation process will take additional time and funding. This is common to all new, knife-edge technologies.

For 2018, Shop 4 will be limited to a combined power input of approximately 200-210 MW, compared to the design level of close to 288 MW. This results in a forecast production for 2018 of 330 kt HCFeCr. In the meantime the limiting plant areas are to be redesigned and upgraded. As the benefits of the capital programme come through, the expected increase in performance suggests a result of 400 kt HCFeCr in 2019. The planned performance of 440 ktpa will require both a capital programme and operating improvements. SRK understands that Kazchrome is engaging the Hatch Ferro-Alloys team to help support them in these improvement activities.

In conclusion, from observations made on site and discussions with senior plant personnel, it was positively concluded by SRK that the technology can work as anticipated and that AZF has made significant strides towards this objective. There are no fatal flaws preventing the plant from eventually reaching its design capacity and performance, albeit at the cost of additional capital for corrective measures.

7.3.3 Product range

The technology applied at AZF for LCFeCr and MCFeCr does not allow the production of high quality products. The product range produced at AZF reflects extensive product differentiation. At least four HCFeCr grades are produced in accordance with the C-grade of the product. Further differentiation of the HCFeCr is successfully employed based on the phosphorous (“P”) and sulfur (“S”) contents. The MCFeCr product is differentiated in two grades, based on the C-grade achieved. The LCFeCr product is also differentiated in three grades based on the C-content. This differentiation is commendable and optimises the achievable prices for the products. It should be noted that the products are not special in terms of P content and neither the carbon (“C”) content of the LCFeCr. Whereas the P content is dependent on the reductants used, the C content in the LCFeCr is dependent on the technology utilised. Regarding the latter, SRK notes that the production process utilised in Shop 2 for the production of MCFeCr and LCFeCr is basic and inherently unable to produce high grade products, but the simplicity and low operating cost of the production process compensates to an extent for the product quality. These product differentiation benefits will largely disappear when the plant reaches the sole Shop 4 scenario.

The typical analyses for the different grades produced in 2017 are shown in Table 7-2. SRK notes the following:

- The Cr_2O_3 content in the LCFeCr slag is higher than generally achieved in the two-stage Perrin process used elsewhere. The LCFeCr slag is hazardous and must be disposed of safely.
- The Cr content of the slag from Shop 4 will reduce as the operating practices improve
- The high Cr content in the alloys makes these products superior compared to charge chrome and L/MCFeCr products produced from lower grade ores.

Table 7-2: Product grades

Product	Product Grade	Cr	Si	C	P	S	Fe
HCFeCr	650	68.6	0.6	6.4	0.03	0.017	Balance
	800	69.4	0.5	7.7	0.012	0.034	
	850	69.3	0.6	7.8	0.027	0.033	
	900	69.1	0.6	8.6	0.027	0.029	
MCFeCr	100	70.6	0.6	0.7	0.024	0.003	Balance
	200	70.8	0.4	1.7	0.023	0.004	
LCFeCr	10	71.7	0.6	0.08	0.024	0.002	Balance
	15	71.5	0.6	0.11	0.025	0.002	
	20	70.8	0.8	0.15	0.023	0.002	
FeSi15			83				
Slag Waste product		**Cr_2O_3**	**SiO_2**	**FeO**	**MgO**	**Al_2O_3**	**CaO**
HCFeCr - AC		4.2	28.5	0.8	47.3	18.7	1.1
HCFeCr - Furnace 39		9.6	27.9	1.5	29.4	11.6	20
HCFeCr - DC		5	20.9	1.8	47.5	27.5	1.2
L/MCFeCr		6.1	26.6	1.3	13.5	48.2	48.2

7.3.4 Metallurgical performance

The plant in its historic configuration could be classified as a small to medium sized plant and operating performance was largely standardised for the technology employed. Performance over the last ten years has been consistent and generally acceptable. The performance numbers for AZF are shown in Table 7-3. SRK notes that the increase in 2015 of HCFeCr production is due to the commissioning of the new Shop 4. All four furnaces have been in operation in 2017.

Both Shops 1 and 2 will cease production at the end of 2022. This will impact on the HCFeCr, MCFeCr and LCFeCr production from 2023 onwards. The future will therefore depend largely on successfully reaching full functionality of Shop 4. In line with ceasing operations at Shops 1 and 2, production at the slag recovery plant will cease as the alloy and slag handling at Shop 4 is such that reprocessing would not be required.

Table 7-3: Historical production performance

Production (kt)	2011	2012	2013	2014	2015	2016	2017
HCFeCr (f)	243	255	263	284	300	369	450
HCFeCr (r)	17	15	16	15	15	13	12
MCFeCr	33	29	21	29	29	7	22
LCFeCr	20	16	11	14	30	37	38
FeSi15	1	1	1	1	1	1	1
Total	**314**	**317**	**320**	**335**	**375**	**427**	**524**

7.3.5 Maintenance and furnace rebuilds

The approaches towards conventional rebuilds are different for Shops 1 and 2:

- In terms of Shop 1, the furnaces are handled conventionally with two types of rebuilds in a cycle: a large rebuild incorporating a shell and refractory replacement, followed by a minor rebuild incorporating only partial refractory replacement. The full cycle (large rebuild to large rebuild) varies from 12-18 years, with a minor rebuild done within this cycle period. It should be noted that since 2006 no rebuilds on the furnaces in Shop 1 have been performed due to the anticipated commissioning of Shop 4 and the eventual resulting decommissioning of Shop 1. Furnaces 39 and 71 are refurbished on an ad hoc basis, normally annually on F39 and monthly on F71.
- In Shop 2, the furnaces do not undergo conventional rebuilds. Each furnace undergoes a major capital repair of 15 days annually for HCFeCr and MCFeCr, and every 14 months for LCFeCr. During this stoppage, all the required work is done to render each furnace suitable to operate for the following year.

In terms of the furnaces in Shop 1 (excluding furnaces 39 and 71), the availabilities (91-95%) are reasonable for the type and age of the infrastructure. Given the fact that the downtime associated with rebuilds has been taken out of the downtime schedule, the availabilities are commendable, even though best practice standards normally exceed 97%. Typical reasons for stoppages are scheduled maintenance, electricity supply interruptions, water leaks, and electrical malfunctions.

Shop 2 represents a different operating situation. The furnaces operate in batch mode and stop when tapping or electrode slipping takes place. Furthermore, the availability (93-94%) also includes the annual 15-day stoppage for capital repairs. The maintenance strategy is to stop each furnace for 16 hours of preventative maintenance each month and only to stop for emergency situations thereafter. The outcome of the operating strategy is approximately 8.5% downtime for operational reasons, 2.0% for preventative maintenance, and the annual capital repairs account for the balance of the downtime. It is clear that the operation in Shop 2 is maintenance intensive with low availabilities, which is inherent to this old technology configuration.

No detail on the availability of furnaces on Shop 4 have been made available, due to the developmental and corrective nature of this operation. SRK, however, was informed that:

- An overall availability on furnaces 41-44 of 88.4% was planned. Almost 8% of the downtime will be utilised for scheduled maintenance and 3% for heat-up losses.
- During the scheduled maintenance, the furnaces will be taken out for 10 days in winter to replace the water-cooled collar, to replace the roof centre section, to repair the balance of the roof, tapholes, and the off-take gas duct. During summer, each furnace will be taken out for 7 days for partial repair of the lining of the water-cooled electrode collar, repairs to the roof, and of the tapholes. A further two stoppages of 2.5 days each will take place during the year for repairs to the roof and tapholes. The total downtime for these scheduled maintenance stoppages represents 6%.
- These scheduled maintenance arrangements will utilise half of the 11.6% total downtime, whilst the balance of the downtime will be taken up by the addition of electrodes, inspections and miscellaneous stoppages.
- From the above, it is clear that these furnaces are still in the developmental and corrective phases of the implementation process. Once all the inherent design and operational issues have been addressed, which are planned to take another two years, the furnaces should settle down on availabilities of 92-93%, which are typical for DC furnaces. Until that stage is reached, these furnaces will suffer from high maintenance costs, low efficiencies (such as unit energy consumption) and reduced outputs. If the corrective measures extend past the planned two-year period, this would impact on AZF capacity until such time that the shop reaches its design capacity.

7.4 Forecast performance

The forecast AZF plant performance is fundamentally linked to the major technology decisions already taken and due to be taken in the next few years. The key performance factor is the performance of Shop 4. The production forecast from Shop 4 is as presented in Table 7-4.

Table 7-4: Production forecast for Shop 4

Product	2017 (actual)	2018	2019	2020	2021
HCFeCr Output (kt)	250	329	401	440	399

AZF forecasts that Shop 4 will reach an estimated output of 400 kt in 2019, with full capacity of 440 kt reached in 2020. These forecast figures assume successful completion of the capital programme and improvements in the operations and maintenance of Shop 4. There are plans for all these activities and Kazchrome needs to deliver on these improvement plans.

The forecast for production from Shop 1 and 2 is as presented in Table 7-5.

Table 7-5: Production forecast for Shops 1 and 2

Product	2017 (actual)	2018	2019	2020	2021	2022	2023
HCFeCr (kt)	212	209	212	213	132	132	0
MCFeCr (kt)	22	10	10	11	11	11	0
LCFeCr (kt)	38	48	49	50	49	49	0

This suggests that the phasing out of Shop 1 will commence in 2021 and that both shops will not produce as from 2022. Production of these products is to move to AFP, which is scheduled to produce 54-60 ktpa of MCFeCr from 2023 onwards.

In general, SRK finds the production forecast for 2018 to be readily achievable. The forecast for 2019 and beyond is at risk with projects, teams and capital to manage the improvement and associated risks.

7.5 SRK Summary Comments

The AZF ferroalloy plant is a well-operated plant, consistently producing commendable operating and cost results. The plant housekeeping is generally good, especially for such an old plant. Over a very long period the logistics, processes and practices have been refined and a competent team is ensuring repeatable results. Efficiencies, productivity and product quality are not on industry leading levels, but this is mainly due to the technology employed, which is old and inherently inefficient. Intra-logistically there is room for expanding plant capacity.

AZF has decided to replace the existing technology for alloy production with the world's leading technology and has installed four large DC furnaces in Shop 4 producing HCFeCr. The intention is to cease production in its existing Shop 1 (mainly HCFeCr) and Shop 2 (mainly MCFeCr and LCFeCr) by 2022.

The decision in terms of Shop 4 had technological risk, as more established technologies have been ignored in favour of a technology that has a limited track record and an inherently long and costly learning curve, like most new technologies. Nevertheless, the merits of the technology are obvious and the following substantial benefits would be derived once the technology is fully functional:

- utilisation of non-agglomerated fine ore;
- utilisation of cheaper, fine reductants;
- elimination of burden effects in submerged arc furnaces; and
- superior metallurgical efficiencies.

Results on the Shop 4 furnaces over the past three years have been disappointing. Capacity constraints on the raw material feed system and the furnace off-gas scrubber have been understood ahead of time and projects initiated to resolve during 2018. Full capacity is not expected until 2020, which should be sufficient time to resolve the issues identified.

The key issue regarding Shop 4 is that it would make no sense to abandon the technology at this stage. The technology has been made to work elsewhere (after a long learning curve) and will eventually work at AZF. The technology benefits will then be achieved and the investment will be warranted. SRK has observed good progress by the operating team to overcome all obstacles.

The quality of briquettes from Donskoy is inferior and Donskoy has now ceased their production going forwards, together with replacement of fine ore fractions, would improve efficiencies and output from existing furnaces in Shop 1.

8 AKSU SMELTER

8.1 Introduction

The Aksu Ferroalloy Plant is located 6 km to the north of Aksu town, 45 km to the south of the regional centre Pavlodar and at a distance of approximately 450 km to the east of Astana. Construction of the plant commenced in the 1960s (originally known as Ermakovsky Ferroalloy Plant) and in January 1968 the first melt was carried out at Shop 2. Modernisation of the original furnaces and construction of new furnaces were carried out in 1979 and 1982. The plant presently employs approximately 6,400 personnel.

8.2 Plant details

8.2.1 Utilities

ERG's fully owned JSC Eurasian Energy Corporation ("EEC"), operates the Aksu Power Station, which is the main electricity supplier to AFP. Electricity is supplied by four aerial lines, 6 km and 9 km long respectively, including two 110 kV and two 220 kV lines. There is a 100% redundancy for each of the 110 kV and 220 kV twin lines. In case of a major interruption from the above power station, electricity can be imported from the other power stations in the grid via EEC's transit distribution substation. Water is supplied by the urban water supply system via three water conduits. River water from the Irtysh is used. Water is supplied via two 1,000 m^3 tanks. Consumption of drinking water is rated at a capacity of 250 m^3/h, but the average actual consumption is in the region of 180 m^3/h. Two closed cycles of process cooling water are available at the plant. Water is also used as cooling water at the wet gas scrubbing plants. A water treatment plant is available on site. Clarified water is accumulated in two pools near the ore slurry area.

8.2.2 Furnace configuration

The following principal production units in the metallurgical complex are located on the territory of AFP industrial estate:

- **Smelting Shop 1**, equipped with six semi-closed submerged-arc furnaces, producing ferrosilicomanganese (FeSiMn) and HCFeCr.
- **Smelting Shop 2**, equipped with eight semi-closed submerged-arc furnaces, producing HCFeCr.
- **Smelting Shop 4**, equipped with eight open submerged-arc furnaces, producing ferrosilicochrome (FeSiCr), ferrosilicon (FeSi) and HCFeCr alloys. In future this shop is planned to also produce a refined product, LCFeCr, through a re-ladling process.
- **Smelting Shop 6**, equipped with four larger semi-closed submerged-arc furnaces, producing HCFeCr. Furnace 64 is presently being replaced with an 81 MVA closed submerged arc furnace.
- **Alloy recovery plant**, with crushing and screening-equipment, yielding saleable HCFeCr, a middling (50% HCFeCr and 50% slag) that is remelted in Shop 2 and a saleable

ferrochrome concentrate (90% HCFeCr).

- **Sinter plant**, producing both chrome and manganese sintered product. AFP indicated that from 2018 onwards the sinter plant will only produce chrome sinter.

The processes employed are all conventional processes. It is SRK's observation that, within the constraints of the limitations of raw material quality, furnace configuration and product handling, the operating results are commendable and within acceptable parameters. It must be noted that the furnace design for the majority of furnaces (semi-open type with partially closed roof and open choke feeding adjacent to electrodes) is typical for the geographical area, but not commonly used elsewhere in the world. These furnaces do not have the benefits of closed furnaces (such as production of CO gas and reduction of hexavalent chromium), but have definite benefits compared to open furnaces. Due to the fact that the physical quality of the raw materials is not optimised (excessive fines entering the furnaces), frequent rabbling of the furnaces next to the electrodes is still required, the majority of which is performed manually.

8.2.3 Raw material supply

Chrome ore is supplied by Donskoy situated approximately 1,500 km to the west of Aksu. Manganese ore is supplied from Kazmarganets' Tur mine and Zhairemsky Mining and Dressing plant, both located in Karaganda Region about 750 km to the southwest of Aksu. The reductants for the smelting of ferroalloys comprise coal, coke, and anthracite supplied by mines in Kazakhstan, Russia, and China. The bee-hive type coke plant on site that provided coke internally is no longer operational as it was not deemed financially viable.

Electrode paste is primarily delivered from the Ukraine, but is also produced at a plant near Taraz in the south of the country, but this paste is considered to be of inferior quality. Delivery of chrome and manganese ore, coal, coke, quartzite, limestone and other materials is by means of open railway trucks. Raw materials are offloaded from the trucks into one of two designated storage areas in large centralised buildings. The raw materials are generally reclaimed from the storage areas by means of grab cranes or are offloaded from the sides of the railway trucks.

8.2.4 Product handling

The furnaces are typically tapped three times per shift and the tapholes are opened with a combination of an arcing bar and steel rod. Oxygen lancing is only used in exceptional cases. The alloy is tapped into a refractory lined ladle and the slag overflows into cascading steel moulds. In the case of Shops 1 and 6, the alloy is cast into casting machines, whilst in Shops 2 and 4 the alloy is cast in cast iron moulds. All slag generated in the tapping process, together with the scrap from the ladles, runners, and moulds are transported to the slag processing area. Few plants worldwide have been successful with this casting approach. The extensive utilisation of casting machines for most of AFP's furnaces is commendable. If utilised optimally, this should minimise alloy fines generation and losses associated with tapping ladles. Conversely, if these machines are not operated and maintained effectively, they could become expensive to operate.

The alloy is crushed into saleable size fractions in the final product processing area and the final product is dispatched either in bulk bags or in bulk to various destinations. Alloy is also recovered in the slag processing area (alloy recovery plant) via various processes, but primarily through density separation, into various product qualities ranging from saleable product to metal concentrate that is recycled to the HCFeCr furnaces for re-melting.

8.3 Operational details

8.3.1 Raw materials

Table 8-1 presents an example of the raw materials typically sourced.

Table 8-1: Typical raw material analyses

Type	Source	Analysis							
		Cr_2O_3	FeO	SiO_2	MgO	Al_2O_3	CaO	P	S
Cr ore (lump)	Donskoy	45.6	11.5	9.9				0.002	0.027
Pellets	Donskoy	51.2	12.4	7.6				0.002	0.009
Sinter	Internal	42.5	7.7	18.5				0.003	0.008
Quartzite	Kramds-Kvartsit		0,5	97		1.0			0.02
Dolomite	Local			1.0	20.8		30.4		
Lime	Glushkov						55.7		
		Mn	Fe	SiO_2					
Mn ore	Zhairemsky	41,5	4.4	17.4					
Mn sinter	Internal	35.5	5.8	31.1					
			Ash	Volatiles				P	S
Anthracite	Krasnogosrk, Sibirsk		11	2.5				0.025	0.16
Coke	China; Zarinsky Shubarkol		4.5	5.4				0.017	0.25
Coal	Shubarkol-Komir (ERG)		42.9	30.5					

8.3.2 Process description

Although sections of the plant are at various ages, with the oldest section spanning back to the 1960s, the plant is in a generally good condition. The plant is neat and all operating areas are well laid out for the general plant logistics. The equipment generally seems well maintained and no signs of serious deterioration were observed. It is evident that the plant has embarked on a systematic programme of refurbishment and modernisation.

The plant remains one of the world's largest ferroalloy plants and over the past 20 years its output has steadily increased through expansions and productivity.

The processes can be summarised as follows:

- HCFeCr: Conventional carbothermic reduction of chromite ores with suitable reductants in semi-closed submerged arc furnaces in Shops 1, 2 and 6.
- FeSiMn: Conventional carbothermic reduction of manganese ore with suitable reductants in semi-closed submerged arc furnaces in Shop 1.
- FeSi75: Conventional carbothermic reduction of quartzite (and potentially iron ore) with suitable reductants, together with melting of steel scrap in open submerged arc furnaces Shop 4.
- FeSiCr: Conventional carbothermic reduction of quartzite with suitable reductants, together with melting of HCFeCr in open submerged arc furnaces in Shop 4.

- Sinter plant: Both manganese and chrome ore, together with waste materials and slag to control the melting temperature of the feed, are presently sintered, utilising Russian iron ore sintering technology.
- Alloy recovery: Alloys are recovered from slag and scrap in conventional density and magnetic separation plants to produce saleable and recyclable products.

SRK notes that the recent installation and operation of a sinter plant to handle ore screenings and other fine waste materials is strategically sound. Not only does this allow the plant to operate the furnaces more efficiently, but also provides the opportunity to utilise and recycle waste materials in an environmentally acceptable way. The flexibility of the sinter plant to handle both chrome and manganese feed materials increases its usefulness. The sinter plant is of basic design with limited control instrumentation, but is robust and uses proven Russian technology. The design capacity of the sinter plant is 350 ktpa, with an anticipated allocation of 280 kt of chrome sinter and 70 kt of manganese sinter. It is planned to cease manganese sintering from 2018 due to manganese ore supply constraints.

The AFP focuses on bulk, commodity products rather than refined, speciality products. It generates substantial economy of scale benefits due to the size of the plant and volumes produced.

The smelting shop buildings are of a four-bay configuration, which include the following:

- transformer bay;
- electric furnace bay;
- teeming bay; and
- product cooling bay.

The smelting process of the plant takes place in the 26 submerged arc electric furnaces of 21 to 63 MVA power rating, located in four smelting shops No 1, 2, 4, 6. The total installed power capacity of the plant exceeds 900 MVA. All furnaces are of a cylindrical type with three self-baking Söderberg type electrodes with a system of hydraulic regulation of electrode lowering and rising. The majority of electrodes are hollow to allow the feeding of fine and waste material through the electrodes. These electrodes, like most other components, are manufactured in their own manufacturing workshops. The successful utilisation of hollow electrode feeding is commendable.

Nineteen of AFP's 26 furnaces have semi-closed roofs, and seven are open type with fume hoods. The open roof furnaces are equipped with bag house dust collectors, whilst the remainder are equipped with wet scrubbing systems to clean the process gas. The four furnaces in Shop 1 utilised for producing FeSiMn are equipped with bag filters in addition to wet scrubbers. Process gas is collected and used as heat source to a boiler to generate hot water and steam for the plant.

8.3.3 Product range

A variety of product grades are produced per product, a typical analysis is shown in Table 8-2.

SRK notes:

- There is relatively little monthly variation in the product analyses, which stems from stable ore sources. The product from Shop 6 seems to generally have higher Cr content in the alloy, which could either be due to different ore combination or better efficiency in the larger furnaces.
- The products are standard grades for the particular products, which is different from AZF which is also producing a number of special product grades.
- The high Cr content in the HCFeCr alloys makes these products superior compared to charge chrome and L/MCFeCr products produced elsewhere (for example, South Africa) from lower grade ores.
- The physical appearance of the final products is good.

Table 8-2: Product grades

Products	Cr	Mn	Fe	Si	C	P	S
HCFeCr	69-70		Balance	0.5	7.8-9.2	0.02-0.03	0.02-0.04
FeSiCr	31-36		Balance	43-49	0.04-0.05	0.025	0.02
SiMn		66-67	Balance	16-17	1.5-2.0	0.13-0.15	0.02
FeSi 75				75			
Waste products	**Cr_2O_3**	**MnO**					
HCFeCr slag	4.0-5.3						
FeSiMn slag		11.1-13.					

8.3.4 Metallurgical performance

The actual production performance for AFP is shown in Table 8-3. SRK notes:

- tonnages include recovered product from slag recovery operation as well as HCFeCr product feed to FeSiCr production; and
- FeSiMn production has been reduced from 2014, presumably to allow increased HCFeCr production. This appears part of the strategy to cease FeSiMn production in 2023.

Table 8-3: Historical production performance

Production (kt)	2011	2012	2013	2014	2015	2016	2017
HCFeCr	796	807	833	811	797	841	887
FeSiCr 48	60	71	82	50	31	45	45
FeSiCr 40	65	65	70	50	33	35	50
FeSiMn	180	178	172	175	131	84	77
FeSi 75	0.711	0	0	19	50	38	30
Total	**1,101**	**1,121**	**1,157**	**1,105**	**1,042**	**1,043**	**1,088**

The increase in HCFeCr production over time will come from the renovated Shop 6.

The focus is on the commissioning of F64 during Q4 2018 successfully, evaluate the results, and decide whether the technology concept of large, closed, preheated furnaces should be used for any further future expansion. This assessment process will postpone the timing of any expansion in Shop 6.

8.3.5 Maintenance and furnace rebuilds

The furnaces are all on a schedule of regular rebuilds (general refurbishment), which take place approximately every 8 years. This requires that approximately three furnaces are rebuilt during each financial year. Rebuilds typically comprise the replacement of the furnace refractory lining and in some cases also the furnace shell. The rebuild opportunity is always utilised to refurbish ancillary equipment such as the gas scrubbers, tapping system, and electrode equipment. All rebuilds are planned and executed internally, including the manufacture and construction of all replacement sections. Generally, the equipment used on the furnaces is simple, trusted and functional, rather than state of the art. Extensive standardisation is employed and the furnace groupings have identical designs, which afford substantial synergies in stock holding and simplicity. In some cases, operational performance of particular equipment is sub-standard, but conforms to historic experience and therefore does not seem to concern the plant personnel. An example hereof is the electrode equipment (such as contact shoes), where in-house manufactured equipment of very basic design is used (being cast or rolled copper sections and having a relatively short working life). By using modern, albeit substantially more expensive, equipment, operating performance should improve substantially, with concomitant improvement in furnace output and efficiencies.

Furnace linings are standardised on conventional insulating lining materials.

The furnace maintenance philosophy is based on regular monthly planned maintenance in order to minimise unscheduled maintenance (breakdowns). This philosophy, although maintaining the furnaces in generally good condition, results in furnace availabilities (92-95%) that are regarded as below international benchmarks. Typical targets for furnace availability are 97-98% and it is recommended that a detailed root cause assessment be performed by AFP to establish actions to improve furnace availability. Better availability results in better asset utilisation, higher furnace outputs and lower operating costs, by far the most viable route to expand capacity.

8.4 Forecast performance

The plan for Aksu Shop 6 is to replicate the upgrade that F64 is currently undergoing across the remaining three furnaces over 7-8 years. A decision confirming this approach is expected in early 2019; however, approximately USD40m per furnace rebuild has been included in the capital expenditure programme. The result will be an additional 130 to 140 ktpa of FeCr capacity; 140 ktpa increased capacity when there is no major maintenance on a furnace, and 130 ktpa when one furnace is undergoing a rebuild. The upgraded furnaces will still operate on AC technology as Aksu is well set-up for this type of smelting technology.

8.5 SRK Summary Comments

The Aksu ferroalloy plant is a well-operated plant, consistently producing commendable operating and cost results. The plant housekeeping is generally good, especially for such an old plant. Over a very long period the logistics, processes and practices have been refined and a competent team is ensuring repeatable results. Efficiencies, productivity and product quality are not on industry leading levels, but this is mainly due to the technology employed, which is old and inherently inefficient.

The existing sinter plant enhances the plant’s flexibility to handle screened materials and waste products and would therefore enhance the efficiency of the furnaces and the handling of waste materials. The viability of the sinter plant may depend on the ultimate production configuration at AZF due to the impact on the ore balance.

The decision to expand the plant by expanding production facilities is in the process of implementation at Shop 6. It should, however, also be considered whether the plant has not already reached its optimal size and whether additional pressure on infrastructure and services would not introduce inefficiencies. The most logical option for plant expansion would be the debottlenecking of the existing furnaces. There is substantial scope for debottlenecking, such as improvement in furnace availabilities and improving the physical quality of feed materials (e.g. ore) to the furnaces.

The apparent flexibility to switch products randomly on the furnaces is a large benefit on the plant. Inevitably this implies that the furnace design would not be optimal for a particular product and that certain efficiencies are lost in lieu of flexibility. In particular, appreciable quantities of off-grade material can be produced when switching from Cr alloys to Mn alloys and vice versa. It is, however, foreseen that the benefits of flexibility exceed the limitations on efficiencies and that the ability to switch products will stand AFP in good stead in the market.

There is substantial potential to improve the availability of the furnaces. A ballpark improvement figure of 3 percentage points is regarded as achievable. The impact of such improvement will directly impact on operating capacity and operating cost.

9 KAZMARGANETS

Kazmarganets operates the Tur open pit manganese mine in the Karaganda oblast of Central Kazakhstan, and up until 2013 the Vostochny Kamys mine. The Tur mine is located approximately 370 km west of Karaganda and 190 km north of Zhezkazgan. The Tur deposit was discovered in 1986 with help of regional-scale geophysics. The GKZ resource statement was approved in the 1998 and trial mining started in the same year. All concentrate is sized and transported to Kazchrome’s Aksu ferroalloy plant.

The Vostochny Kamys mine’s resources as reported on the Form 8 were depleted in 2013, and mining operations ceased, see Section 10.6.

9.1 Geology

9.1.1 Regional Geology

The manganese deposits are of synsedimentary-exhalative (“SEDEX”) origin and were deposited in graben valleys formed by tectonic movements. The mineralisation is thought to have occurred during the Devonian and Middle Carboniferous periods. The iron-manganese mineralisation is stratiform and intercalated with limestone. The manganese was concentrated during Mesozoic times by chemical weathering of the limestone. The area was then covered by Tertiary and Quaternary sediments.

9.1.2 Deposit Geology

The manganese deposits at Tur are present in strata-controlled beds, but in sub-horizontal orientation. Two zones containing economically significant grades have been defined across an area of 1,500 by 1,600 m, which are cut by minor faults. The thickness of each of the two zones ranges from 0.5 to 15 m. In some areas, these two zones merge into one where both units can be mined together. Manganese grades for these zones range from 10% to 56% Mn. Bedding in the pit area is slightly undulating with fold amplitude of about 180 m. The principal manganese minerals are pyrolusite, vernadite and psilomelane. Two mineralisation textures have been recognized: hard laminated or bedded mineralisation, and loose earthy mineralisation. High-grade manganese is associated with lower iron grades of less than 5% whilst lower grade manganese is associated with iron grades of up to 10%.

9.1.3 Data Quantity and Quality

Quality Assurance and Quality Control Procedures

All core samples used in grade estimation were sampled and analysed according to GKZ protocols. Core samples are analysed using wet chemistry techniques, initially in approved state laboratories, later also in the mine laboratories. As part of well-established protocols, there are routine internal checks within the mine laboratory that include: analysis of manganese and iron government certified standards; re-assay of pulps; and submission of 5% of pulps to external labs for analysis. QA/QC programmes are under control of the Chief Geologist.

Together with information supplied by the GKZ reports for the respective deposits, SRK concludes that the quality of drillhole information and assays is sufficient for the estimation resources.

Data for Resource Estimation

The Tur deposit has been delineated by 414 cored drillholes, with a total length of 22,914 m, from which approximately 1,870 samples were taken. The deposit is delineated exclusively with vertical drillholes, with the majority of holes drilled to depths of approximately 100 m. Drilling patterns were based on section lines orientated spaced at 200 m with drillhole spacings along the section lines at 100 to 50 m. A second more detailed drillhole spacing pattern consists of section lines spaced from 100 to 70 m apart with drillhole spacing at approximately 50 m along the section lines. The average core recovery in the mineralised intervals was approximately 85%.

9.2 Mineral Resource Estimation

9.2.1 Resource Estimation Technique

Resources are estimated using manual sectional estimation techniques. Mine resources are based on an estimate that was completed by an independent technical institute using data collected by drilling completed by 2002. The most recent resource estimate was approved by GKZ in 2002.

Contours of mineralisation were determined using a 7.5% Mn cut-off grade at Tur, with a minimum thickness of the deposits of 1 m and maximum waste interburden of 2 m.

Material with an iron content greater than 25% is consigned to an ‘‘iron’’ stockpile and is not sent for processing. SRK considers that the cut-off grades used are slightly lower than the current economic cut-off grades.

Computerised geological block models and wireframe outlines have been developed by Kazchrome and a Kazakh consulting group in 2004. This block model is currently used for grade control and for building a detailed model of mineralisation based on new drilling and pit mapping. SRK has not seen any comparison of the kriged resource estimates and the sectional estimates used for reporting to the GKZ.

SRK conducted spot-checks on the calculation of the average grades, density and estimation of tonnage, and overall SRK found the original GKZ calculations to be reliable.

9.2.2 Resource Classification

Resources are classified on the basis of drillhole spacing as per the standard GKZ guidelines for manganese deposits. At Tur, C1 oxide resources are defined by section lines spaced 70 to 100 m apart with drill spacing along each section of 50 m. C2 oxide resources are delineated by section lines spaced 200 m apart, with drill spacing along each sectional line of 100 to 200 m.

SRK reclassified C1 material as Indicated Mineral Resources and C2 material as Inferred Mineral Resources. Specific adjustments were done for iron-rich material and primary manganese resources.

According to the supplied Form 8 statement for Kazmarganets, the total GKZ approved Balance Reserves for Tur, as of 1 January 2018 is as shown in Table 9-1. SRK notes that 260 kt of material are included in the Balance Reserves declaration for Tur-1 (not included under Table 9-1). This material has not been audited for inclusion in the SRK Mineral Resources. In order for these additional Balance Reserves to be declared, SRK would need to review the underlying grade and tonnage estimates.

In addition to the Balance Reserves, off balance material for oxidised iron and manganese mineralisation are declared on the Form 8. These have not been reviewed SRK, and therefore are not included in the Mineral Resource statement.

Table 9-1: Kazmarganets – Tur GKZ approved Balance Reserves, as of 1 January 2018

Category	Tonnage (kt)	Grade (%Mn)	Grade (%Fe)	Contained Metal (kt Mn)	Contained Metal (kt Fe)
C1	1,078	26.1	9.5	282	102
C2	803	22.2	6.3	170	51
Total	**1,881**	**24.0**	**8.1**	**452**	**153**

9.3 Mining

Production continued during 2017 at the Tur open pit at a similar rate of extraction from the previous years.

No blasting is required at the Tur mine due to the soft nature of the mined materials and grade control is visual. The Tur mine requires management of groundwater in the pit through a network of channels excavated prior to mining and a large in-pit pumping capacity.

The actual production information as provided by Kazmarganets is presented in Table 9-2, alongside the life of mine.

Table 9-2: Kazmarganets –Historical and Forecast Production

	RoM Ore (Mt)	Mn Grade (%Mn)	Fe Grade (%Fe)
2015	0.52	27.9	8.4
2016	0.52	29.2	8.8
2017	0.40	27.1	7.8
2018	0.48	24.4	8.9
2019	0.48	24.4	8.9
2020	0.11	24.4	8.9
Total	**1.07**	**24.4**	**8.9**

9.4 Processing

Beneficiation statistics for 2017 are shown in Table 9-3. Concentrates are stockpiled ahead of shipment, and shipments are made according to the specific contract conditions in place, which include size range and Mn grade.

Table 9-3: Kazmarganets – 2017 Beneficiation Statistics – Tur

Dry Screening	Tonnage (kt)	Mn Grade (%)	Fe Grade (%)	Mn Distribution (%)
-150 mm +40 mm Concentrate	102	41.8	4.8	39%
-40 mm +10 mm Middlings	137	30.9	7.5	39%
-10 mm Tailings	125	18.3	10.7	21%
Total	**363**	**29.6**	**7.8**	**100%**

9.5 SRK Mineral Resource and Ore Reserve Statement

SRK notes that apart from a yearly mine production schedule, no future production data have been provided for review, specifically process plant production and cost forecasts.

Overall, the LoMp for the operation is deemed achievable. The profitability of the operation in a 'stand-alone' scenario remains questionable; however, as the operation is fully integrated within Kazchrome's structure, SRK has based the stating of Ore Reserves on the overall economic viability of Kazchrome.

The Mineral Resource and Ore Reserve Statement is shown in Table 9-4, based on the review of the depletions within the Form 8 statements, the historical performance to date, the review of the LoMp and the adjustments made, as described above.

Table 9-4: Kazmarganets – Tur Mineral Resources and Ore Reserves, 1 January 2018

	Tonnage (Mt)	Mn grade (%)	Fe grade (%)		Tonnage (Mt)	Mn grade (%)	Fe grade (%)
Proved Ore Reserves				**Measured Mineral Resources**			
Tur	-	-	-	Tur	-	-	-
Probable Ore Reserves				**Indicated Mineral Resource**			
Tur	1.1	24.4	8.9	Tur	1.1	26.1	9.5
Proved and Probable Ore Reserves				**Measured and Indicated**			
Tur	**1.1**	**24.4**	**8.9**	**Tur**	**1.1**	**26.1**	**9.5**
				Inferred Mineral Resources			
				Tur	0.8	21.2	6.3
				Grand total Mineral Resources			
				Tur	**1.9**	**24.0**	**8.1**

10 ENVIRONMENT, COMMUNITY, H&S, AND PERMITTING

The environmental and social ("E&S") assessment presented in this report is based on review of documents made available by Kazchrome prior to and during the site visits of approximately 1.5 to 2 days each. As such, the focus of the assessment was on environmental or social aspects that have the potential to materially affect the project. Where possible, comment is made on the permitting status of the assets, however SRK's work does not constitute a legal review nor were detailed compliance assessments undertaken to confirm if conditions of approval were being met.

The chapter focuses on the environmental and social requirements of the JORC Code with respect to reporting Ore Reserves, providing the current status on the following aspects:

- studies of potential environmental impacts of the mining and processing operation;
- governmental agreements and approvals relating to environmental matters that are critical to the viability of the project;
- details of mine residue characterisation and the status of approvals for process residue storage and waste dumps;
- agreements with key stakeholders and matters leading to the social licence to operate;
- identification of potential issues of materiality (risks); and
- a summary of recommendations on how these potential material issues can be addressed.

This section commences with a brief overview of the legal framework, comments generally about environment, health and safety ("H&S") and community management by the company and then discusses each of the four assets individually. The section concludes with comments on how the company could improve its adherence to good international industry practice ("GIIP").

10.1 Legal and regulatory framework

The four main pieces of legislation relating to environment, mining, water, and land are summarised below, along with the key permissions required in terms of environmental protection, water use and H&S. Requirements for pollution prevention (air, water, and waste) and closure management are not consolidated in one piece of legislation and multiple authorities are often involved in the controlling mechanisms. Numerous other minor permissions, certificates, or approvals may be required, but SRK has assumed these are in place where required or their lack is not material with respect to the resources and reserves.

10.1.1 Environmental Code

The Environmental Code (Law No 212-III, January 2007, amended 15 June 2017) defines the legal, economic and social aspects of environmental protection. The Committee of Environmental Regulation and Control of the Ministry of Energy is currently the responsible environmental authority.

The Code includes a number of generic requirements applicable to mining projects but these can be superseded by specific requirements within the asset's environmental permits or other legal agreements. Noncompliance may lead to suspension or stoppage of the project.

The Environmental Code defines the procedure of obtaining environmental permits, which is a document certifying environmental emission rights of individuals and legal entities (Article 69 of Environmental Code). Permits must be renewed every one to five years, depending on the type of activity and permit.

The mandatory procedure for obtaining environmental permits is the environmental impact assessment ("EIA" or "OVOS" in Russian) which must be approved by regulatory authorities. An approved OVOS is required for a new project, but also if new technology is introduced, if new facilities are constructed or if existing facilities are altered. There is a requirement for public hearings in the OVOS process.

Estimates of the expected environmental releases and waste likely to be generated by a project are initially submitted with the OVOS, along with the industrial environmental monitoring programme and environmental action plan to enable the necessary permits to be obtained. If the OVOS documentation is no longer applicable, then permit renewal will be based on separate submission documents (projects) such as the Maximum Allowable Discharge Report, Maximum Allowable Air Emission Report, Quantitative Estimates of Waste Generation and Disposal Report. The documents outline source controls, present data on quantities and qualities of releases that have been made historically and predict the quantities and qualities of discharges to be made in future.

The industrial environmental monitoring programme establishes a mandatory list of parameters to be monitored (air, soil, groundwater and other), duration and frequency of the measurements, and instrumental or computational methods used. The environmental action plan provides the costs incurred by the operation for implementation of required environmental protection measures and pollution payments.

The emissions permitting system in Kazakhstan is a "pay-to-pollute" system wherein the developer pays for the 'right' to make emissions to the environment in accordance with the permit. There are also maximum allowable concentrations ("MACs" or sanitary norms) that apply on the boundary of sanitary protection zones ("SPZ") around hazardous facilities. Permit fees are paid annually. Fees for standard emissions are paid based on fixed rates, while multipliers are applied to fees for releases in excess of the permit limits or sanitary norms.

Environmental reports must be regularly submitted to regulating authorities as specified in the permit. If the required documentation is not submitted this may lead to fines.

10.1.2 Land Code

The Land Code (Law No 442 II ZPK, 2003, amended 11 July 2017) enables land to be given designated uses. The Code requires owners/users of land, whether state or privately owned, not to harm public health or the environment, not to pollute the land or cause deterioration in soil fertility, to conserve topsoil and to rehabilitate disturbed land. The Land Code allows for state appropriation of land for "public needs" (which may include mineral exploration/exploitation). It also includes the legal procedure for changing land use. Managing land is the responsibility of the Committee for Land Management of the Ministry of Agriculture of the Republic of Kazakhstan.

10.1.3 Water Use Code

The Water Use Code (Law No 481, 2003, amended 11 July 2017) describes the general procedure for water protection activities, including payments for water use and protection of waters from pollution and depletion. As with the Environment Code, the Water Use Code stipulates a permit must be obtained for water abstraction, industrial (and mining) water use and the discharge of effluents (referred to as “special water uses”). The permitting, monitoring and reporting process is as described for the Environment Code and is the responsibility of the Committee of Environmental Regulation and Control of the Ministry of Energy.

10.1.4 Subsoil and Subsoil Use Law

Mining is regulated by the Subsoil and Subsoil Use Law (No291-IV 24 June 2010, amended 11 July 2017). It identifies the types of subsoil use (mining), the procedure for granting land for subsoil use, and lists the subsoil use regulatory and oversight bodies. Depending on the category of minerals, there are three competent authorities; the Ministry of Investment and Development (solid minerals), Ministry of Energy (oil, gas, coal and uranium) and regional akimats (local authorities) (sand and clay). The Ministry of Investment and Development also supervises the mining industry through its sub-ordinate Committee on Geology and Subsoil Use (the Geology Committee). Permission to mine is by means of a Subsoil Use Contract, with a limited validity period. At the end of this period, a new contract must be arranged or the site must be handed back to the Government.

Mining contracts in Kazakh Republic generally contain requirements related to environmental and social aspects. Usually, these are general statements about the need to meet legislative norms; however, a licence may contain requirements specific to a contracted deposit including:

- annual payments for the social and economic development of the region and its infrastructure (amount varies depending on contract);
- annual investments into education of employees that are citizens of Republic of Kazakhstan, generally in the order of 1% of annual operating expenses (OPEX);
- annual financing of research and development works of Kazakhstan producers of not less than 1% of annual income;
- annual payments to the liquidation fund (amount varies depending on contract).

10.1.5 Specific requirements for closure

Legislation relating to closure and rehabilitation can be found in all of the following:

- The Subsoil and Subsoil Use Law (Law No 291-IV, 24 June 2010, amended 11 July 2017) and associated Rules for Mine Closure and Conservation (Rule No 634 06 June 2011);
- Environmental Code (Law No 212-III, January 2007, amended 15 June 2017);
- Instruction for land reclamation projects development (Instruction No 57-P, 02 April 2009, amended 17 April 2015);
- The Land Code (Law No 442 II ZPK, 20 June 2003, amended 11 July 2017);
- The Water Code (Law No 481, 09 July 2003, amended 11 July 2017); and
- The Forest Code (Law No 477-II 08 July 2003, amended 15 June 2017).

Closure in a Kazakhstan context relates to: a) liquidation or conservation (temporary closure) of the site, which involves making the site safe and handing it back to the government; and b) reclamation of land affected by mining operations (pollution remediation and re-vegetation). These are treated separately in terms of the law.

According to Article 111 of the Subsoil and Subsoil Use Law, mines and associated auxiliary facilities must be closed when mineral resources are depleted or have their remaining ore bodies 'conserved' when mining operations are terminated (for example, when the contract has expired). This must be carried out in accordance with project design documentation and a government-approved liquidation (closure) plan designed by an authorized engineering company.

As shown in Figure 10-1, reclamation activities may be included in the closure plan, or may be provided for in the environmental action plan.

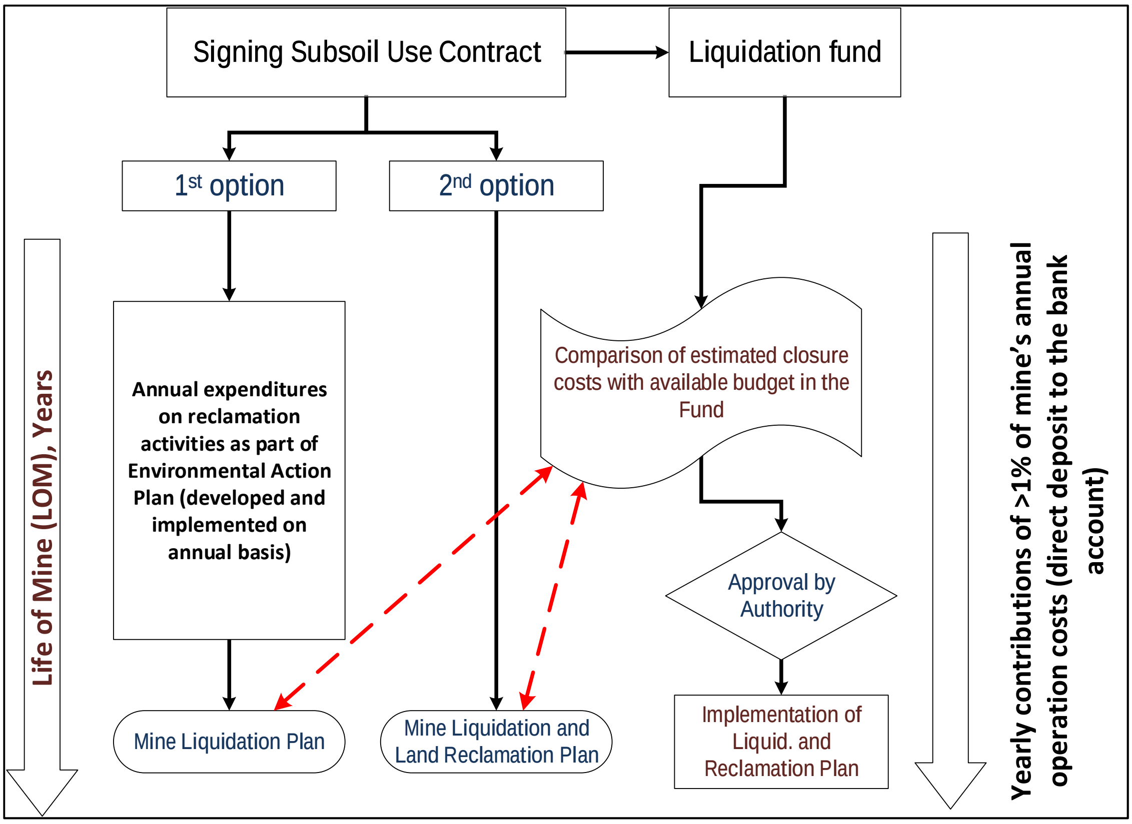


Figure 10-1: Schematic diagram for mine closure and reclamation process in Kazakhstan

Closure or conservation work is considered complete after approval by a committee of competent authorities in the fields of: environmental protection; mineral resources management; industrial safety; sanitary-epidemiological service; land management services; and local authority. A certificate of acceptance of closure or conservation work will be issued by the Environmental Protection Authority.

Mine closure or conservation activities are funded from a liquidation fund, with contributions made by the mine operator according to the subsoil use contract. The mine operator can use the funds for its closure activities with the permission of the competent authority. If the actual closure cost exceeds the fund's savings the mining operator must cover the remaining costs.

10.1.6 Health and safety

H&S in Kazakhstan are regulated by the Constitution[1], Labour Code[2] and Law on Civil Protection[3].

The Constitution of the Republic of Kazakhstan is the basis of national labour legislation. It defines an individual's right to work, choice of occupation, employment conditions (working hours, entitlement to breaks during work and vacation allowance). Forced labour is allowed only as a result of a court decision or in the case of an emergency or during martial law. Working conditions must be in accordance with the national labour legislation and payment must be provided without any discrimination.

The *Labour Code* regulates labour relations and other relations directly related to labour, aimed at protecting the rights and interests of the parties to labour relations, establishing minimum guarantees of rights and freedoms in the world of work.

The *Law on Civil Protection regulates* fire safety and industrial safety, and also defines the main tasks and organizational principles for the construction and operation of the civil defence of the Republic of Kazakhstan.

10.1.7 Status of permits, fees and penalties

Table 10-1 summarises SRK's understanding of the key permissions containing controls relevant to environment and water management. The validity period is given. Where no end date is provided, it is assumed the permit is valid until agreed otherwise with the authorities.

Table 10-2 provides a summary of the pollution payments and environmental penalties imposed on the Kazchrome assets from 2014 to 2017.

SRK notes that this does not constitute a legal audit and the details are provided for information and are based on what was provided by Kazchrome at the time of the SRK review.

[1] The Constitution of the Republic of Kazakhstan (adopted at the republican referendum on August 30, 1995) (with amendments and additions as of March 10, 2017).

[2] The Labour Code of the Republic of Kazakhstan of November 23, 2015 No. 414-V (as amended and supplemented as of June 13, 2017).

[3] Law of the Republic of Kazakhstan of April 11, 2014 No. 188-V "On Civil Protection" (as amended and supplemented as of June 13, 2017).

Table 10-1: SRK's understanding of current Kazchrome environmental and water permits

Asset	Site	Type of permit	Permit #	Issuing authority and legislation	Period of validity
Kazchrome (corporate)	Kazchrome residence	Environment permit (for emissions)	#KZ70VDD00048879	Akimat of Aktobe District. Department of Natural Resources and Environmental Management of Aktyubinsk Oblast	From 20/01/2016
Donskoy GOK	Main mine site	Environment permit (for emissions)	#KZ09VCZ00077053	Ministry of Energy. Committee for Environmental Regulation, Control and State Inspection in the Oil and Gas Sector	From 29/12/2015 to 31/12/2017 (expired, no update provided)
	Main mine site	Environment permit (for emissions)	#KZ87MCЯ00142094	Ministry of Energy. Committee for Environmental Regulation and Control	From 09/06/2017 to 08/11/2018
	Main mine site	Water use permit for process water supply	#KZ75VTE00000394	Committee on Water Resources of the Ministry of Agriculture of the Republic of Kazakhstan. Republican State Enterprise "Zhaiik Caspian basin inspection for regulation of water resources use and protection"	From 12/08/2016 to 31/12/2021
	Kairaktinskoye groundwater deposit	Contract for groundwater intake for potable water supply	#490 dated 23/06/2000	Investments Agency of the Republic of Kazakhstan At present, the competent authority of Investment and Development Ministry of the Republic of Kazakhstan	To 20/06/2026
	Donskoy uchastok groundwater intake	Contract for groundwater intake for potable water supply	#489 dated 23/06/2000	Investments Agency of the Republic of Kazakhstan At present, the competent authority of Investment and Development Ministry of the Republic of Kazakhstan	To 20/06/2039
	Mugodzhary summer camp	Special permit for water use for potable water supply	RK#17-13-04-23/091 dated 11/11/2014	Committee on Water Resources of the Ministry of Agriculture of the Republic of Kazakhstan. Republican State Enterprise "Zhaiik Caspian basin inspection for regulation of water resources use and protection"	From 01/01/2015 to 31/12/2019
Aktobe Ferroalloys Plant	Main smelter site	Environment permit (for emissions)	#KZ19VCZ00077067	Ministry of Energy	From 01/01/2016 to 31/12/2018
	Sholoksay-South pit	Environment permit (for emissions)	#KZ75VDD00049274	Akimat of Aktobe District. Department of Natural Resources and Environmental Management of Aktyubinsk Oblast	From 27/01/2016 to 31/12/2018
	Main smelter site	Contract for ground water intake Licence GKI#10108	#394 dated 21/12/1999	Ministry of Investment and Development	To 08/12/2025
	Main smelter site	Additional Agreement to the above contract for groundwater intake	#1385	Ministry of Energy and Kazakhstan Mineral Resources Ministry	From 14/04/2004 to 08/12/2025
	Main smelter site	Contract for river water abstraction from the Ilek River "Actubvodchoz"	#13/36	Republican State Enterprise "Kazvodkhoz"	From 03/02/2016 to 31/12/2018
Aksu Plant	Main smelter site	Environment permit (for emissions)	#KZ59VCZ00118542	Ministry of Energy. Committee for Environmental Regulation and Control	From 01/01/2017 to 31/12/2019

Asset	Site	Type of permit	Permit #	Issuing authority and legislation	Period of validity
	Socio-cultural development	Environment permit (for emissions)	#KZ66VDD00063986	Akimat of Pavlodar District. Department of Subsoil Use, Environment and Water Resources of Pavlodar District	From 09/12/2016
	Update to ash-sludge storage	Environment permit (for emissions)	#KZ80VCZ00142317	Ministry of Energy. Environmental Department of Pavlodar District	From 05/07/2017 to 31/12/2017 (expired, no update provided)
	Multi-family accommodation	Environment permit (for emissions)	#KZ39MBB00064375	Akimat of Pavlodar District. Department of Subsoil Use, Environment and Water Resources of Pavlodar District	From 14/12/2016
	Main smelter site	Special water use permit	No 03-15/ПВЛ-187 Серия Ертіс	Ministry of Agriculture of the Republic of Kazakhstan RSO Ertis Basin Inspection for Regulation of Use and Protection of Water Resources of the Committee on Water Resources	From 01.01.2016 to 31.12.2018
Kazmarganets	Tur mine	Environment permit (for emissions)	KZ32VCZ00133190	Ministry of Energy of the Republic of Kazakhstan; Department of Ecology in the Karaganda Region of Committee for Environmental Regulation and Control	From 01/01/2017 to 31/12/2018
	Reclamation and liquidation at Tur mine	Environment permit (for emissions)	KZ67VDD00060379	Department of Ecology in the Karaganda Region of Committee for Environmental Regulation and Control	From 01/01/2017 to 31/12/2022
	Point of shipment of finished product at the station Kyzyl-Zhar	Environment permit (for emissions)	KZ93VCZ00126272	Ministry of Energy of the Republic of Kazakhstan; Department of Ecology in the Karaganda Region of Committee for Environmental Regulation and Control	From 01/01/2017 to 31/12/2019
	Kazmarganets mine administration office	Environment permit (for emissions)	KZ31VDD00070048	Department of Natural Resources and Regulation of Natural Use of the Karaganda Region	Issue date: 31.03.2017
	Reconstruction of canteen at Tur Mine	Environment permit (for emissions)	KZ95VDD00052503	Department of Natural Resources and Regulation of Natural Use of the Karaganda Region	Issue date: 07.04.2016
	Reconstruction of the washing plant at Tur mine	Environment permit (for emissions)	KZ45VDD00079787	Department of Natural Resources and Regulation of Natural Use of the Karaganda Region	Issue date:02.11.2017
	Tur mine	Special water use – abstraction for drinking and domestic use	KZ81VTZ00000428 Серия Нура	Ministry of Agriculture of the Republic of Kazakhstan RSO Nura-Sarysu Basin Inspection for Regulation of Use and Protection of Water Resources of the Committee on Water Resources	From 17.06.2016 to 06.06.2019
	Tur mine	Special water use – discharge of the industrial, domestic, and drainage waste water – discharge of water from dewatering wells	No 19-11-4-11/1099 Серия Нура	Ministry of Agriculture of the Republic of Kazakhstan RSO Nura-Sarysu Basin Inspection for Regulation of Use and Protection of Water Resources of the Committee on Water Resources	From 11.09.2015 to 31.12.2017 (expired, no update provided)
	Tur mine	Special water use – discharge of the industrial, domestic, and drainage waste water – discharge of clarified water from the settling pond	No 19-11-4-13/1567 Серия Нура	Ministry of Agriculture of the Republic of Kazakhstan RSO Nura-Sarysu Basin Inspection for Regulation of Use and Protection of Water Resources of the Committee on Water Resources	From 15.12.2015 to 31.12.2017 (expired, no update provided)

Table 10-2: Summary table of environmental payments

Asset	Year	Emission fees (pollution payment) (KZTk)			Environmental penalties (KZTk)		
		Fees for emissions within agreed emission limits	Fees for emissions in excess of emission limits	Total environmental fees	Fines for environmental damage	Fines for administrative violations	Total penalties
Donskoy GOK	2014	111,877	15,100	126,977	21,125	39,875	61,000
	2015	140,392	2,651	143,043	0	0	0
	2016	167,056	103,212	167,159	10,028	8,048	18,076
	2017	no data	no data	no data	0	0	0
Aktobe	2014	147,646	0	147,646	0	0	0
	2015	126,082	0	126,082	0	0	0
	2016	238,556	628	239,184	1,303	1,352	2,655
	2017	no data	no data	no data	8,739	14,356	23,095
Aksu	2014	1,021,769	7,767	1,029,536	117,926	38,774	156,701
	2015	818,133	84	818,217	6,724	84	6,808
	2016	547,562	1,630	547,562	2,406	1,470	3,876
	2017	no data	no data	no data	1,955	1,952	3,908
Kazmarganets	2014	75,123	7259	82,382	8,185	4,055	12,240
	2015	66,650	5	66,655	0	0	0
	2016	47,981	4	47,991	7,539	90	7,629
	2017	no data	no data	no data	0	0	0

10.2 General management

This section provides the general approach to E&S and H&S management undertaken by Kazchrome across its assets. If there are exceptions to the management approach summarised below, this is identified in the asset-specific sections below.

10.2.1 Management systems

The asset has integrated management systems for environmental (ISO 14001), occupational health and safety management (OHSAS 18001), quality control (ISO 9001), and energy management ISO 50001). Donskoy first obtained certification in 2002 (9000) and 2003 (14000). From 2004 the certification was maintained at a corporate level with OHSAS added in 2004 and energy in 2015. The certificates are issued by TÜV Thüringen, an international certification company with the last audit done in June 2017. As of June they have certifications for the updated 14000:2015 and 9000:2015, and by the end of 2018 they are preparing for the new ISO 45001 (replaces OSHAS 18001).

The corporate H&S manager indicated that responsibility for H&S lies with workers and their line management, with the corporate team providing support, training and guidance. There is a tiered internal audit system covering environment, health and safety. The first level is with the 'masters' (the workers) with one check at the start of each shift (results are recorded in a log). The second level is by the head of department or workshop and is once per day. The third level is an audit by the chief engineer or head specialist, which is once per week.

In addition to this system, the H&S department undertakes internal audits several times per month with a schedule to cover the different working areas. About once a month there is an internal audit by a management representative and possibly by a corporate Kazchrome H&S representative. There may also be several audits by ERG personnel. Once a year there is a full audit at the corporate level that includes H&S and environmental specialists.

The aim of these audits is to identify potential problems on an ongoing basis before the state inspections. If there are non-compliances notifications are given to undertake remedial work. Audit information is stored in an electronic database and tracked to monitor when closed out. Monthly there is a report with the number of non-compliances classified by type and where they have occurred.

The environmental management at all the assets is focused solely on legal compliance. Much of the environmental staff time is spent on obtaining and maintaining environmental approvals, gathering the stipulated monitoring data and dealing with state inspections from the relevant regulators. Environmental action plans are prepared on a regular basis as agreed with the regulators (generally annually) that indicate what activities the Company will take during the period and how much budget has been allocated. Compliance with the action plans, permit requirements and relevant statutory norms has to be reported to regulatory authorities on a regular basis (generally quarterly but can be annually), with the reports having to be approved by the relevant regulators.

Annually the corporate EMS Report is prepared. It includes the main overall results of environmental efficiency for every business unit: environmental payments and fines, achievement of planned targets, analysis of identified non-conformities (Table 10-3), summary of monitoring and control results, summary data of air emissions, discharges and waste generation, etc.

10.2.2 Health and safety statistics

As input to ERG's sustainability reporting, H&S statistics for each asset are collated on an annual basis by Kazchrome in accordance with the LA7 requirements of the Global Reporting Initiative. A summary of key statistics for fatalities and lost time injuries ("LTI") is given in Table 10-4. The fatalities reported are only those related to reportable production deaths and not death caused by non-work related or natural causes while on the work premises. SRK understands first aid injuries, medical injuries, equipment damage and near misses are also recorded (an example of the data from Donskoy was provided).

Table 10-3: Internal environmental audit results (2015-2017), number of non-compliances[1)]

Type of audit	Aktobe			Aksu			Donskoy GOK			Kazmarganets		
	2015	2016	2017	2015	2016	2017	2015	2016	2017	2015	2016	2017
Internal audit of the business unit	1	1	0	368	384	309	4	9	178[2)]	0	0	1
Internal audit (Kazchrome corporate level)	9	6	3	8	4	9	14	8	-0	3	0	1
External certification audit	0	-	0	-	2	0	0	-	2	-	0	0
Environmental state inspections	0	6	6	1	4	4	1	8	0	-	1	0

1) "-" sign means that audit has not been undertaken this year
2) No explanation for this steep increase in non-compliances has been provided

Table 10-4: Fatalities and LTIs (excludes subsidiary companies)

Asset	Direct employee or contractor	2015		2016		2017	
		Fatality	LTI	Fatality	LTI	Fatality	LTI
Donskoy GOK	Employee	1	8	1	11	0	10
	Contractor	0	2	0	0	1	1
Kazmarganets	Employee	0	4	0	0	0	2
	Contractor	0	0	0	0	0	0
Aktobe	Employee	0	1	0	1	0	2
	Contractor	0	0	0	0	0	0
Aksu	Employee	0	5	1	11	0	4
	Contractor	0	1	0	1	0	4
Totals	**Employee**	**1**	**18**	**2**	**23**	**0**	**18**
	Contractor	**0**	**3**	**0**	**1**	**1**	**5**

The presence of any fatalities is of concern though a slight improvement since 2014 is apparent. Although some of the LTI numbers above are quite high, the lost time injury frequency rate ("LTIFR") across Kazchrome (including contractors) ranges from 1.05 in 2014, 0.62 in 2015, to 0.61 in 2016 (2017 not provided at time of writing), which is relatively low when compared to industry norms. This is because the LTIFR is based on the LTI per 1,000,000 people hours and the projects are fairly labour intensive with high people hours.

Some observations across the assets regarding H&S performance observed during the course of the site visits are included below:

- inductions were mandatory for all visitors;
- housekeeping appears to have improved since the previous SRK visits in 2014;
- there was a strict requirement to wear personal protective equipment in the form of safety glasses, dusk masks, protective clothing and safety boots and staff were observed wearing the equipment where it was required;
- it was noticed that there was a lack of hearing protection being used around some of the noisy furnace equipment;
- it is questionable whether the simple dust masks used are adequate in all areas to manage dust inhalation (a specific issue where dusts may contain hexavalent chromium ("Cr(VI)") or workers are exposed to ultrafine manganese (Mn) bearing dusts and carcinogenic coal tar pitch volatiles); and
- although most vehicles were provided with seatbelts and these were stipulated as compulsory, SRK observed that these were not worn consistently by staff.

10.2.3 Stakeholder engagement

There is no formal stakeholder engagement undertaken by the Company or its assets other than those required by law, specifically the public hearings required whenever an OVOS is undertaken.

The public hearings should theoretically be arranged by the local environmental authority, but they are arranged by the Company (or the technical institute appointed to undertake the OVOS) under the auspices of the authority.

There are two types of public hearings:

- Public hearings in the form of open meetings. Invitations to the meetings are sent out to key stakeholders and adverts are placed in local media. The minutes are recorded by a candidate selected by the stakeholders who attend the hearing. Attendance varies from a few to over 100 people.
- Public hearings in the form of surveys. The materials are placed for stakeholders in the liaison office. There are adverts in local media. Comments are collected and the protocol (meeting record) is prepared.

Full records of the notification process and protocols are kept for every public hearing. The records of the hearings are public documents available from the local authority.

Monitoring data are not published in the local media and no annual reports are prepared for public consumption other than the corporate information presented by ERG in its sustainability report. SRK understands that ERG/Kazchrome are preparing a public relations plan (annual PR plans) on how further information should be shared with the wider public. The intent is to inform the public about production modernization and environmental campaigns (tree planting, competitions, etc.). The main methods of information dissemination being considered include publications in national, regional and corporate media, on the Internet and on television.

Aksu ferrochrome plant publishes a free weekly newspaper “Vestnik Kazchroma” that is distributed to all employees.

There is no formal grievance or complaints system in place. As is standard in Kazakhstan, complaints are generally to be directed to local government, the relevant national department (environment, labour protection etc.) or the Kazchrome head office (via the website). The assets will have an ‘open door’ day on a regular basis which is intended to facilitate staff having free access to the General Manager and the Company states members of the public are free to attend this as well. Prompt responses to complaints made through local authorities or regulatory authorities are legally required and may result in unscheduled inspections by the relevant authority.

A review of some of the recent OVOS public hearing protocols indicate there is interest in the environmental impacts of industrial activities in the region and an increasing number of stakeholders attend the hearings. Typical environmental questions relate to the control measures to be put in place (including dust control) and how closure will be managed. Other general questions relate to employment opportunities and how tax money paid by the company is spent.

10.2.4 Community investment

Kazchrome states its social programmes are focused on its own staff, which it considers are critical to the Company’s success. In the case of Khromtau (Donskoy Mine), staff make up a significant proportion of the residents.

The mining contracts (Donskoy and Kazmarganets) have clauses requiring provision of money to a social fund, provision of training for both staff career development and the wider community and funding of research and development. The Company complies with these requirements in a number of ways:

- there is a social programme which is managed by the human resources department (at a corporate and asset level) supporting cultural and sporting events, educational support;
- Kazchrome works with local colleges and universities to train and develop local students and give practical experience on site, with many beneficiaries then being employed; and
- there is a memorandum of understanding with the relevant akimats to fund work in the city, such as roads and playgrounds.

Plans and budgets are developed each year for the social programme and other voluntary support provided by the Company, with a quarterly report on progress produced. In the case of work agreed within the memorandum, the money is paid to the akimat and it is responsible for undertaking the agreed tasks. A summary of the social investment budgets over 2015-2018 is presented in Table 10-5.

Table 10-5: Kazchrome social investment budgets

Budget (KZTk)	2015 planned/expected	2016 planned/expected	2017 planned/ expected		2018 planned	
	SP[1)]	SP	SP	YP[2)]	SP	YP
Management apparatus			19,543/ 15,172	12,443/ 12,245	22,703	6,322
Donskoy GOK	356,888/ 1,063,047	363,434/ 1,307,574	1,206,212/ 1,094,579	18,529/ 17,275	304,864	17,039
Aktobe			206,451/ 197,019	12,194/ 10,476	393,125	11,074
Aksu			176,742/ 151,146	18,527/ 19,697	324,523	18,129
Kazmarganets			38,939/ 28,115	6,225/ 5,845	36,200	5,250

1) Social development projects ("SP") include: holiday celebrations, supporting cultural and sporting events, social benefits to employees, charity.
2) Youth policy ("YP") include payment for the conferences, trainings, social benefits, equipment purchasing, supporting cultural and sporting events for the young people.

10.2.5 Liquidation, reclamation and closure

SRK has collated the available liquidation data provided Kazchrome for the assets (Table 10-6). The current liquidation estimates and the money being set aside in the liquidation fund relates only to the areas where mining and mine/process wastes disposal is occurring. These align with the Kazakhstan regulatory requirements (Section 10.1.5). There is no regulatory requirement for demolition and rehabilitation of the processing plants and other ancillary infrastructure such as roads, power supply, water supply or workshops.

Table 10-6 also presents the most recent asset retirement obligations ("AROs", dated December 2013) prepared on behalf of the then ENRC corporate office as input to its financial reporting. AROs reflect the cost to close the asset at the time of financial reporting whereas a life of mine closure costs, requires the cost to close the asset at the end of its current LoM plan. As it is not a legal requirement, the AROs also do not include provision for closure of processing plants and supporting infrastructure. SRK has not seen a breakdown of these costs, but in SRK's 2014 review SRK was told these AROs represented the most accurate estimate of closure costs for the mining and mine residue disposal sites. Additional provisions are noted by SRK to reflect the lack of provision for the processing and supporting infrastructure. These were estimates based on SRK's experience and benchmarks of similar types of operations around the world and are in no way accurate calculations.

A similar approach was taken for this review (Table 10-6). The 2013 AROs were inflated to 2017 terms and then converted to USD at an exchange rate of 327 KZT per 1 USD. SRK has added a provisional sum to account for the items not covered in the liquidation estimates or AROs. With respect to these provisions, SRK notes the following:

- In terms of the financial report requirements, ARO calculations should not account for scrap value, however the assets SRK spoke to indicated the costs of infrastructure closure would be (at least partially) funded by sale of equipment and scrap.
- AROs should also assume third party contractor costs and SRK understands this aligns with the method of calculating liquidation costs required by the Kazakhstan regulator;

however, SRK understands that in the case of Aktobe, Kazchrome intends to use its existing workforce to close Shops 1 and 2 (Section 10.4.5).

- For a financial model, the LoM closure costs are required, however as the operations are all mature it is unlikely the LoM costs would differ significantly from the AROs.
- LoM closure costs do not have the same requirements as AROs regarding allowance for scrap; however, accurate predictions of scrap value at the time the operations cease is difficult to predict and this affects the accuracy of the additional provisions suggested by SRK.
- Exploration work is ongoing by Kazchrome and other mining operators in the area and thus there is potential for processing plants and supporting infrastructure to continue to be used well beyond the currently predicted LoM.
- There is also a reasonable assumption by Kazchrome that some supporting infrastructure considered useful to the local authorities would be transferred not demolished (for example, roads, workshops and water supply systems); however, it is generally considered best practice to assume full closure of all assets unless something is already agreed in writing.
- SRK notes a stated intention by Kazchrome to work with the akimats to transfer ownership of some of its smaller subsidiary companies (for example brick production) to third parties as part of its liquidation plans and thus no provision for these assets has been determined.
- SRK has made no allowances for soil or groundwater contamination clean up, particularly at the smelter sites. Should this be required closure costs could be significantly higher.

Further consideration of these costs is discussed under the individual assets below.

Table 10-6: Summary of liquidation provisions and ARO estimates for Kazchrome assets[1)]

Asset	Liquidation estimates			ARO estimate			Additional provision by SRK (USDm)	SRK's suggested closure provision for financial model (USDm)
	2017 LoM estimate (KZTm)	Current value of fund (30/09/2017) (KZTm)	Expenditure to 31/12/2016 (KZTm)	2013 AROs (KZTm) (as provided by ENRC)	2017 inflated (KZTm)	2017 (USDm)		
Donskoy GOK	964	279	117	2,577	3,478	10.6	15	26
Aktobe Ferroalloys	653	526	0	4,184	5,649	17.3	50	67
Aksu Ferroalloys	2,610	912	794	2,647	3,573	10.9	50	61
Kazmarganets	275	107	139	1,146	1,547	4.7	0	5

1) No updated numbers as at 1 January 2018 were provided at the time of writing, this however does not impact on the suggested closure cost provision.

10.3 Donskoy

10.3.1 Environmental and social setting

Donskoy mine is the Khromtau District of Aktobe Province approximately 115 km east of Aktobe City. It is located on sparsely populated gently undulating steppe plains. The nearest settlement is the town of Khromtau, which has a population of over 20,000 and is surrounded by the mine's infrastructure. It was established to support the newly opened mine and the mine is the primary employer in the Khromtau community; some 8,000 people are employed at the mine. The infrastructure within the town of Khromtau is linked to the mine, which operates a network of railways and roads, water supply and wastewater treatment facilities, food production and numerous other infrastructure facilities in the town. There are several smaller settlements on the outskirts of the Donskoy mining area. Land surrounding the mine is used for agriculture. Wheat and potato are the main crops grown.

The regional climate is extreme continental, with long cold winters and short hot summers. Average monthly temperatures range from -13°C (January and February) to +21°C (July). Extremes can reach -40°C in winter and +40°C in summer. The area is semi-arid with about 300 mm of precipitation per annum, mainly occurring as snow during winter. Thunderstorms can result in peak rainfall events with more than 50 mm of precipitation during the event. The predominant wind direction is to the west.

The mine is in the catchment of the Or River, in the Ural River basin which discharges to the Caspian Sea. Several non-perennial watercourses drain the site.

10.3.2 Environmental and social approvals held by Donskoy Mine

From an environmental perspective, Donskoy mine holds the necessary environmental approvals to operate (Table 10-1). It has an environmental permit that covers the following releases from site: air emissions, water discharges and waste disposal. Pollution payments for the releases documented in the permit have to be paid each year. The payments are variable, being based on the actual quantities discharged/ disposed of, but averages KZT146m over the last three years.

One of the conditions of the emissions permit is the implementation of the environmental measures envisaged by the Environmental Measurements (Management) Plan ("EMP"). The plan for 2015 had an estimated budget of KZT1.83 billion (B); of this, the implemented budget was KZT1.63B. The plan for 2016 had a budget of KZT1.98B, while the actual implemented cost was KZT1.92B. The estimated budget for the EMP in 2017 and 2018 are KZT2.08B and KZT1.29B, respectively (2017 actuals were not available at the time of writing). The biggest cost items generally relate to (2015-2018):

- waste rock and coarse tailings disposal back into the old pits (generally about 50-60%);
- reprocessing of the old sludge;
- reuse of treated waste water and mine drainage water for returning to the process; and
- dust control of technological roads.

Donskoy mine has four permissions for water supply (Table 10-1). SRK understands that water is supplied to the process via treatment systems. Process water is derived from pit inflow water or treated city waste water, topped up with borehole water if needed. Potable water is supplied from boreholes. The majority of discharges of waste water are either returned to the process for reuse or released in lakes/evaporation pans where the water either soaks away or evaporates. Excess water from the process plant/ tailings return water system is discharged to the river during the spring if needed. Water is also discharged to surface water courses from some of the pits.

OVOS public hearings or surveys were held 16 times in 2016 and 2017. These covered minor project changes such as workshop construction, amendments to in pit tailings disposal and small scale construction material quarries. Questions from the public were limited and generally focused on waste disposal.

The last State Inspection by the environment authorities to Donskoy mine was in 2016 and there have been no recent unscheduled inspections (in response to community complaints). A number of violations were identified, such as: exceedances of relevant standards for dust, nitrogen dioxide (“NO_2”), and sulfur dioxide (“SO_2”) at one of the emission points and when emissions at the process plant were measured by the inspector there were exceedances in the dust standard. A summary of the penalties received for these non-conformances is given in Table 10-2.

10.3.3 Environmental monitoring and control

Monitoring by or on behalf of the environment departments of Kazchrome generally takes two main forms: control monitoring which assesses compliance with the emission/ discharge/ disposal limits in the environmental permit; and environmental monitoring which looks at ambient levels within and beyond the SPZ. The control monitoring includes:

- quantity and quality of emissions (inorganic dust, timber dust, if necessary, and for the pelletising plant: carbon monoxide (“CO”), NO_2, nitrous oxide (“NO”), SO_2);
- water discharges with parameters including chlorides, sulfates, oil products, suspended solids, ammonium nitrogen, nitrites, nitrates, iron (“Fe”), phosphates, pH, Cr(VI); and
- types and volumes of waste generated.

There is no continuous stack monitoring equipment at the processing facilities. The analyses are undertaken on the mine site by a certified laboratory.

Environmental monitoring includes:

- Ambient air quality (inorganic dust, CrO_3, Cr_2O_3, NO_2, SO_2 control) and surface water quality (chlorides, sulfates, oil products, suspended solids, ammonium nitrogen, nitrites, nitrates, Fe, phosphates, pH, Cr(VI)) at locations within the SPZ, as required by the authorities.
- Surface water monitoring is done occasionally by a third party and SRK understands monitoring of snow quality is also done occasionally, but the data for this were not received.
- Groundwater monitoring within the SPZ for Fe, Cr(VI), chlorides, ammonium nitrogen, nitrite, nitrates. The concentrations of Cr(VI) range from 0.005 mg/L (limit of detection) to 0.022 mg/L. There are also groundwater wells around the sludge ponds but as these are not included in the environmental permit compliance reporting, SRK has not seen the associated data.
- Soil monitoring once every three years (last was in 2015) and the parameters monitored

include oil products, Fe total, trivalent chromium (Cr(III)), Cr(VI) and mineralisation.

- The spectral analysis of flora, radiation and vibration level investigations were also undertaken within the SPZ in 2015.

The analytical work for environmental monitoring are carried out mostly by Donskoy's environmental laboratory, sometimes involving specialist subcontractors. There were no exceedances of permitted limits for the controlled parameters in 2015-2017, with the exception of regular chlorides and Fe exceedances in groundwater. These exceedances are reportedly connected with natural geochemical anomalies.

Limitations in the monitoring programme are discussed for all the Kazchrome sites in Section 10.7.1.

10.3.4 Key technical environmental and social Issues

Water Management

Large quantities of water have historically been discharged from the mine to watercourses and evaporation ponds, some of which is then reused in the process. Dewatering of mine workings is the main source of discharged water. The mine has implemented plans to reduce water discharges to the environment and abstraction from groundwater by using sewage effluent, water from pit #29 and water from mine dewatering rather than fresh make up water and by improving recycling of water in the process water circuit. It is planned to reduce the total discharge quantity by about 21 Mm^3 per annum in 2017/19 (down from previous highs of about 47 Mm^3 per annum).

The water from dewatering of the mine workings discharged to the environment historically contained naturally elevated concentrations of chloride, calcium ("Ca") and magnesium ("Mg"). The mine is not required to treat this water prior to discharge, but does have to make payments for discharge of salts and other substances in the water to the environment. The mine is currently discharging water with quality within the specified norms. The mine also operates five sewage treatment plants.

The soils and water in rivers in the area of the mine have been shown to have naturally high levels of some elements (such as chromium ("Cr"), copper ("Cu") and zinc ("Zn")) and this has been attributed to their location in an area of geochemical anomaly.

Air Emissions

The main source of air emissions is open pit mining and ore processing plants. The latest State Inspections (2014-2016) highlighted some emissions exceed agreed limits for CO, nitrogen oxides, and inorganic dust. Dust from gas cleaning facilities at the process plants is now recycled back to the process, but prior to 2014 some was disposed of to the sludge pond in breach of requirements as it is classified as an 'amber' (slightly hazardous) waste.

Mine residues

The process generates two types of waste residues. The first is a coarse tailings (like gravel) that is disposed of into the old pits. The second is a fine material disposed of into the sludge ponds as a slurry. The ponds are lined and the decant water is returned to the plant. The mine has implemented plans to process sludge (about 294,000 to 360,000 tpa in 2016-2018) and to transfer old sludge to a third-party company (about 400,000 tpa in 2017-2018).

SRK was not provided with geochemical characterisation of the sludge or the implications on geochemistry of its co-disposal with aspiration gas cleaning system dust. There is groundwater monitoring taking place at the edge of the SPZ that shows compliance with normatives, but this is not in the immediate vicinity of the disposal site and does not include a comprehensive set of parameters (it does include Cr(VI)). The Company states it meets regulatory requirements, but this does not necessarily mean there are no impacts occurring and there is currently insufficient information to confirm this.

Social closure and reliance of the town on mining

The current LoM runs up to 2051, but that may be extended by future exploration work. Currently, Khromtau is almost solely supported by the mining operations of Donskoy and a few smaller companies. At some point, mining at Donskoy is likely to stop, at which time there will be massive retrenchment and potentially economic collapse of the town unless alternative commercial and economic employment opportunities are generated. Although this may be many years in the future, it can take a substantial time to plan and implement programmes in association with the akimat to support the town through this eventual economic upheaval. Current social investments are focused on supporting local infrastructure, education and cultural/sport activities. There is an opportunity to work with the akimat to redirect the focus of Kazchrome's social investments towards developing alternative livelihoods for staff who will eventually need to be retrenched.

10.3.5 Closure costs (liquidation and rehabilitation)

As shown in Table 10-6, there is a current LoM liquidation cost estimate of approximately KZT964m, which includes the then liquidation fund value of KZT279m and the KZT117m spent on liquidation (leaving a further KZT568m to be provided for). The liquidation cost covers the cost of rehabilitation of the Donskoy mine workings, tailings disposal, sludge disposal and waste rock dumps. It does not cover any demolition, disposal or rehabilitation of the plant and other supporting infrastructure.

An ARO estimate was completed for the mine in December 2013 of KZT2,577m (2.5 times higher than the liquidation estimate at that date) and does not appear to have been updated. Based on inflation and current exchange rates this currently equates to about USD10.6m. SRK considers the ARO to more closely reflect the actual closure costs for the mine and associated mine residue facilities. SRK suggests an additional provision of USD15m to cover the demolition of the processing plants, associated power stations, and other ancillary infrastructure, as well as post closure monitoring and maintenance.

10.3.6 Risks, opportunities and recommendations

No significant environmental and social risks that could stop the operation or significantly affect the value of the asset were identified during the review of the mining complex. The mine does have an opportunity to more accurately define and plan for the bio-physical and social implications of the eventual closure of the mine and what this means for the town of Khromtau so that appropriate financial and human resources can be allocated.

Also refer to general comments on adherence to GIIP in Section 10.5.1.

10.4 Aktobe Ferroalloys Plant

10.4.1 Environmental and social setting

The Aktobe Ferroalloys Plant is located on a 370 ha site within an industrial area on the north-western outskirts of Aktobe City. The plant has a 1,000 m-wide regulatory SPZ, which overlaps the SPZ of adjacent industrial operations. Part of Makambetovka village is located within the SPZ of the plant and the SPZ of adjacent operations. To the west of the Aktobe Ferroalloys Plant is an area of dachas[4] and forest.

The smelter receives ore from Donskoy by rail, along with other raw materials such as anthracite, chromium silicate, coke, bauxite and lime from other parts of Kazakhstan and Russia. The product is also transported away from the site by rail. Power to the site is provided by Kazchrome's own Akturbo gas and steam power generating facility located on the site of the city power station, supplemented by the national grid and the Aktobe TEC thermoelectric power station.

The climate at Aktobe is similar to that described for Donskoy mine (Section 10.3.1). The terrain surrounding Aktobe City is relatively flat dry steppe grassland. The city is in the Ural River basin and is at the confluence of the Kargala and Ilek rivers. Aktobe is in the catchment of the Ilek River, immediately downstream of the confluence with the Zheneshke River. The Ilek River was reported to be the most polluted water body in the Ural-Caspian basin in 2002, with the main pollutants in the river being boron (B) and Cr[5].

Aktobe City has a population in the order of 400,000 people and heavy industry was established during the Second World War. The various industrial operations in Aktobe have cumulative impacts on air and water quality. The Aktobe Chromium Compounds Plant is adjacent to the Aktobe Ferroalloys Plant. It produces sodium dichromate, chromium oxide, chromic anhydride, chromium sulphate (chrome tanning agent). The Aktobe Power Plant located next to Aktobe is responsible for the ash dump that occupies the space between the Aktobe process infrastructure and the slag dump.

SRK understands that the Kazakhstan Ministry of Environment investigated Cr(VI) in soil and groundwater in the area of these sites in 2006, the investigation focused solely on Aktobe Chromium Compounds Plant and Aktobe Power Plant. Reportedly, Aktobe Ferroalloys Plant was not considered to be a contributor to this pollution.

Much of the industry in the Aktobe City industrial area is in the oil and gas sector and includes operations of Chinese National Petroleum Company ("CNPC") Aktobemunaigaz, Kazakhoil Aktobe and Intergas Central Asia. These three operations are considered to be the primary source of air pollution in the region and they have been penalised in the past by State Authorities for exceedances of their permit limits.

Other operations in the Aktobe City industrial area include aircraft repair and manufacture of paints, piping, x-ray equipment, and polyurethane products.

[4] "Dacha" is a term of Soviet origin referring to second homes, originally built as recreation getaways by city dwellers and for the purpose of growing little gardens.
[5] Water resources of Kazakhstan in the new millennium," Water Resources Committee of the Republic of Kazakhstan, 2002, cited in http://www.unece.org/fileadmin/DAM/env/water/blanks/assessment/caspian.pdf

10.4.2 Environmental and social approvals

Aktobe holds the necessary environmental approvals to operate. The smelter has a permit to discharge emissions and dispose of waste within the established limits (Table 10-1). The permit includes the Aktobe gas-fired power station Akturbo.

Pollution payments have to be made for the emissions and waste disposal. The payment of environmental fees are variable, being based on the actual quantities discharged/ disposed of, but have averaged KZT170m per year over the last three years. Reportedly, the plant had a minor fine (KZT0.6m) for exceedances of limits in 2016, with no other fines since 2011.

One of the conditions of the emissions permit is the implementation of the environmental measures envisaged by the EMP. The plan for 2015 had an estimated budget of KZT1,78B; of this, the implemented budget was KZT1.36B. The plan for 2016 had a budget of KZT1.77B, while the actual implemented cost was KZT1.53B. The estimated budgets for the EMP in 2017 and 2018 are KZT1.83B and KZT2.01B, respectively (2017 actuals were not available at the time of writing). The biggest cost items generally (2016-2018) relate to:

- reprocessing of the ferrochrome slag (generally about 80% of the cost);
- bag filters replacement (2017-2018);
- dust from the gas cleaning systems (Shops 1 and 2) transfer to third-party company for reprocessing;
- capital repair of locomotives; and
- dust from bag filters utilisation.

Aktobe abstracts and uses groundwater (for potable supply) and surface water (process water supply). Groundwater is abstracted under a licence for the subsurface use from eight boreholes located next to the Rossovkhoz settlement. Surface water is abstracted from Ilek River and stored in a sedimentation pond before use in cooling facilities (Shop 1 and 2 have open cooling systems, whilst Shop 4 has a more efficient closed system with water treated in a reverse osmosis plant first); scrubbers; slag irrigation; and dust suppression. The plant does not discharge any effluent into water bodies, though seepage to groundwater from some areas of the site is occurring. Effluents from the site are transferred to the Aktobe City municipal wastewater system via a third party contractor.

10.4.3 Environmental monitoring and control

Aktobe performs air quality monitoring quarterly within the SPZ for CO, NO_2, SO_2, hydrogen sulfide ("H_2S"), suspended matter, and Cr(VI). In-stack monitoring is also undertaken quarterly to report emissions to regulatory authorities, but there are no continuous stack monitoring facilities at the smelter. The quarterly air quality monitoring for residential areas in Aktobe City includes the same parameters as monitoring within the SPZ. The monitoring reports to authorities indicate the smelter is compliant with its permitted limits. When reviewing the available data, SRK queried some of the quality control and assurance as some values did not make sense (discussed further in Section 10.7.1).

Water quality in Ilek River is monitored on a regular basis upstream and downstream of the smelter. Parameters monitored include pH, suspended solids, Cr(VI), B, Fe, Cu, hydrocarbons, chlorides and sulfates. The water quality monitoring data are submitted to regulatory authorities on a regular basis. The concentrations of Cr(VI) in the river water ranges from 0.0005 to 0.012 mg/L (the Kazakhstan norm is 0.015 mg/L, compared to the US EPA criterion for maximum and continuous concentration for surface waters of 0.016 and 0.011 mg/L, respectively). SRK notes one higher value of 0.096 mg/L, but this may be a reporting error since it is out of line with other data. Exceedances of normative limits are recorded for Cu and sulfates. The State Inspectors do not appear to have required Aktobe to make any specific management measures to address these exceedances.

Groundwater is monitored twice per year at a few locations on the site. The parameters monitored include Cr(VI), Fe, Mn, Zn, cadmium (“Cd”), nickel (“Ni”), lead (“Pb”), and Mg. Elevated concentrations of Cr(VI) are recorded in the boreholes in the region of the slag dump (Section 10.4.4). The concentrations of Cr(VI) in the groundwater range from 0.11 to 18.9 mg/L, which are significantly higher than the Kazakhstan norm for groundwater of 0.05 mg/L and the World Health Organisation drinking water standard for total Cr of 0.05 mg/L. The implications of these significant exceedances are discussed further below.

Soils monitoring within the SPZ and residential areas is done for Cr(VI), Mn, Cu, Ni, Pb, and Zn. Of these parameters, Kazakhstan norm are only given for total chrome (which is not analysed) and Zn, which has had occasional exceedances on site. With respect to international guidelines, SRK has compared the available data to the US EPA[6] screening level for residential and industrial areas and the UK Environment Agency contaminated land exposure assessment (CLEA) guideline values for residential and agricultural areas. All parameters except Cr(VI) indicate no issues of concern.

For Cr(VI) the data ranges are 33.1-541.7 mg/kg for monitoring within the plant area and 40.2-491.8 mg/kg for monitoring in the dachas. These data compare to the US EPA[7] screening level for residential areas at 0.3 mg/kg and for industrial areas at 6.3 mg/kg. The UK CLEA guideline value[8] for residential areas is 21 mg/kg and for agricultural areas is 170 mg/kg. This shows there are significant exceedances of these guidelines both within the plant area and in the adjacent dachas which are used for growing summer crops. This is discussed further below.

There is a baseline monitoring point, which is selected by the regulators as 5 km from the SPZ. It is understood this represents ‘background’ concentration against which the soil results are compared. The regulator monitoring reports include this point but do not make any comparison with soil norms provided by the Kazakhstan Government nor have they required any specific remedial measures be taken by Kazchrome.

Once per year radiation parameters, noise and vibration levels are also monitored.

[6] Screening levels (SL) are derived from equations combining exposure assumptions with chemical specific toxicity values. The SL's presented are concentrations that may warrant further investigation or site clean up. https://semspub.epa.gov/work/HQ/197025.pdf

[7] Screening levels (SL) are derived from equations combining exposure assumptions with chemical specific toxicity values. The SL's presented are concentrations that may warrant further investigation or site clean up. https://semspub.epa.gov/work/HQ/197025.pdf.

[8] Soil guideline values are 'trigger values' for screening-out low risk areas of land contamination. They give an indication of representative average levels of chemicals in soil below which the long-term health risks are likely to be minimal. https://www.alsenvironmental.co.uk/media-uk/pdf/datasheets/contaminated-land/als_cl_heavy-metals-guidelines-in-soil_uk_feb_17_v2.pdf.

10.4.4 Key technical environmental and social issues

Air Emissions

Particulates from the gas cleaning systems on site are grouped as “abatement dust from the furnaces” and “dust from the aspirational system”. The aspirational gas cleaning system collects dust from around the furnaces, whilst the abatement dust is gathered from within the furnace itself. It is noted there was limited gas abstraction from the tapping bay areas and this potentially poses risks for occupational health and safety and may contribute to fugitive emissions from the site. For Shops 1 and 2 the abatement and aspiration systems are combined; for Shop 4 there are separate systems.

Emission control processes used on site include:

- cyclones and bag filters at Shop 1, with the dust provided as a powder to third parties as a by-product (including to Aksu smelter) and more recently with the addition of a briquette facility it can now be recycled to the Aktobe process;
- electrostatic precipitators at Shop 2, with some of the dust being recycled on site and the rest being co-disposed with slag on the slag dump;
- wet scrubbers in the abatement system at Shop 4; and
- cyclones and bag filters in the aspiration system at Shop 4, with the collected waste material handled in the same way as Shop 1.

The key determinant in deciding if the collected dust can be reused or disposed of is the metal content, in particular Cr(III). High metal content is good for reprocessing, low metal content results in disposal. The site indicated there should not be Cr(VI) present, so it is not analysed for. SRK’s concerns about this are discussed further below.

Prior to 2006, the smelter paid considerable sums in fines for exceeding air emission limits, but this has significantly reduced because gas cleaning systems at the smelter have been installed or upgraded; however, there is a legacy of high levels of emissions before the systems were put into place that could have historically affected surrounding soil and water resources.

While Shops 1 and 2 are now operating within limits approved by regulatory authorities, there are still substantial stack emissions from these shops. During previous SRK visits (in 2014), substantial fugitive emissions from Shops 1 and 2 were observed along with a thick smog, which impaired visibility across the site. SRK understands that such conditions are not unusual at the site.

SRK understands dust from the Shop 1 and 2 furnaces is not classified as hazardous; a “green waste” regulatory passport has been issued for this dust. Green waste does not have to be disposed of in engineered facilities, with measures to prevent releases to the environment such as a liner to prevent seepage and capping at closure. In contrast, dust from the aspirational system is classified as hazardous; an “amber waste” regulatory passport has been issued for this dust and thus it should be returned to production. Data for the aspirational dust and sludge from wet scrubbers for Shop 4 was also classified as green waste, although SRK notes the x-ray diffraction data used to classify the data did not include Cr(VI).

On a positive note, SRK was told that Kazchrome is currently investigating if the offgas from Shop 4 furnaces could be used to generate power from the site, which would further reduce emissions.

Historical liabilities associated with process waste disposal and releases from site

Historical liabilities associated with Cr(VI) at the site are thought to be linked to two key aspects: seepage and dust blow from the slag dump, and historical untreated emissions from the furnaces. The potential risks associated with these are discussed further below.

Kazchrome staff do not acknowledge the potential issues associated with Cr(VI) and the amount of monitoring data for this parameter is limited. Staff indicated a) the Aktobe Chromium Compound (a chemical plant which was established prior to the ferroalloy plant) is responsible and b) the authorities have not indicated any action should be taken by Kazchrome. SRK has identified one report on Cr contamination in the industrial area of Aktobe[9]. This study was apparently undertaken at the request of the Ministry of Environment and Water Resources. Groundwater data presented in this paper confirm the chemical compound appears to be the greatest contributor to Cr(VI) in the area, but other hot spots do occur, some to the east of the ferroalloy plant and away from the chemical plant. This does not, however, negate the fact it is considered likely the ferroalloy plant is also contributing to the overall pollution levels, as discussed below.

Most slag is sold as a construction material, after processing in a metal recovery facility. Dust from the Shop 2 furnace gas-cleaning systems is co-disposed with some of the slag on a dump on the northern region of the plant site. Historically, these were mixed, but SRK understands some effort to separate the wastes on the dump is now occurring. The dump occupies an area of about 50 ha. It is expected the dump was unlined and thus seepage from the facility will have occurred over a number of years.

Neither the dust nor the slag is recognised as being hazardous by the Company or regulatory authorities. SRK believes the analyses required to understand the true hazardous nature of this waste have not been undertaken, particularly with respect to the Cr(VI) content. The composition of the waste described in the waste passport is fitting for slag, but not necessarily the furnace dust, as explained further below. Neither of the wastes has been subject to tests of leaching potential coupled with analysis of elements in the leachates.

There was also a historical stockpile of HCFeCr slag on the plant site but this has been processed over the last decade but historical seepage may have occurred.

According to the liquidation plan, the dump is scheduled to commence being closed and rehabilitated in 2019, after Shops 1 and 2 have been decommissioned; however, with the delay in closing these furnaces, it is assumed the closure will be further delayed.

Satellite images of the smelter site taken in the summer months indicate there is significant dust dispersion from the slag and furnace dust dump and it is expected historical deposition from the furnace emissions (before emission controls were implemented) may also be present in lands surrounding the site as evidenced by the high Cr(VI) identified in the monitoring data

[9] Numerical Modelling of the Intensification Processes of Groundwater Treatment for Hexavalent Chromium Using In Situ Technology, Sagin et al, Journal of Environmental Hydrology, 2016. http://www.hydroweb.com/protect/pubs/jeh/jeh2016/sagint.pdf

(Section 10.4.3). Dust dispersion from the dump is limited by snow cover in winter and SRK understands that water sprays are used to limit dust dispersion in summer but this is a recent control measure.

The greatest risks to health and the environment in the smelting of ferrochrome are associated with the dust from bag filters or sludge from gas cleaning systems. The tapping process, especially if oxygen lancing is utilised, also creates conditions for Cr(VI) generation, as does dry milling of chrome ore. These additional sources may also contribute to fugitive Cr(VI) emissions from ferrochrome sites.

There is abundant literature on the hazardous nature of dust from the gas cleaning systems of ferrochrome furnaces[10], which is known to commonly contain Cr(VI) and other metals such as Fe, Mn, Zn, Cd, Ni, and Mg. As Cr(VI) is both toxic and carcinogenic, the dust is generally considered to be a hazardous waste. The mobility of Cr(VI) in soil and water is generally high.

While the production of ferrochrome alloy is conducted under highly reducing conditions, it is not possible to exclude oxygen from all high temperature process steps and so small amounts of Cr(VI) bearing material are formed. Closed furnaces (such as those at Shop 4) generate less Cr(VI) than open or semi-closed furnaces (Shops 1 and 2). Factors such as slag composition and furnace design have an impact on Cr(VI) generation. Furnaces operating under acidic slag regimes have significantly lower water-soluble Cr(VI) content in the dust than furnaces using basic (alkaline) slag practices.

The handling, transport and disposal of bag filter dust or sludge from gas cleaning systems must be carefully managed and monitored to reduce the risk of environmental contamination by Cr(VI) (particularly with respect to surface and ground waters) and exposure of employees via dust inhalation and skin contact.

The most common process for dealing with possible Cr(VI) containing waste in the global ferrochrome industry is aqueous chemical Cr(VI) reduction, with subsequent precipitation of non-toxic Cr(III) hydroxides and landfilling in specially designed waste facilities. The paper referenced above, indicated some success with in situ treatment using a reagent pumped into the contaminated groundwater. Neither of these methods are currently applied at the Aktobe.

Other pollution sources

In addition to the slag and dust dump described above, there are other potential sources of soil and groundwater contamination at the site. These sources include workshops and underground

[10] *Chromite mining and processing, Public Health Ontario, 2015. http://www.publichealthontario.ca/en/eRepository/Chromite_Mining_2015.pdf*

Potential Toxic Effects of Chromium, Chromite Mining and Ferrochrome Production: A Literature Review, Mining Watch Canada, May 2012. https://miningwatch.ca/publications/2012/5/9/environmental-and-health-effects-chromium

Treatment of Cr(VI)-containing wastes in the South African ferrochrome industry–a review of currently applied methods. J.P. Beukes, P.G. van Zyl, and M. Ras. The Journal of The Southern African Institute of Mining and Metallurgy, Volume 112, May 2012. http://www.saimm.co.za/Journal/v112n05p347.pdf

Theoretical and practical aspects of Cr(vi) in the South African ferrochrome industry. J. P. Beukes, N. F. Dawson and P. G. van Zyl. The Twelfth International Ferroalloys Congress, June 2010, Helsinki, Finland. http://www.pyro.co.za/InfaconXII/053-Beukes.pdf

A review on the characteristics, formation mechanisms and treatment processes of Cr (VI)-containing pyrometallurgical wastes. G. Ma and A.M. Garbers-Craig. The Journal of the Southern African Institute of Mining and Metallurgy, Volume 106, November 2006. http://www.saimm.co.za/Journal/v106n11p753.pdf

Environmental Aspects of Ferrochrome Production. .A. Gericke. International Ferro-Alloys Congress (INFACON 7), Trondheim, Norway, June 1995. http://www.pyrometallurgy.co.za/InfaconVII/131-Gericke.pdf fuel storage tanks (petrol, diesel, and kerosene). Most of the site is unpaved and the surface water management infrastructure is lacking. This all contributes to fugitive emissions from the site.

Occupational exposure to pollutants

Workers are potentially exposed to a range of harmful pollutants. Certain Cr(VI) species are regarded as carcinogenic and exposure to these through inhalation and skin contact is associated with increased risk of lung cancer, asthma, and damage to the nasal epithelia and skin. Manganese exposure may occur through inhalation and contact with ultrafine Mn-bearing dusts from high temperature smelting processes, resulting in negative neurological and neurobehavioral effects. Carcinogenic coal tar pitch volatiles may be produced at the taphole.

Although there is an occupational health monitoring programme involving mandatory blood and urine sampling for every employee, this is a reactive system; if an issue is flagged following the medical examination, the worker is typically moved to another more appropriate job that will not aggravate the medical condition. At this point, however, health impacts may be long-term or irreversible and a better approach would be to stringently limit exposure by providing enhanced PPE provision (Section 10.1.6) and strictly enforcing its use.

Social implications of closure of Shops 1 and 2

With a combined employee and contractor workforce in the order of 5,000 people, the eventual closure of the site will lead to significant social implications on the employees and Aktobe City itself. This will happen to a lesser extent upon the closure of Shops 1 and 2, which is scheduled in the next few years. SRK understands the liquidation plan makes an assumption that existing staff will be used in the liquidation process and this will extend their employment for a few more years.

The closure of the shops will result in significant retrenchment costs that needs to be incorporated into the assets financial planning. In terms of GIIP, there is an expectation that efforts will be made to retrain or redeploy affected staff and this may result in additional costs above and beyond the retrenchment costs. These costs are not currently included in the liquidation provisions.

There is then the indirect effect on Aktobe City's economic situation. Aktobe is significantly larger than Khromtau, with a number of commercial and industrial employment opportunities, which should help to minimise negative impacts. SRK is not aware if discussions have been held with the authorities to determine how these potential negative impacts could be managed.

Houses in the SPZ

About 250 people from Makambetovka village live in the SPZ of the smelter (and also SPZ of adjacent industrial facilities). It is understood that the houses have been there for a long time and this is not a major issue for Aktobe as the regulators have indicated no problems. In SRK's view, there are insufficient data to fully evaluate potential impacts on this community from either the smelter itself or the other industries in the area which may impact upon the health and wellbeing of the residents. Without direct action by either the environment regulator or the community themselves, this situation is unlikely to change, but there is a risk that at some point in the future this may become an issue and Aktobe has the opportunity to better defend itself by gathering additional data above and beyond what is required by law (refer to Section 10.5.1).

10.4.5 Closure cost (liquidation and rehabilitation)

No closure date has been set for Aktobe and although currently supplied by Donskoy, there is the opportunity for other chrome mines to come on line in the future which could potentially extend the life of the smelter. Liquidation costs have been determined and payments to the liquidation fund (KZT526m as at 30 September 2017, as shown in Table 10-6) are occurring for the following facilities (the values provided exclude the cost of preparing the liquidation plan which varies from KZT3 to 6.4m):

- slag dump: KZT604m due to commence liquidation in 2019 (based on a 2013 cost estimate);
- construction waste dump: KZT10.1m due to commence in 2042 based on a 2013 cost estimate); and
- Sholoksai Uzhny waste rock dump: KZT21m due to commence in 2024 based on a 2012 cost estimate.

The site has indicated it is only planning to do a liquidation project (study) for the process plants and gas power plant three years before the actual closure occurs and thus no closure cost estimates exist for the processing and ancillary facilities. In the case of Shops 1 and 2, these are currently planned to continue to operate till the end of 2022. The intention is therefore to start preparing the liquidation project for Shops 1 and 2 at the end of 2019/2020. SRK was told in 2014 there was a closure cost estimate for Shops 1 and 2 amounting to about USD24m.

It is envisaged by Kazchrome that the liquidation and demolition will take approximately three years to complete and the process will use the workers from the current Shops 1 and 2. As Kazchrome has not made financial provision for either the financial costs of demolition or the cost of employment for these workers, it has stated the scrap and equipment will be sold to cover the employment and demolition costs. Kazchrome’s view is that 100% of the demolished material can be recycled or reused.

The ARO for Aktobe covered the slag dumps and other process waste disposal sites. It amounted to KZT4,184m in 2013, which with inflation and current exchange rates equates to about USD17.3m (Table 10-6). SRK’s suggested additional provision of USD50m covers: Shops 1 and 2 (using the USD24m estimate from 2014), Shop 4 (assumed to be similar to Shops 1 and 2), and the gas fired power plant (SRK benchmarks indicate at least USD3m for this). Also included is provision for post closure monitoring and maintenance. If there were decisions by the regulator or Kazchrome’s corporate office to clean up the known contamination of soil and groundwater, the cost of soil remediation and water treatment could be substantial and the closure cost could be over USD100m.

10.4.6 Risks, opportunities and recommendations

SRK notes that with no regulatory requirement to investigate and if necessary remediate the potential Cr(VI) pollution, Kazchrome is not currently obligated to address this issue; however, SRK does consider there to be a significant risk that at some point in the future this situation could change. The key driver may be the regulator or it may be the wider community, for example in response to noted increases in cancer rates within Aktobe City[11].

The cost of remediation is currently unknown as there is insufficient monitoring of soil and groundwater to understand the extent of pollution at the site, who the key contributors are, and how this could be remediated. It is difficult to determine the risk of this being required considering the significant contribution made by the neighbouring chemical plant to this problem.

Further discussion on proactive management of environmental risks is discussed in Section 10.7.1 and 10.7.2, but for Aktobe should include:

- The slag and furnace gas cleaning dust dumped on site should be subject to appropriate geochemical characterisation including leach tests to determine the pollution potential of the wastes. They should be studied separately, not as combined waste.
- Groundwater investigations should be undertaken to understand hydrogeological conditions on the site and to distinguish the water quality impacts of Aktobe from those of its neighbours.
- Further soil studies should be undertaken in association with an evaluation of wind direction to identify the contribution from the ferroalloys plant to elevated Cr(VI) in soils surrounding the site and the risks this poses to potential receptors.
- Potential other sources of Cr(VI) should be identified and assessed to confirm if the occupational health and environmental protection measures applied are appropriate and adequate.

The above studies should be used to inform appropriate strategies for ongoing management and eventual closure of the slag and dust dump and the plant as a whole.

10.5 Aksu Ferroalloys Plant

10.5.1 Environmental and social setting

Aksu ferroalloy plant is located on flat steppe that slopes gently towards Irtysh River, which flows past the plant about 4 km to the east. It is on the outskirts of the town of Aksu, which has a population of about 40,000. Most of AFP’s personnel (approximately 6,400) are from the town of Aksu.

JSC Eurasian Power Corporation’s power plant is located 4.5 km to the north east of the AFP’s industrial site No.1 and the power plant’s slurry-ash pond is located 2.5 km to the west.

Surrounding land is used for agriculture. Land between AFP and the Irtysh River is cultivated and there is an abandoned chicken farm just west of the operation. Numerous dachas are present between AFP and Irtysh River, the closest of which is 0.35 km to the east. The dachas were erected after construction of the ferroalloy plant and occur within the smelter’s SPZ. The dachas use municipal water. Many dachas have been abandoned in recent years.

Surficial groundwater is confined to sandy sediments at a depth of approximately 5-5.8 m; the thickness of watered sands varies between 2 m and 9.5 m. The direction of groundwater flow

[11] Cancer Incidence and Mortality Data in Aktobe, West Kazakhstan 2000-2010, Bekmukhambetov et al, Asian Pac J Cancer Prev, 16 (6), 2379-2383, 2015. https://www.ncbi.nlm.nih.gov/pubmed/25824768

is towards the Irtysh River. Deeper groundwater is found below an approximately 40 m thick clay horizons at a depth varying from 104-112.5 m.

The climate of the region is sharply continental, characterised by an inadequate and unstable amount of annual precipitation, cold air temperatures in winter with strong winds, late spring and early autumn frosts, and significant temperature fluctuations throughout the year.

According to monitoring data, the estimated annual average temperature is 2.2°C, the annual average temperature of the coldest month is -22.5°C and the hottest month is 27.9°C, and the maximum and minimum temperatures are 40°C and - 47°C, respectively. The AFP area has an average annual precipitation of 278 mm. The majority of precipitation falls in the summer months; this leads to significant loss of moisture due to evaporation. Evaporation in this period is 4-5 times higher than the amount of precipitation.

The wind regime is of a continental nature. The prevailing winds are from the west, south-west, and south. Seasonal reversal of prevailing wind directions is one of the principal features of the climate. The average annual wind speed is 4.5 m/s, but can exceed 15-20 m/s, particularly in the spring. Dust storms are common; on average, there are 23 days per year with a dust storm, mainly in the months of May and June.

10.5.2 Environmental and social approvals

AFP's environmental permits are summarised in Table 10-1. The emissions permit is valid for two years. Permit renewals are based on draft estimates supporting changes to limits for air emissions and waste disposal from the operation. Water for domestic and industrial uses is abstracted from Irtysh River.

Pollution payments have to be made for the permitted emissions and waste disposal as outlined in Table 10-2. The 2015 state inspection identified exceedance of air emission limits and AFP had to pay KZT83.7k for this exceedance and a KZT7.1m fine for environmental damages. In 2016, the state inspection again identified exceedance of air emission limits and AFP had to pay KZT1.6m for the exceedance and a KZT1.5m fine for environmental damages.

One of the conditions of the emissions permit is the implementation of the environmental measures envisaged by the EMP. The plan for 2015 had an estimated budget of KZT3,1B; of this, the implemented budget was KZT2.2B. The plan for 2016 had a budget of KZT2.3B, while the actual implemented cost was KZT2.4B. The estimated budget for the EMP in 2017 is KZT2.6B with the actual spend in the first three quarters being KZT1.7B (full year 2017 actuals were not available at the time of writing). The estimated EMP budgets for 2018 and 2019 are KZT2.53B and KZT2.58B, respectively. The biggest cost items generally (2015-2017) relate to:

- reprocessing of the ferrochrome slag (generally in excess of 75% of the cost);
- reconstruction of gas cleaners in Shop No.4 (2015);
- gas cleaner filter replacement;
- repair work on the drinking water supply pipeline (2015);
- reclamation of Dam No.1 (2016);
- repair work of the drinking water supply pipeline (2016); and
- purchasing and installation of dust collector in shop No.6 (2016).

10.5.3 Environmental monitoring

The Environmental Code requires development of an industrial environmental monitoring programme ("PEK"). Based on the programme, the plant undertakes quarterly monitoring of air emissions and waste disposal and the results of monitoring are reported to the Department of Ecology.

The plant also monitors stack emissions on a quarterly basis. There is no continuous monitoring of stack emissions. Monitoring of the emissions in Shop No.4 has registered only one short-term exceedance of CO in October of 2015. The monitoring did not register any further exceedance in air emissions and waste disposal.

During the state inspection, the results of air emissions monitoring revealed exceedance of NO, NO_2, inorganic dust (which can be assumed to contain Cr(VI), see Section 10.5.4), CO, and SO_2 MACs at Shop No.4 on 30-31 May 2016. There were no other exceedances documented in 2016 for air emissions and waste disposal.

Monitoring of the efficiency of gas cleaning equipment is done quarterly and monitoring of dust collector efficiency is done annually.

Environmental impact monitoring is carried out on the basis of programmes and schedules approved by the smelter's Technical Director and coordinated with the head of the regional governmental Department for the Protection of Consumer Rights in Aksu and includes:

- control over emission sources of pollutants;
- control of atmospheric air quality at the border of the SPZ;
- monitoring of atmospheric air quality (flare plume monitoring);
- monitoring of groundwater quality;
- monitoring at the stage of commissioning of process facilities;
- monitoring of emergency emissions into the environment; and
- monitoring of soils.

AFP's SPZ was determined in 1992. The zone extends in a roughly 3 km radius from the point source with the highest emissions to air. Historically, this was Shop No.4. Air quality is monitored along the boundary of the SPZ every 10 days. A mobile monitoring station is used. Monitoring locations are based on prevailing wind directions. Air quality monitoring also takes place within the SPZ at a 500 m radius from Shop No.4 and outside the SPZ at a 5 km radius from Shop No.4. The monitoring results show constant exceedance of MACs for inorganic dust, NO_2, and Cr(VI) at 500 m and 1,000 m from Shop No.4; it is not clear if the Cr(VI) is measured as part of the inorganic dust or a separate fraction.

Soil is monitored annually in the summer at about a dozen locations in and along the boundary of the SPZ.

Groundwater quality and levels are also monitored quarterly at 27 boreholes in and outside the SPZ. Analysis of samples are undertaken in a laboratory certified to Kazakh standards. Monitoring data are reported to regulatory authorities in accordance with permit conditions. Results from locations within the SPZ are not reported to authorities because there is no legal requirement to do so. Authorities conduct their own monitoring in the SPZ annually.

Groundwater monitoring demonstrated an excess of total dissolved solids, which corresponds to the results of monitoring for the past period. Excess levels of Mn and Fe in groundwaters of the floodplain and the above-flood terrace of Irtysh River are considered to have a natural origin (as concluded in the hydrogeological study issued by JSC "Azimut Energy Services").

10.5.4 Key technical, environmental and social issues

Historical liabilities associated with process waste disposal and releases from site

As discussed above for Aktobe, Cr(VI) forms in ferrochrome furnaces at high temperatures and oxidising conditions and this material enters the process waste streams from the site. There are three waste disposal dams at the site; two are operational (Dam No.2, constructed in 1986, and Dam No.3, constructed in 2008), with a forecast liquidation date of 2029, while liquidation of the oldest dam (Dam No.1, constructed in 1968) commenced in 2007 and is forecast to be completed in 2018. The dams receive furnace slag, sludge from gas cleaning[12], and ash from on-site boiler houses.

There are no records of a liner system being constructed at Dam No.1 (which was constructed in a natural depression, with embankments to increase retention capacity) or Dam No.2; however, the three dams are reportedly underlain by a natural impermeable clay layer of approximately 40 m thickness, sitting below approximately 6 m of surficial sands. Dam No.3 is also bounded by an impermeable bentonite curtain wall to prevent the lateral movement of contaminated leachate into the surficial sands.

Although it is reasonable to assume the pond waters contain Cr(VI), based on groundwater monitoring data for wells located in surficial sands around the perimeter of the dams, Cr(VI) concentrations are consistently less than 0.02 mg/L, which complies with the Kazakh standard of 0.05 mg/L (which itself is equivalent to the World Health Organization’s drinking water limit and below the US Environmental Protection Agency’s drinking water limit of 0.1 mg/L total Cr[13]). While groundwater data show elevated levels of Fe and Mn around the dams (and also below the smelter area), regional studies have reportedly confirmed these are naturally occurring and not linked to industrial activities at AFP (Section 10.5.3).

Permeability of the 40 m clay layer has been tested and estimated to be 0.0004 m/day (0.146 m/year); however, no evidence was provided with respect to the footprint of the clay layer and whether it underlies the entire AFP site or just specific areas or whether the measured permeability is consistent across the entire area. The quality of groundwater below the clay layer (at a depth of approximately 104-113 m) and the potential connectivity to Irtysh River have not been assessed. While the three dams do not appear to be causing contamination of the surficial sandy layer, there is some risk that deeper groundwater may be contaminated through the vertical movement of contaminated water from the dams through the clay layer. The probability of this risk is uncertain, particularly as the water balance for the dams is incomplete and assumptions are made about the extent of water evaporation that have not been verified by measurement. The consequence with respect to remediation liabilities would be significant if such groundwater contamination was proven in the future.

[12] Although dry methods are used alongside wet cleaning of furnace off- gases, dry dusts are slurried and pumped along with wet cleaning sludge to the ponds; this significantly reduces payments associated with permitted emissions as wet wastes are charged at a lower rate than dry wastes.
[13] The USEPA’s limit is derived from risk assessments that assume the total chromium content is present as the hexavalent form.

Closure of Dam No.1 commenced in 2007 and seven out of eight areas have now been closed and revegetated; the final area is expected to be closed in 2018. In the absence of proactive lining for this dam (and Dam No.2), the potential for migration of contaminated water through the 40 m clay layer may be higher than for the more recently constructed and engineered Dam No.3.

Dust emissions

Emissions to air have generally reduced since 2014 through improved treatment of point sources and investment in gas cleaning systems; however, a number of significant fugitive dust sources were noted during the site visit. These include the smelting shops, the alloy recovery plant, furnace recipe preparation facilities, and internal roads (many of which are unsurfaced). Visual observation of snow cover indicates that dust dispersion is largely localised, with snow discolouration limited to a few tens of metres from the point of origin; however, given the dry climactic conditions, it is reasonable to assume during periods of high winds (recorded most frequently in April and May) and dust storms the dispersion of contaminated dust can occur over significantly larger distances. This may be exacerbated by limited precipitation and concomitant washout of airborne dust.

From observations during the site visit, it is apparent that large movements of dusty material in enclosed spaces can expose workers to high short-term dust concentrations; for example, dumping of +10 t of reclaimed slag in the alloy recovery plant resulted in ‘whiteout’ conditions in the immediate vicinity.

Overall, these observations are borne out by air quality monitoring data, which show consistent exceedances of ‘inorganic dust’ within the footprint of the industrial facility. As noted previously, it is assumed that one of the contaminants in the inorganic dust will be Cr(VI) with the potential to affect both workers (if appropriate PPE is not worn) and the wider community if it travels beyond the site boundary.

Occupational exposure to pollutants

See general discussion under this issue under the Aktobe Ferroalloys Plant section above. Air quality monitoring data for Aksu City (approximately 5 km from the smelter) indicates compliance with legal requirements for inorganic dust, CO, SO_2, NO_2, Cr(VI), Mn, and formaldehyde; however, the transfer of contaminated dusts (with specific reference to Cr(VI)) on clothing from the workplace to domestic environment should be reviewed as a potential indirect exposure pathway for workers and their families.

10.5.5 Closure cost (liquidation and rehabilitation)

AFP is legally obliged to prepare liquidation plans and estimate costs for its waste facilities. The closure strategy for the facilities is summarised below and the breakdown of liquidation costs is given in Table 10-7.

Dam No.1 is closed. Kazchrome started rehabilitating parts of the dam in 2008 and plans to complete the work in 2018. Both Dam No.2 and Dam No.3 will be closed and rehabilitated beginning in 2029. The slag dam will be closed and rehabilitated in 2034. The main closure activities include:

- dewatering and drainage;
- levelling terrain;
- application of topsoil; and
- planting vegetation.

According to the liquidation plan, the quality of groundwater quality will be monitored for 30 years after closure.

Table 10-7: Closure cost estimate for AFP waste facilities (based on estimates dating to 2009 and 2010)

Waste facility	Area (ha)	KZTm
Dam No.1	9.77	1,352
Dam No.2	1.24	171
Dam No.3	1.76	243
Slag dam	6.09	842
Total		**2,610**

Funds for closure are provided annually into a liquidation fund (bank deposit) accessed by authorities and the Company for closure purposes only with the current value for the above facilities totalling KZT912m. The 2013 ARO for the above sites was KZT2,647m (Table 10-6), which with inflation is now equivalent to about KZT3,573m (USD10.9m), but this does not account for the KZT794m already spent for reclamation of Dam No.1. With this accounted for, the LoM liquidation cost and the ARO estimate are similar.

SRK believes the cost of fully closing the operations, including demolition of plant and ancillary infrastructure and rehabilitation of disturbed land, is likely to be in the order of USD50m (similar to the additional costs suggested for Aktobe Ferroalloys Plant). This would give a total closure provision of USD61m. The closure costs could be 50% to 100% higher if the operations were found to have caused significant soil and/or groundwater pollution.

10.5.6 Risks, opportunities and recommendations

The environmental impact of ferrochrome production can be effectively contained using existing techniques and processes, such as preventative measures (for example, furnace design and slag composition), treatment of Cr(VI) containing material (for example, chemical treatment) and protection of employees by issuing enhanced PPE and strictly enforcing its use.

As a general comment, AFP personnel appear to deny that the process would produce any Cr(VI), implying conditions where Cr compounds at elevated temperatures are exposed to oxidising conditions would not exist and could not occur. It is SRK’s contention that these conditions can occur, at the very minimum during furnace upset conditions (short electrodes and low furnace burden) and during tapping. This would imply that some Cr(VI) contamination of the dust in the gas extraction system and surrounding areas of the tapping process would occur. Consequently, appropriate and continuous monitoring and measurement of possible Cr(VI) is regarded as a minimum starting point for assessment, particularly in view of ongoing inorganic dust exceedances within the site’s footprint.

As with Aktobe, the cost of closing AFP could be very much higher if significant soil or groundwater pollution was found below the smelter or dams; the quality of deep groundwater should be analysed to assess if any pollution has already occurred and the extent and homogeneity of the reportedly low permeability natural clay layer should be defined.

10.6 Kazmarganets Mine

10.6.1 Environmental and social setting

Kazmarganets operates the Tur mine, located in Nura district of Karaganda region in Central Kazakhstan, some 200 km north east of Zhezkazgan. The nearest settlement is Shubarkol village 89 km southeast of the deposit. The Tur deposit was discovered in 1986 with help of regional-scale geophysics.

The climate is sharply continental, dry, characterised by sharp fluctuations in temperature during the day and year, with strong and quite frequent dry winds. Winter is long and severe, summer is hot and dry. Spring and autumn are characterised by short-term, sharp changes in heat and cold.

The average annual temperature is 3°C, the average temperature in January is -16°C and in July 22°C. The maximum temperature in July is 43°C, the minimum temperature in January is -40°C. The annual precipitation is 200-250 mm, with most of it falling in winter. The duration of snow cover is 140 days or more per year. The area is characterised by strong winds; in summer, the prevailing direction is from the north and west, and in the winter from the east. The wind speed varies from 3-4 m/s to 17-20 m/s.

Kazmarganets' head office is in the city of Karaganda. The ore is crushed and sized at the mine and then transported to Kazchrome's AFP.

Kazmarganets' previous mine, Vostochny Kamys, ceased operations as its resources had been depleted. Reclamation work was completed in 2016. The act of acceptance was signed on 22 December 2016 and therefore Vostochny Kamys mine is no longer Kazmarganets' liability with the exception for camp, road and power lines. It is expected that these infrastructure components will be transferred into Karaganda region's akimat management.

10.6.2 Environmental and social approvals

Kazmarganets' environmental permits are summarised in Table 10-1. The emissions permit is valid for two years. The permit includes total cumulative volumes of permitted emissions, discharges and waste disposal.

Permit renewals are based on draft estimates supporting changes to limits for air emissions, discharges of water and waste disposal from the operation. Water for domestic and industrial uses at Tur mine is abstracted from well No.6e and 6e-2013.

Pollution payments have to be made for the permitted emissions, discharges and waste disposal as outlined in Table 10-2.

One of the conditions of the permit for emissions to the environment is to implement environmental measures envisaged by the EMP. The actual cost of the EMP implantation for 2017 was on budget at KZT1.5B. The biggest cost components of the EMP for 2017 included:

- storage of overburden in the internal waste rock dump (71.3% of the total cost); and
- reclamation of Vostochny Kamys mine (22.4% of the total cost).

The estimated EMP cost for 2018 is KZT1.4B.

10.6.3 Environmental monitoring

The environmental monitoring programme was provided for 2015 and 2016. Based on the programme, the plant undertakes quarterly control monitoring of air emission, discharges, and waste disposal, and the results of monitoring are reported to the Department of Ecology. Monitoring is carried out by two laboratories, Ecoexpert LLP and Centrgeolanalit LLP. Based on the monitoring, an exceedance of nitrogen ammonium concentrations was registered in the second quarter of 2016. There were no exceedances in air emissions and waste disposal limits.

Environmental impact monitoring is carried out on the basis of programmes and schedules. In 2016, environmental monitoring was carried out in the second and third quarter. There were no exceedances registered for air quality, surface water quality, and soil. Monitoring of surface water quality at several monitoring points on the river Bas Aktuma, pit water and settling pond registered exceedances in Li, Nb, P, Fe, Mn, Ni, P, and Pb. Monitoring of surface water is submitted to the Karaganda regional Department of Ecology.

The 1998 report of geological resource estimation at the Tur deposit provides a baseline description of surface water quality that explains the high concentrations of Li, Nb, P, Fe, Mn, Ni, P, and Pb. The report states that the chemical contamination of the surface is mainly due to natural factors, the chemical composition of the main lithologic-stratigraphic complexes of rocks, loose sediments, soils, and the presence of ore-prospecting zones, deposits, and manifestations of minerals. Since the exceedances in Li, Nb, P, Fe, Mn, Ni, P, and Pb are considered to be naturally occurring, the results are not deemed as contamination by regulator and there is no requirement for Kazmarganets to take remedial action.

Groundwater monitoring is carried out by hydrogeologists separately from the environmental monitoring. There are 11 monitoring wells in and around the open pit and along the reaches of river Bas Aktuma. Monitoring in 2016 did not register exceedance of MACs set for drinking water in Kazakhstan.

10.6.4 Key technical, environmental and social issues

No significant technical, environmental or social issues were identified.

10.6.5 Closure cost (liquidation and rehabilitation)

The liquidation schedules and costs for the facilities are summarised in Table 10-8. SRK notes the values given here to do not align with the corporate numbers provided in Table 10-6.

Table 10-8: Closure cost estimate and schedule for Kazmarganets

Mine	Scheduled liquidation and reclamation	Estimated closure cost (KZTm)
Vostochny Kamys	2013-2016	629
Tur	2017-2022	829
Total		**1,458**

Although the estimated cost of Vostochny Kamys liquidation and rehabilitation was KZT629m, the actual cost of completed reclamation and liquidation work was KZT386m. The decrease in the cost was caused by the lower cost of services provided by sub-contractor ZemDorStroy LLP. The same sub-constructor has been selected to do reclamation works for Tur mine.

The OVOS of Vostochny Kamys reclamation and liquidation design was approved in December 2015. An act of acceptance for completion of the work was signed by the committee commissioned by Minister of Investment and Development on 22 December 2016 and therefore Vostochny Kamys mine is no longer Kazmarganets' liability with the exception of the camp, road, and power lines. The Company assumes these infrastructure components will be transferred into Karaganda region's akimat management.

Tur mine started reclamation works in 2017. The closure works are expected to take six years and will be complete in 2022.

The liquidation and reclamation design of Tur mine includes:

- regrading and revegetation of the waste rock dumps;
- flooding of the open pit (forecast to take 2.8 years);
- demolition and removal of the crushers;
- removal of the pipelines and powerlines; and
- closure of the wells.

An EIA (OVOS) was developed for the Tur mine liquidation and reclamation design in 2015. Planned reclamation and liquidation design of Tur mine is in line with legal requirements and SRK assumes the reclamation work will be accepted by the inspecting committee in 2022 if it is undertaken to the same standard as done for Vostochny Kamys. The design does not include post-liquidation monitoring and this does not appear to be required by the regulatory authorities.

All 592 employees of Kazmarganets are expected to be transferred to different ERG companies after reclamation and liquidation works are completed at Tur mine. A number of employees have already transferred to neighbouring Shubarkol coal mine. With no associated town, social closure impacts are expected to be minimal.

The 2013 ARO for the asset was KZT1,146m (Table 10-6), which is in the same order of magnitude of the liquidation costs given above. Although this did not include provision for closure and reclamation of the processing and supporting infrastructure, as the Vostochny Kamys mine has already been closed, SRK believes the remaining cost of closure will be similar to that allowed for in 2013, which inflated to today's terms amounts to KZT1,547m (USD4.7m).

10.6.6 Risks, opportunities and recommendations

No significant environmental and social risks that could stop the operation or significantly affect the value of the asset were identified during the review of the Tur mine.

10.7 Opportunity to improve adherence to GIIP

To aid Kazchrome in its stated aim for continuous improvement, comment is provided here on SRK's perception of adherence of the assets with GIIP, recognising this was not the main objective of SRK's scope and the review was not detailed enough to enable a full compliance assessment to be made. SRK considers GIIP to be represented by guidelines and standards such as:

- IFC Performance Standards (2012);
- World Bank Group Environmental, Health and Safety Standards (2007); and
- Other voluntary codes or guidelines for the mining industry.

H&S performance appeared to be broadly in line with GIIP so is not discussed further here. The sections below provide comment with respect to aspects where closer adherence to GIIP would benefit Kazchrome.

There is an inherent assumption at the mines that if regulatory compliance is achieved, then impacts on sensitive receptors are not occurring. With the current global trend of increased awareness of environmental issues and increased litigation, the mines need to shift their environmental impact definition and monitoring paradigms beyond regulatory compliance.

SRK notes that ISO certification is procedural in nature rather than establishing specific standards. So Kazchrome can be certified because it has appropriate management systems in place, but this is not necessarily guarantee of robust performance. This is recognised as a weakness of 14001 and 18001. There is overlap with GIIP and it is better to be certified than not.

10.7.1 Environmental management

The legal compliance approach to environmental management is standard throughout Kazakhstan, but does mean there is a general lack of ownership of potential environmental impacts or liabilities arising from the assets. There is a lack of interest to undertake studies to fully evaluate impacts and prepare for the future unless specifically required by the regulator.

The assets have insufficient understanding of environmental and social context and do not use the full potential of monitoring to ensure or prove they not having impacts, individually and cumulatively. For example, monitoring data is only collected at the points specified by the regulator and only for the parameters stipulated (the reasons behind the locations and choice of parameter suite are generally not understood or queried). This has the following monitoring programme limitations making appropriately characterising potential liabilities challenging:

- Parameter suites are limited so full quality control cannot be undertaken on the data (for example cation/anion balances).
- The locations are not necessarily located to facilitate an understanding of the potential impacts (and few of the monitoring programmes had comprehensive maps showing the locations of the monitoring points).
- Some key parameters are not being analysed for, for example particulate matter with a diameter less than 10 µm (known as PM_{10}) is not being monitored either for the emissions or ambient air quality. This means health impacts on communities (and staff) may not be fully understood.
- Quality of the data does not appear to be queried by the environment teams; for example, at Aktobe, many of the ambient air quality monitoring data are reported as 0, which in the case of things like NO_2 and SO_2 is basically impossible considering the industrial setting.

The same was observed for Cr(VI) at both Donskoy and Aktobe. It may be they were found at the limit of detection but this was not stated.

- Data is only assessed each time it is collected against the relevant norm and the data is not stored in a database that enables trends to be evaluated on a regular basis with this resulting in the site not being able to easily:
  - track a deterioration in performance that might result in a future non-compliance;
  - assess if there are spatial characteristics in the data that might indicate a problem which could be resolved before it gets notified to the regulatory authorities;
  - determine if a particularly high or low data result is clearly an outlier and thus potentially due to sample collection or laboratory analysis error.

As noted above, there is an inherent assumption that if regulatory compliance is achieved then impacts on sensitive receptors are not occurring or if they are occurring this is considered acceptable to the authorities. The general historical compliance by the Company with Government requirements may mean that regulatory action is unlikely to be taken against the Company for past problems; however, regulations change and it is expected they will become more stringent over time, particularly with respect to closure and rehabilitation. There is also a current global trend of increased awareness of environmental issues and increased litigations, meaning that future risks associated with weak environmental management (such as not fully understanding an asset's liabilities) may not be restricted to regulatory non-compliance but rather to community action for historical impacts against which the Company cannot defend itself due to a lack of robust data.

The Company puts itself at risk if it does not acknowledge potential future issues (by, for example, not doing a proper water balance, not continuously monitoring Cr(VI) and other key pollutants, not undertaking detailed hydrogeological studies, not commissioning cumulative impact assessments etc). Waiting until regulators or community action is taken may mean the issues will be that much worse and more expensive to address, even in a scenario where retrospective liability is not strictly applied. The Company has the opportunity to undertake internal programmes to get a better handle on a range of issues that will facilitate the Company preparing a long-term strategy to address those that are most urgent.

10.7.2 Cumulative effects assessment

In the case of Aktobe, the ferroalloys plant is only one of five major industrial activities associated with the town. GIIP acknowledges that in situations where there are multiple potential sources of contaminants that one industry cannot attempt to solve the problems on its own, and that a cumulative effects assessment would be needed that involves as a minimum the relevant industries and government working together. Ideally, such an assessment would also actively involve local community representatives. There is an opportunity for Kazchrome to take a proactive lead in trying to mobilise the other industries and government to address this issue in a constructive manner, particularly with respect to groundwater seepage of Cr(VI) and general air quality.

10.7.3 Stakeholder engagement

A basic fundamental of GIIP is an active two-way communication with local communities. This generally involves a stakeholder engagement plan and regular interaction with a representative group from the community.

The OVOS public hearings do not fully meet the intent of GIIP. It was also noted that with respect to Kazmarganets, the hearings do not necessarily include the closest affected community. This is because the law requires public hearings to be held in the district capital, which, in this case, is 200 km from the mine. Although the closest (and potentially most impacted) community is still far away (50 km), no hearing was held there.

Linked with appropriate engagement is an effective community complaints or grievance system that actively encourages feedback from the community (without fear of reprisal) and allows for issues to be investigated in an open and transparent way.

Kazchrome currently does not have systems in place that would be considered compliant with GIIP. Although routes for complaints to be received and addressed exist this often involves regulators and thus may discourage some people from complaining.

10.7.4 Community investment

There is active social investment taking place above and beyond what is required by Kazakhstan law (Section 10.2.4). This is broadly in line with GIIP; however, there are two areas where Kazchrome has an opportunity to better align with GIIP principles:

- Firstly, the current programmes focus on community development where it would benefit staff and, although this is admirable, consideration should also be given to those communities most directly impacted by the operations (particularly around Aktobe); and
- Secondly, the current programmes focus on infrastructure development, educational and cultural/sporting activities. There does not seem to be much attention paid to developing alternative livelihoods in the affected communities, which would support the broader economic development of these communities and provide sustainable opportunities beyond the life of the current operations. This is particularly relevant at Aktobe where retrenchments as a result of the closure of Shops 1 and 2 are expected in the next few years (Section 10.4.4).

11 ECONOMIC ASSESSMENT

An economic assessment of the Ore Reserve has been undertaken, including the Donksoy, Aktobe, Aksu and Kazmarganets operations, including the Akzhar tailings retreatment. This exercise has been undertaken in an Excel based LoMp, in United States Dollar and nominal money terms.

The inputs and outputs presented here include all adjustments made by SRK. The inputs have been sourced from the production schedule and financial model provided by the Company. SRK notes the following:

- the Company's financial model reflects its strategic plans. As such, there may differences between the strategic plan and those generated by the departments at the operations;
- the production schedule is as prepared by the mining department, which drives the production of Donskoy products (crushed ore, fine and lump concentrates) and smelter products (notably HC, MC and LC FeCr); and
- the production schedule has been limited by the Mineral Resource and extends to 2051. The Company's financial model extends to 2026. SRK has projected operating and capital costs going forwards in line with projected production.

11.1 Economic Parameters

11.1.1 Taxation

The economic assessment has been undertaken pre-corporate income tax. As such, depreciation has neither been modelled.

The LoMp includes royalty payments (mineral extraction tax). The formula is based on a calculated value of the contained chrome (Cr) at a price of approximately USD70/t Cr. A correction, between 13% and 34% reduction, is applied in recognition of the actual grade of the ore mined versus that stipulated in the subsoil use agreement. The tax rate applied to the calculated Cr value is 16.2%. A royalty is equally payable in relation to the Tur manganese Ore Reserves, applying a rate of 2.5% of the calculated manganese value.

11.1.2 Macro-Economic Assumptions

The exchange rates and inflation indices applied are presented in Table 11-1.

The Company applied different inflation rates for the costs of power and labour. Notably, the labour inflation is higher than that KZ inflation presented in Table 11-1. The nominal prices for Brent crude oil have also been projected by the Company.

Table 11-1: Macro Economic Assumptions

	2017	2018	2019	2020	2021	2022 onwards
USD/KZT	327	332	328	320	315	315
KZ inflation	-	-	5.8%	5.6%	5.5%	5.2%
US inflation	-	-	2.2%	1.7%	1.9%	1.9%

11.1.3 Commodity Prices

The commodity prices applied in the LoMp are presented in Table 11-2, as presented in the Company's financial model. These are the Company's internal forecasts and have not been independently verified, although are in line with prices achieved during 2017.

Table 11-2: Commodity Prices (USD/t product, nominal)

	10 Yr Ave	LoMp Ave	2017[1)]	2018	2019	2020	2021	2022	2023	2024	2025
Chrome Ore [2)]	**90**	**90**	70	90	90	90	90	90	90	90	90
Akzhar Conc	**249**	**249**	258	240	245	249	254	259	264	269	274
Aksu HC FeCr	**1,656**	**2,383**	1,404	1,368	1,385	1,416	1,640	1,690	1,714	1,756	1,799
Aktobe HC FeCr	**1,609**	**2,273**	1,350	1,361	1,362	1,380	1,613	1,663	1,731	1,773	1,808
Aksu LC FeCr	**3,420**	**4,669**	-	-	-	-	-	-	3,254	3,333	3,416
Aktobe LC FeCr	**3,074**	**3,074**	2,535	2,775	2,883	2,929	3,374	3,402	-	-	-
Aktobe MC FeCr	**2,967**	**2,967**	2,341	2,746	2,799	2,843	3,170	3,272	-	-	-
Aksu FeSiCr 40	**1,593**	**2,237**	1,334	1,347	1,382	1,408	1,551	1,603	1,602	1,641	1,685
Aksu FeSiCr 48	**1,477**	**2,008**	1,156	1,154	1,275	1,308	1,418	1,459	1,502	1,539	1,581
Aksu FeSiMn	**1,157**	**1,157**	1,059	1,090	1,131	1,161	1,173	1,222	-	-	-
Aksu FeSi 75	**1,106**	**1,531**	995	1,005	1,030	1,057	1,084	1,113	1,141	1,171	1,202
Aktobe FeSi 15 [2)]	**1,811**	**2,221**	1,815	1,800	1,800	1,800	1,800	1,800	1,800	1,800	1,800

1) 2017 actual is an updated estimate during Q4 2017
2) SRK notes that the prices are flatlined for some of the products (chrome ore, FeSi15), which suggests that when presented in real terms, and are decreasing over time. This has a minimal impact on the overall revenue as these are minor contributors.

11.1.4 Working Capital and Stocks Values

Working capital has not been considered, notably as the operations are at steady state. No value has been attributed to saleable product stocks held. The stockpiles of Donskoy products that feed the smelters have been included in the production plan.

11.2 Production and Revenue

The LoMp is based on the Ore Reserve production schedule and calculates revenues for the respective saleable products. The production schedules through to revenue are presented in Table 11-3 through to Table 11-6, and Figure 11-1 through to Figure 11-6.

SRK notes the following:

- the mining schedule ends in 2051. From 2023 onwards, all mining is from DNK;
- ore grades increase as a result of higher grades at DNK;
- the Akzhar concentrate numbers presented only include the saleable tonnages; some additional production is consumed by the pelletising plant;
- the mining schedule generated more ore than is consumed by the smelters. This results in ore being stockpiled and processed between 2051 and 2054. The Company is planning additional operational improvements to the smelters to increase their production rates, however these additional plans are not included in the life of mine plan as this stage;
- the reduced mining production between 2022 and 2025 is due to the drop in ore mining as Molodezhnaya comes to an end and DNK continues to ramp up to full production. During this period, the process plants will be fed with stockpiled ore (amounting to approximately 2.2 Mt RoM over the 4-year period). The smelter forecasts will also be met by consuming the currently stockpiled Donskoy products (totalling 1.13 Mt);
- Aktobe's Shops 1 and 2 are planned to be shut down in 2022, hence the cessation of MCFeCr and LCFeCr products from Aktobe. Aksu commences the production of LCFeCr in 2023; and
- the main revenue generating products are the Aksu and Aktobe HCFeCr, accounting for some 80% to 90% of revenue during the LoM. The next important product is LCFeCr, accounting for some 5% and 7% of revenue.

Table 11-3: Donskoy Mining Schedule

		10 Yr Total	LoMp Total	2017 Actual[1)]	2018 Plan	2019 Plan	2020 Plan	2021 Plan	2022 Plan
Tonnage									
Molodezhnaya [2)]	(kt)	10,120	10,120	2,380	2,200	2,200	2,200	1,880	1,210
Yuzhny	(kt)	2,324	2,324	820	600	600	470	390	264
DNK	(kt)	39,162	167,502	2,380	2,792	3,200	3,330	3,538	3,430
Total	(kt)	**51,606**	**179,946**	**5,580**	**5,592**	**6,000**	**6,000**	**5,808**	**4,904**
Grade									
Molodezhnaya	(% Cr_2O_3)	40.5	40.5	37.1	40.4	40.5	40.5	40.5	40.3
Yuzhny	(% Cr_2O_3)	43.2	43.2	44.2	43.6	43.8	42.9	42.7	42.2
DNK	(% Cr_2O_3)	40.1	42.1	37.3	38.2	39.1	39.4	39.6	39.6
Total	(% Cr_2O_3)	**40.3**	**42.0**	**38.2**	**58.7**	**61.0**	**61.9**	**64.2**	**67.6**

1) 2017 actual is an updated estimate during Q4 2017
2) The Molodezhnaya tonnage includes some 0.34 Mt at 35.9% Cr_2O_3 from the Dubersai deposit.

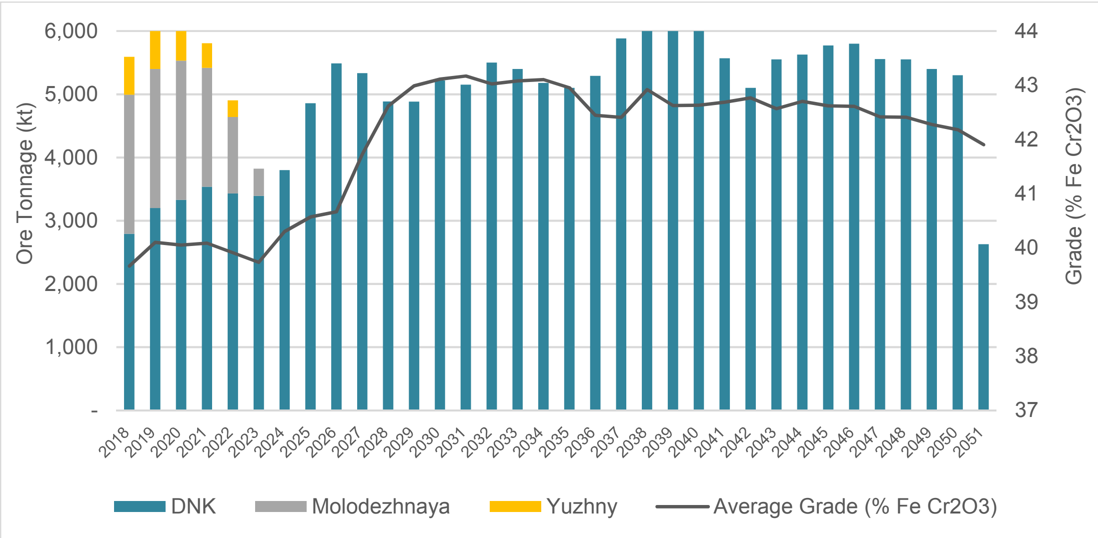


Figure 11-1: Donskoy Mining Schedule, Tonnage by Mine

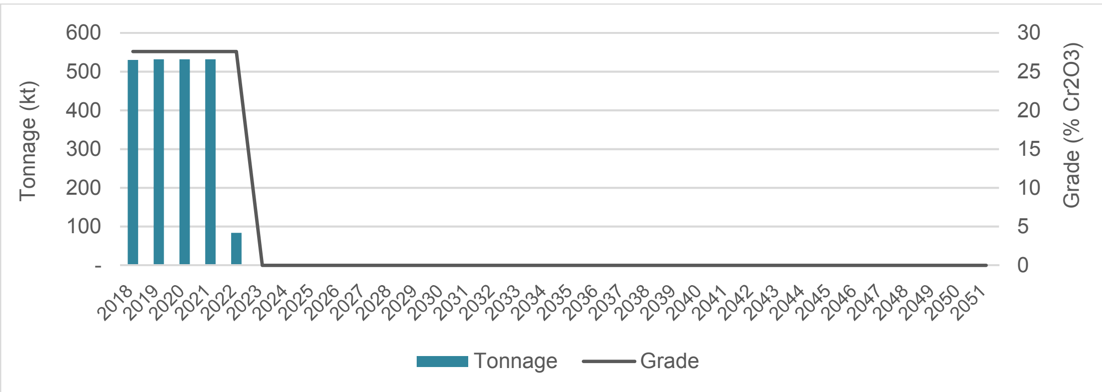


Figure 11-2: Re-treatment of Tailings at Akzhar

Table 11-4: Donskoy and Akzhar Products

	10 Yr Total	LoMp Total	2017 Actual[1)]	2018 Plan	2019 Plan	2020 Plan	2021 Plan	2022 Plan
Tonnage (kt)								
DOF1 & FOOR								
Fines	9,544	35,444	441	705	1,119	1,115	932	832
Lump	15,273	61,757	1,950	1,617	1,687	1,686	1,594	1,545
Pellets	10,266	37,068	770	995	863	881	897	1,167
Total	**35,084**	**134,270**	**3,161**	**3,317**	**3,668**	**3,683**	**3,424**	**3,543**
Akzhar [2)]								
Akzhar	331	331	78	17	102	100	96	16
Grade (%Cr_2O_3)								
DOF1 & FOOR								
Fines	50.4	50.4	50.2	50.4	50.4	50.4	50.4	50.4
Lump	47.1	47.1	48.4	47.1	47.1	47.1	47.1	47.1
Pellets	51.2	51.2	51.5	51.2	51.2	51.2	51.2	51.2
Total	**49.3**	**49.2**	**49.5**	**49.1**	**49.1**	**49.1**	**49.1**	**49.3**
Akzhar [(2)]								
Akzhar	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0

1) The 2017 actual is an estimate calculated by SRK from the various input figures, updated in Q4 2017
2) Akzhar tailings retreatment

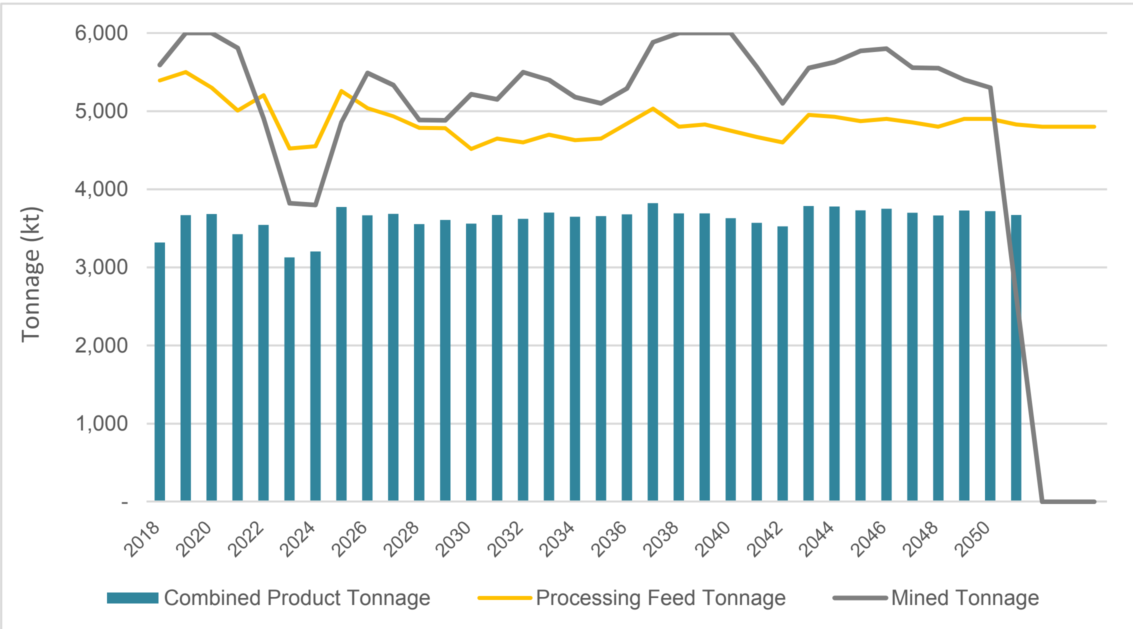


Figure 11-3: Donskoy Product Schedule, excluding Akzhar Concentrate

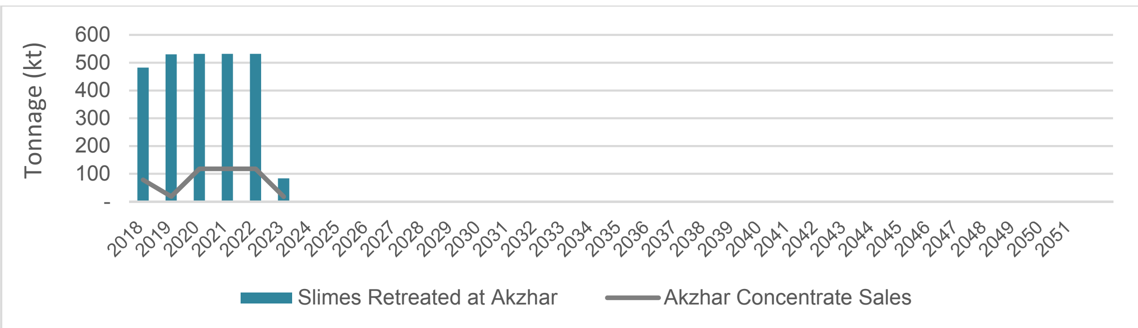


Figure 11-4: Akzhar Concentrate Sales Schedule (excludes internal consumption of Akzhar concentrate, notably in 2019)

Table 11-5: Saleable Products

(kt)	10 Yr Total	LoMp Total	2017 Actual[1)]	2018 Plan	2019 Plan	2020 Plan	2021 Plan	2022 Plan	2023 Plan
Chrome Ore to Serov	1,125	1,125	489	500	500	125	-	-	-
Akzhar Concentrate	331	331	78	17	102	100	96	16	-
Aksu HCFeCr	9,834	39,217	812	835	893	826	856	869	1,103
Aktobe HCFeCr	4,992	16,192	467	549	625	666	530	537	399
Aksu LCFeCr	288	1,821	-	-	-	-	-	-	54
Aktobe LCFeCr	245	245	39	48	49	50	49	49	-
Aktobe MCFeCr	53	53	21	10	10	11	11	11	-
Aksu FeSiCr 40	376	1,549	29	38	25	27	33	33	45
Aksu FeSiCr 48	97	387	14	6	6	9	10	11	14
Aksu FeSiMn	345	345	65	61	74	74	62	74	-
Aksu FeSi 75	196	572	30	27	29	29	29	14	10
Aktobe FeSi 15	13	51	1	1	1	1	1	1	1

1) 2017 actual is an estimate calculated by SRK form the various input figures, updated in Q4 2017.

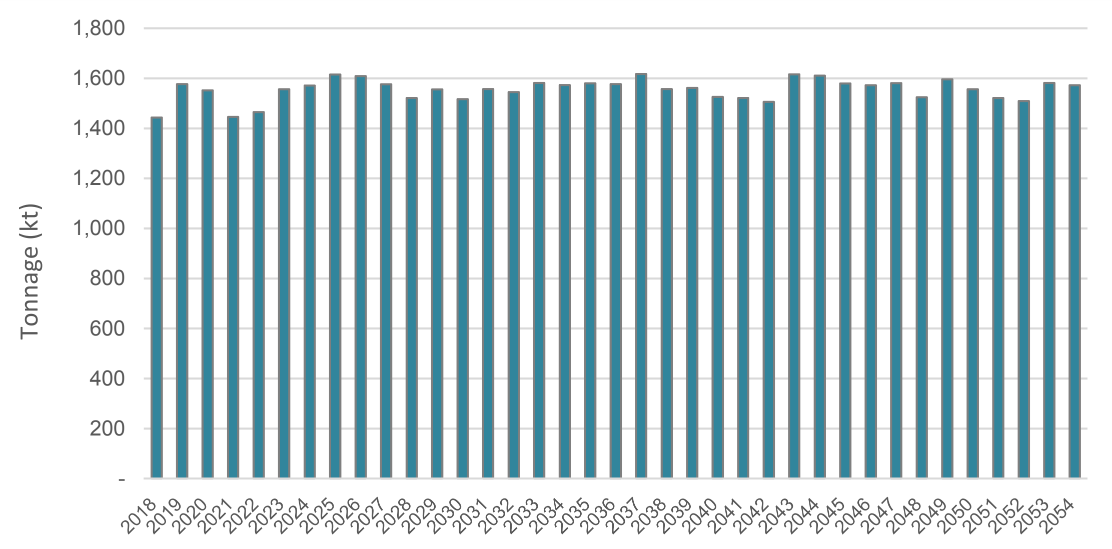


Figure 11-5: FeCr Product Schedule, including HC, MC, LC

Table 11-6: Sales Revenue, Nominal

(USDm)	10 Yr Total	LoMp Total	2017 Actual[1)]	2018 Plan	2019 Plan	2020 Plan	2021 Plan	2022 Plan	2023 Plan
Chrome Ore to Serov	101	101	34	45	45	11	-	-	-
Akzhar Concentrate	83	83	20	4	25	25	24	4	-
Aksu HC FeCr	16,427	96,955	1,140	1,143	1,236	1,169	1,404	1,468	1,891
Aktobe HC FeCr	8,046	38,559	630	748	851	919	854	892	691
Aksu LC FeCr	984	8,838	-	-	-	-	-	-	174
Aktobe LC FeCr	753	753	100	133	141	145	167	167	-
Aktobe MC FeCr	156	156	49	29	29	30	34	35	-
Aksu FeSiCr 40	599	3,621	39	51	34	38	50	52	72
Aksu FeSiCr 48	144	815	16	7	8	12	15	16	21
Aksu FeSiMn	399	399	69	66	84	86	72	90	-
Aksu FeSi 75	216	912	30	27	30	30	31	16	12
Aktobe FeSi 15	24	116	2	2	2	2	2	2	2
Total	**27,932**	**151,308**	**2,131**	**2,255**	**2,486**	**2,468**	**2,654**	**2,742**	**2,863**

1) 2017 actual is an estimate calculated by SRK from the various input figures, updated in Q4 2017.

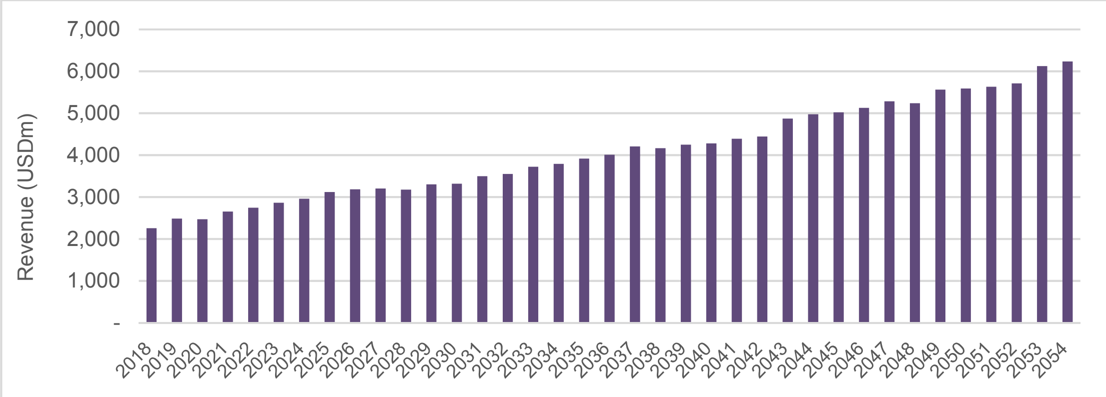


Figure 11-6: LoM Sales Revenue, Nominal

11.3 Operating Costs

The Company's financial model formed the basis of the operating costs as presented below. SRK has made adjustments where seen fit, with regards to mining method applied and production schedule fluctuations. A summary of the LoMp operating is presented in Table 11-7 and Figure 11-7. The operating costs relative to the sales revenue is shown in Figure 11-8. The trend is relatively flat.

SRK notes the following in respect of the operating costs:

- The Company changed the categorisation of costs in 2017. Notably, a large element of costs falling under mining, processing and smelting is now attributed to "Other". This has made the comparison of individual costs difficult. SRK has therefore focused on the overall costs, and the new forecasts. "Other" includes transport, workshops, costs, and various auxiliary and miscellaneous costs. This revised way of reporting costs, also makes any reconciliation with prior to 2017 difficult.
- Mining: The mining costs take account of the different mining methods. Average assumptions have been made to guide minor adjustments made, notably a cut and fill average cost of USD60/t has been used; and USD30/t for caving methods. Whereas the mechanised mining may reduce the cost to say USD15/t for Phase 2, this has not been considered; nor has an increased cost for the unlikely reinforced caving method proposed by the Company. The proportion of cut and fill increases from 5% in 2018, to between 20% and 35% from 2022 onwards. Mining costs are only a small portion of overall operating costs, and any changes in them do not materially impact on overall economics.
- Processing and smelting costs: SRK has accepted the Company's costs and projecting these applying inflation.
- The cost of mining and delivering the Kazmarganets manganese ore to the smelters is included in the smelter operating costs.
- Smelter costs are competitive, with the low unit cost of power being a main contributor. The sustainability of such low price may be questioned.
- Royalties have been included in the operating costs.
- SRK has made an allowance for closure costs for Donskoy, Aktobe, Aksu and Kazmarganets, respectively amounting to USD26m, USD67m, USD61m and USD5m (based on Table 10-6, in nominal terms). These have been inflated and applied in the last

year of the asset's operation; namely 2054 for Donskoy and the smelters, and 2020 for Kazmarganets.

- No overall or specific contingencies are deemed required nor have been added.
- SRK has not reviewed the 2018 approved budget to compare this with the Company financial model, to see the magnitude of any differences.

Table 11-7: Operating Costs Summary, Nominal

(USDm)	10 Yr Total	LoMp Total	2017 Actual[1],	2018 Plan[2]	2019 Plan	2020 Plan	2021 Plan	2022 Plan	2023 Plan
Mining	**329**	**2,078**	132	25	27	29	31	29	28
Processing	**489**	**2,820**	81	38	39	41	44	52	49
Smelting	**5,416**	**29,150**	553	454	510	521	517	531	533
Other	**3,698**	**19,903**	59	309	349	398	399	395	341
Royalties	**443**	**1,810**	49	51	55	55	53	45	33
SG&A	**1,231**	**6,633**	131	102	109	119	127	131	113
Distribution	**163**	**863**	18	13	14	15	16	17	17
Asset Closure	**5**	**331**	-	-	-	5	-	-	-
Total	**11,773**	**63,588**	**1,024**	**992**	**1,102**	**1,183**	**1,188**	**1,199**	**1,114**

1) 2017 actual is an estimate calculated by SRK from the various input figures, updated in Q4 2017.
2) The difference in categorisation can be clearly seen, as "Mining", "Processing" and "Smelting" decrease from 2018 onwards, and "Other" significantly increases.

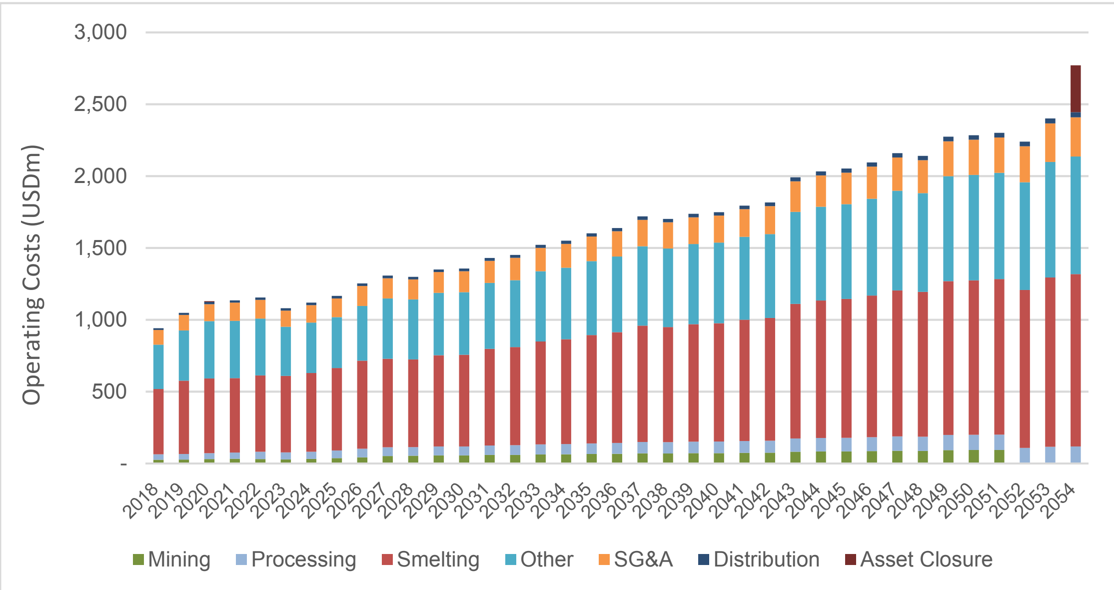


Figure 11-7: Operating Costs, Nominal (USDm)

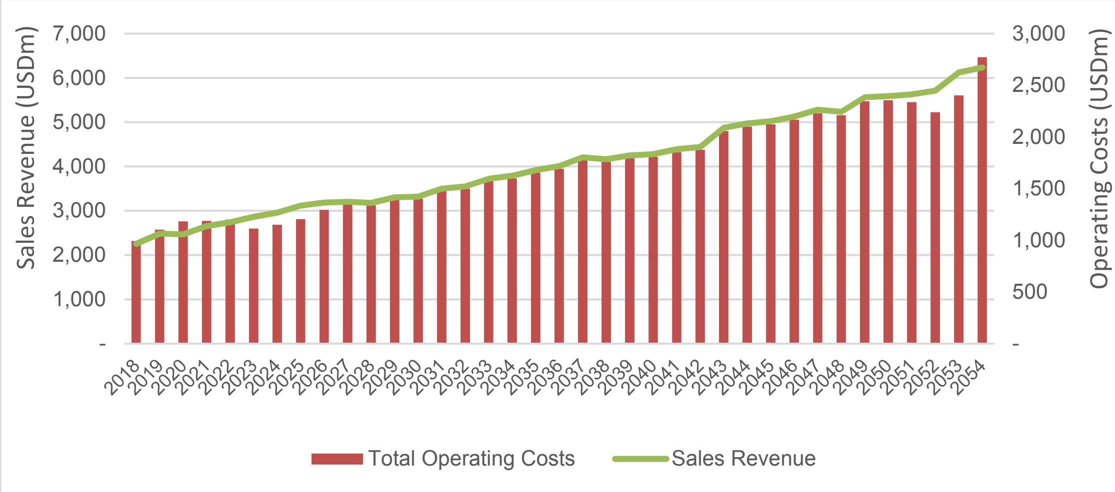


Figure 11-8: Operating Costs vs Revenue Nominal (USDm)

11.4 Capital Expenditure

A summary of the LoM capital expenditure plan is presented in Table 11-8 and Figure 11-9. SRK notes the following in respect of the capital expenditures:

- Donskoy expansion capital expenditure includes, in 2018 real money terms:
  - USD660m of expansion capital between 2018 and 2026;
  - an annual average USD70m of additional sustaining capital for the duration of mining operations;
  - the planned pre-feasibility study (US2.7m), drilling (USD2.5m), new plant, shaft and rolling stock (USD5m) in 2018; and
  - the relocation of the reservoir in 2019 (USD60m).
- Aktobe expansion capital include the capital required to made the required modifications to smelting Shop 4;
- Aksu expansion capital includes USD158m for reconstruction/upgrading of the four furnaces of Shop 6, with the remainder to be spend on modifications to two furnaces of Shop 4;
- whereas the operating costs are driven by the smelters, notably due to power consumption, the highest capital costs are attributed to Donskoy, notably mining; however, the magnitude of capital costs is far smaller than that of the operating costs; and
- capital costs have only been projected in detail up to 2026 inclusive; thereafter, an allowance for sustaining capital has been calculated based on an average of the previous years.

Table 11-8: Capital Expenditure Summary, Nominal

(USDm)		10 Yr Total	LoMp Total	2017 Actual	2018 Plan	2019 Plan	2020 Plan	2021 Plan	2022 Plan	2023 Plan
Donskoy										
	Expansion	**750**	**750**	46	70	141	79	63	87	75
	Sustaining	**788**	**3,871**	69	83	79	63	78	73	95
Aktobe										
	Expansion	**66**	**66**	11	39	19	8	-	-	-
	Sustaining	**233**	**1,151**	19	18	27	36	25	30	29
Aksu										
	Expansion	**335**	**335**	22	13	33	36	53	31	71
	Sustaining	**483**	**2,387**	62	47	69	39	53	63	66
Kazmarganets										
	Sustaining	**7**	**7**	2	3	2	1	-	-	-
Total										
	Expansion	**1,151**	**1,151**	79	122	193	123	116	118	146
	Sustaining	**1,511**	**7,416**	152	151	177	140	156	165	190
	Total	**2,661**	**8,566**	231	273	370	263	272	283	336

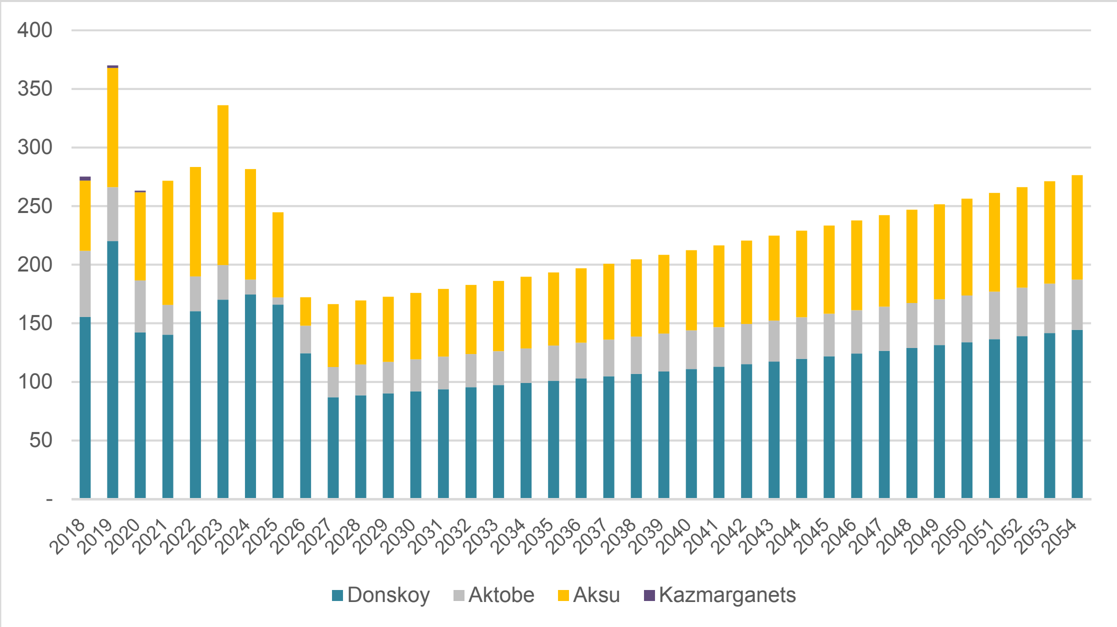


Figure 11-9: Capital Costs, Nominal (USDm)

11.5 Economic Analysis

The asset, comprising the Donskoy, Kazmarganets and the smelters, are profitable on an annual basis, for the life of the mine. The operating profit and free cash flow, both pre-tax, are presented in Table 11-9 and Figure 11-10.

Table 11-9: Operating Profit and Free Cash Flow, Nominal

(USDm)	10 Yr Total	LoMp Total	2017 Act[1)]	2018 Plan	2019 Plan	2020 Plan	2021 Plan	2022 Plan	2023 Plan
Revenue	**27,932**	**151,308**	2,131	2,255	2,486	2,468	2,654	2,742	2,863
Operating Costs	**-11,773**	**-63,588**	-1,024	-992	-1,102	-1,183	-1,188	-1,199	-1,114
Operating Profit, Pre-Tax	**16,159**	**87,720**	**1,107**	**1,263**	**1,384**	**1,285**	**1,466**	**1,543**	**1,750**
Capital Costs	**-2,661**	**-8,566**	-231	-273	-370	-263	-272	-283	-336
Free Cash Flow, Pre-Tax	**13,498**	**79,153**	**875**	**990**	**1,014**	**1,022**	**1,194**	**1,260**	**1,414**

1) 2017 actual is an estimate calculated by SRK from the various input figures, updated in Q4 2017.

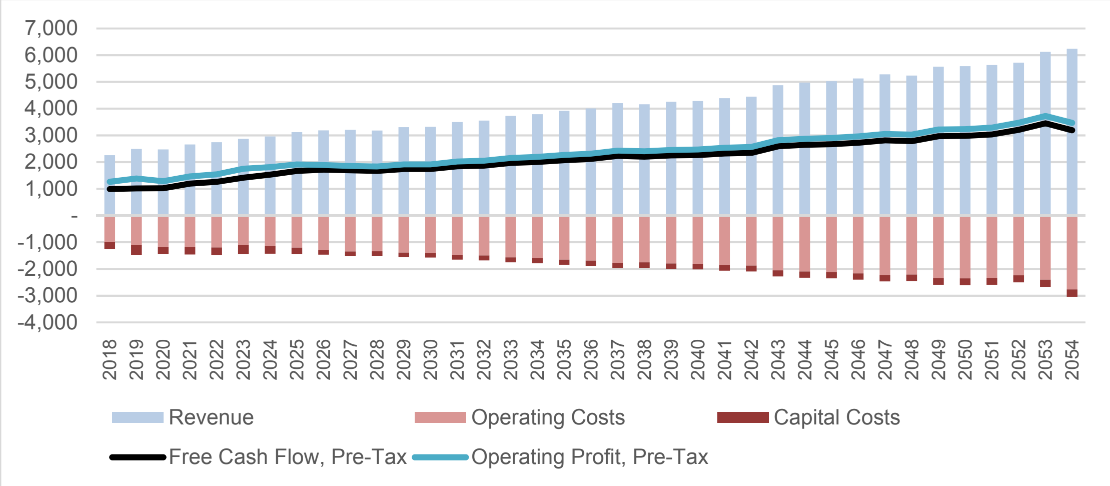


Figure 11-10: Operating Profit and Free Cash, Nominal (USDm)

11.6 Conclusion

The profitability of Kazchrome is convincingly demonstrated. The key sensitivity is to commodity prices, followed by operating costs, notably the cost of power.

The dip in mining production in years 2023 and 2024 shows the impact of a shortfall in ore feed to the plants. This shortfall is made up from stockpiled RoM in the previous years and existing Donskoy products. This reinforces the importance of advancing the Donskoy projects which relate to mining. Delivery of run of mine tonnage at the required grade will remain critical for the life of mine.

Based on the robust economics of the asset as demonstrated here, the Donskoy Ore Reserves are confirmed to be viable based on the assumptions made.

12 DONSKOY MINERAL RESOURCE AND ORE RESERVE STATEMENT

The terms and definitions outlined in the JORC Code have been adopted for the reporting of Mineral Resources and Ore Reserves. The JORC Code is published by the Joint Ore Reserves Committee of the Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and Minerals Council of Australia, and has been developed with the input of the Committee for Mineral Reserves International Reporting Standards.

The Competent Person who has reviewed the Mineral Resources as reported by the Company is Dr Lucy Roberts, a Competent Person who is a Member of The Australasian Institute of Mining and Metallurgy. Dr Roberts is a Principal Consultant (Resource Geology) and a full-time employee of SRK. Dr Roberts has sufficient experience that is relevant to the style of mineralisation and type of deposit under consideration and to the activity being undertaken to qualify as a Competent Person as defined in the 2012 Edition of the JORC Code. Dr Roberts consents to the inclusion in this report on the matters based on her information in the form and context in which it appears.

The Competent Person who has reviewed the Ore Reserves and the LoMp as reported by the Company is Mr Jurgen Fuykschot, a Competent Person who is a Member of The Australasian Institute of Mining and Metallurgy. Mr Fuykschot is a Principal Consultant (Mining) and a full-time employee of SRK. Mr Fuykschot has sufficient experience that is relevant to the style of mineralisation and type of deposit under consideration and to the activities being undertaken to qualify as a Competent Person as defined in the 2012 Edition of the JORC Code. Mr Fuykschot consents to the inclusion in this report on the matters based on his information in the form and context in which it appears.

SRK understands that Kazakhstan has introduced a national reporting code, namely "*The 2016 Kazakhstani Association for Public Reporting of Exploration Results, Mineral Resources and Mineral Reserves"* ("KAZRC"), as prepared by the Kazakhstani Association for Public Reporting of Exploration Results, Mineral Resources and Mineral Reserves (the KAZRC Association) with the support of the Committee of Geology and Subsoil Use of the Ministry of Investments and Development of the Republic of Kazakhstan and KAZRC Association founders. To the best of SRK's knowledge, no date has set for the introduction of the KAZRC.

Both the JORC Code and KAZRC are reporting codes which have been aligned with the CRIRSCO reporting template. As such, SRK finds that, in principle, the Kazchrome Mineral Resource and Ore Reserve should be able to be re-reported under KAZRC. SRK's comments and recommendations would be expected to remain under KAZRC. No discussions have been held with the Company, in relation to reporting under KAZRC. At present, SRK has continued to report under the JORC Code.

12.1 Donskoy Mineral Resources

The Mineral Resource Statement for Donskoy is presented in Table 12-1.

Table 12-1: Statement of Mineral Resources for Donskoy at 01 January 2018

Mineral Resource Category		Tonnage (Mt)	Grade Cr_2O_3 (%)	Content Cr_2O_3 (Mt)
Measured Mineral Resources				
DNK (U/G)	Almaz-Zhemchuzhina[1)]	40.9	50.9	20.8
	Millionoye	4.3	48.7	2.1
	Pervomaiskoye	0.0	0.0	0.0
	No 21	0.0	0.0	0.0
	Zapadny	0.0	0.0	0.0
	Subtotal DNK	**45.2**	**50.7**	**22.9**
Molodezhnaya (U/G)	Molodezhnaya	6.9	51.0	3.5
	Dubersai	0.0	0.0	0.0
	Subtotal Molodezhnaya	**6.9**	**51.0**	**3.5**
Open Pit	Yuzhny	0.0	0.0	0.0
Exploration	Geophysical VII	0.0	0.0	0.0
Total Measured		**52.1**	**50.8**	**26.4**
Indicated Mineral Resources				
DNK (U/G)	Almaz-Zhemchuzhina[2)]	103.5	50.9	52.7
	Millionoye	17.1	48.7	8.3
	Pervomaiskoye	2.6	43.9	1.1
	No 21	5.4	46.5	2.5
	Zapadny	1.5	43.7	0.7
	Subtotal DNK	**130.0**	**50.2**	**65.3**
Molodezhnaya (U/G)	Molodezhnaya	2.5	51.0	1.3
	Dubersai	0.3	43.8	0.1
	Subtotal Molodezhnaya	**2.8**	**50.2**	**1.4**
Open Pit	Yuzhny	2.5	51.7	1.3
Exploration	Geophysical VII	0.2	41.2	0.1
Total Indicated		**135.7**	**50.2**	**68.2**
Measured & Indicated Mineral Resources				
DNK (U/G)	Almaz-Zhemchuzhina	144.3	50.9	73.5
	Millionoye	21.4	48.7	10.4
	Pervomaiskoye	2.6	43.9	1.1
	No 21	5.4	46.5	2.5
	Zapadny	1.5	43.7	0.7
	Subtotal DNK	**175.2**	**50.4**	**88.2**
Molodezhnaya (U/G)	Molodezhnaya	9.5	51.0	4.8
	Dubersai	0.3	43.8	0.1
	Subtotal Molodezhnaya	**9.8**	**50.8**	**5.0**
Open Pit	Yuzhny	2.5	51.7	1.3
Exploration	Geophysical VII	0.2	41.2	0.1
Total Measured & Indicated		**187.7**	**50.4**	**94.6**

Mineral Resource Category		Tonnage (Mt)	Grade Cr_2O_3 (%)	Content Cr_2O_3 (Mt)
Inferred Mineral Resources				
DNK (U/G)	Almaz-Zhemchuzhina[3)]	23.0	50.8	11.7
	Millionoye	0.0	0.0	0.0
	Pervomaiskoye	2.9	40.0	1.2
	No 21	8.0	42.5	3.4
	Zapadny	0.0	0.0	0.0
	Subtotal DNK	**34.0**	**47.9**	**16.3**
Molodezhnaya (U/G)	Molodezhnaya	0.0	0.0	0.0
	Dubersai	0.0	0.0	0.0
	Subtotal Molodezhnaya	**0.0**	**0.0**	**0.0**
Open Pit	Yuzhny	0.0	0.0	0.0
Exploration	Geophysical VII	0.0	0.0	0.0
Total Inferred		**34.0**	**47.9**	**16.3**
Total Mineral Resources				
DNK (U/G)	Almaz-Zhemchuzhina[4)]	167.3	50.9	85.2
	Millionoye	21.4	48.7	10.4
	Pervomaiskoye	5.5	41.8	2.3
	No 21	13.4	44.1	5.9
	Zapadny	1.5	43.7	0.7
	Subtotal DNK	**209.1**	**50.0**	**104.5**
Molodezhnaya (U/G)	Molodezhnaya	9.5	51.0	4.8
	Dubersai	0.3	43.8	0.1
	Subtotal Molodezhnaya	**9.8**	**50.8**	**5.0**
Open Pit	Yuzhny	2.5	51.7	1.3
Exploration	Geophysical VII	0.2	41.2	0.1
Total Mineral Resources		**221.7**	**50.0**	**110.9**

1) Includes Level -640 Measured Mineral Resources of 8.0 Mt at 51.8% Cr_2O_3.

2) Includes Level -640 Indicated Mineral Resources of 20.3 Mt at 51.8% Cr_2O_3.

3) Includes Level -640 Inferred Mineral Resources of: 5.4 Mt at 50.8% Cr_2O_3.

4) Includes Level -640 total Mineral Resources of 33.7 Mt at 51.6% Cr_2O_3.

With regards to the Donskoy Mineral Resource Statement, SRK notes the following:

- All Donskoy's mines are operated according to the terms and conditions of the contract MG No. 110 issued on 3 March 1997 and valid to 21 March 2041.
- The Company's GKZ Balance Reserves form the basis of the information reviewed for the Mineral Resource audit.
- For DNK, a 3D geological model that was prepared by DMT in 2015, and brought to SRK's attention in 2017, revealed that the currently declared GKZ Balance Reserves are overstating the in situ tonnage due to simple assumptions regarding the geological continuity of the orebody which are not completely realistic.
- The DMT database has some identified errors, so SRK does not consider the DMT model suitable to be used to directly report Mineral Resources. To account for these issues, SRK has used a factoring approach, based on analysis of the DMT model, to adjust the GKZ Balance Reserve tonnages, whilst leaving the grades unchanged.

- The applied factors are based on a comparison of the volume of DMT wireframes to the volume of the GKZ estimates, on a by mining phase basis. The average factors per phase were then applied to the GKZ Balance Reserves, to derive an audited Mineral Resource Statement.
- SRK considers this a valid approach as SRK acknowledges the quality of the work completed during the derivation of the GKZ estimates.
- None of the GKZ Balance Reserves for the Level -880 and below (part of mining Phase 4) are included in the Mineral Resource estimate as they are not considered to demonstrate *"…reasonable prospects for eventual extraction*" as required by the JORC Code. This is because this material lies at significant depths and it is uncertain whether a mining method exists which would lead to the successful mining of this material. If Kazchrome is to undertake appropriate technical development studies, introducing further new technology, that would demonstrate a feasible mining method in the future, SRK would at that point consider it appropriate for this material to be included in the Mineral Resource statement. This is a typical development in the mining industry as a whole, as often deposits previously considered to be either un-mineable or uneconomic have been moved successfully into production.
- For Molodeznhaya, the 3D model produced by DMT indicates that there are fewer geological features which impact on the geological continuity, and hence, SRK considers that the GKZ Balance Reserves can be used to report Mineral Resources directly.
- For the other smaller deposits, no 3D modelling has been completed, and the ongoing mining has not identified any large scale geological features which will impact on the geological continuity. As such, the GKZ Balance Reserves are used to report the Mineral Resources directly.
- Mineral Resources are reported inclusive of that material used to derive the Ore Reserves. The Mineral Resources at DNK between Levels -640 and -880 have not been converted into Ore Reserves.

Kazchrome has multiple paths for increasing its Mineral Resource base. Current plans to improve the quality of the geological and grade models and underlying database, along with potential exploration and technical developments in deep mining methods all provide upside potential. Once this work has been completed, the Mineral Resource statement will be updated to reflect the results.

As per the requirement of the JORC Code, Table 1, Sections 1-3, has been completed and is provided in Appendix A.

In addition to the above in-site Mineral Resources, Donskoy also has some historical tailings Mineral Resources, which are retreated at a rate of approximately 0.4 Mtpa at Kazchrome's fully owned subsidiary Akzhar. Mineral Resources as at 1 January 2018 (Table 12-2) are based on the 1 January 2017 Mineral Resources depleted by 2017 production. Mineral Resources are in this case equivalent to Ore Reserves.

Table 12-2: Statement of Tailings Mineral Resources for Donskoy at 01 January 2018

Mineral Resource Category		Tonnage (Mt)	Grade Cr_2O_3 (%)	Content Cr_2O_3 (Mt)
Measured Mineral Resources				
	Tailings	-	-	-
Indicated Mineral Resources				
	Tailings s	2.2	27.6	0.6
Measured & Indicated Mineral Resources				
	Tailings	2.2	27.6	0.6
Inferred Mineral Resources				
	Tailings	-	-	-
Total Mineral Resources				
	Tailings	**2.2**	**27.6**	**0.6**

12.2 Donskoy Ore Reserves

The Ore Reserve Statement for Donskoy is presented in Table 12-3. In addition to these, Tailings Ore Reserves, are presented in Table 12-4.

Table 12-3: Statement of Ore Reserves for Donskoy at 1 January 2018

Ore Reserve Category		Tonnage (Mt)	Grade Cr_2O_3 (%)	Content Cr_2O_3 (Mt)
Proved Ore Reserves				
DNK (U/G)	Almaz-Zhemchuzhina[1)]	38.5	42.6	16.4
	Millionoye	4.4	40.0	1.8
	Pervomaiskoye	-	-	-
	No. 21	-	-	-
	Zapadny	-	-	-
	Subtotal DNK	**42.9**	**42.4**	**18.2**
Molodezhnaya (U/G)	Molodezhnaya	7.4	40.5	3.0
	Dubersai	-	-	-
	Subtotal Molodezhnaya	**7.4**	**40.5**	**3.0**
Open Pit	Yuzhny	-	-	-
Total Proved		**50.3**	**42.1**	**21.2**
Probable Ore Reserves				
DNK (U/G)	Almaz-Zhemchuzhina[2)]	97.4	42.6	41.6
	Millionoye	17.6	40.0	7.0
	Pervomaiskoye	2.6	40.7	1.1
	No. 21	5.4	38.7	2.1
	Zapadny	1.5	35.4	0.5
	Subtotal DNK	**124.6**	**42.0**	**52.3**
Molodezhnaya (U/G)	Molodezhnaya	2.4	41.2	1.0
	Dubersai	0.3	35.9	0.1
	Subtotal Molodezhnaya	**2.7**	**40.5**	**1.1**
Open Pit	Yuzhny	2.3	43.2	1.0
Total Probable		**129.6**	**42.0**	**54.4**
Proved & Probable Reserves				
DNK (U/G)	Almaz-Zhemchuzhina[3)]	135.9	42.6	58.0
	Millionoye	22.0	40.0	8.8
	Pervomaiskoye	2.6	40.7	1.1
	No. 21	5.4	38.7	2.1
	Zapadny	1.5	35.4	0.5
	Subtotal DNK	**167.5**	**42.1**	**70.5**
Molodezhnaya (U/G)	Molodezhnaya	9.8	40.6	4.0
	Dubersai	0.3	35.9	0.1
	Subtotal Molodezhnaya	**10.1**	**40.5**	**4.1**
Open Pit	Yuzhny	2.3	43.2	1.0
Total Ore Reserves		**179.9**	**42.0**	**75.6**

1) Includes Level -640 Proved Ore Reserves of 8.3 Mt at 43.8% Cr_2O_3.

2) Includes Level -640 Probable Ore Reserves of 21.0 Mt at 43.8% Cr_2O_3.

3) Includes Level -640 total Ore Reserves of 29.3 Mt at 43.8% Cr_2O_3.

With regards to the Donskoy Ore Reserve Statement SRK notes the following:

- The Mineral Resource statement as presented in Table 12-1 as per 1 January 2018 forms the basis of the Ore Reserve statement;
- Modifying factors for losses and dilution have been applied to the Measured and Indicated Mineral Resources on a per mining method and per level basis to derive Ore Reserve tonnages and grades;
- SRK recognises that concept studies undertaken during 2017 as part of the "Kazchrome 2.0" project have considered in more detail the technical factors related to the development

of Phase 2 (and Phase 3) through a Mechanised Block Caving method for mining and the use of the New Austrian Tunnelling Method for development in these deeper levels. ERG has committed to undertaking the following actions during 2018:

- Completion of an updated geological and block model in full, to include structural geology, lithology, geotechnical parameters, to the standards that SRK considers suitable for DNK. This model will include the results of additional drilling, sampling and testing in the -640 Level, which must be completed prior to finalising this model,
- Commencing and completing a Pre-feasibility Study to demonstrate the technical feasibility and economic viability of implementation of a Mechanised Block Caving mining method for mining levels down to the -640 Level,
- Full implementation of the New Austrian Tunnelling Method for all development in the lower levels of DNK (-320 Level and below),
- Relocation of the reservoir located above the future subsidence zone of DNK in order to reduce water ingress and the risk of mudrushes and thereby enabling a robust mining plan for Phase 2 (and later, Phase 3),
- Analysis of backfill requirements and determination of batch plant parameters for the drift and fill mining method,
- If any assumptions applied are changed after completion of the various technical studies, changes will be made to future Ore Reserve estimates;

- Based on the firm commitments to the above, a satisfactory work programme, input from the Company and its team of independent consultants and contractors, and a commensurate budget, the -640 Level has been included in the current Ore Reserve statement; and
- In line with reporting an Ore Reserve in compliance with the JORC Code, SRK has assessed the economic viability of the Ore Reserve, based on the integrated nature of the business. This takes into account the technical feasibility and economic viability of the overall operations to the point of sale of the final smelter products.
- The Aktobe smelter shop 4 is to yet to reach full capacity. This will be required in order to meet the projected production schedule.
- SRK has undertaken the economic assessment on a pre-tax basis, which demonstrates that the Ore Reserve is economically viable, with robust economics that remain positive when tested against appropriate increases in operating and capital costs, and changes in commodity prices.

As per the requirement of the JORC Code, Table 1, Section 4, has been completed and is provided in Appendix A.

Tailings Ore Reserves, are presented in Table 12-4, and are in addition to the Ore Reserves stated in Table 12-3.

Table 12-4: Statement of Tailings Ore Reserves for Donskoy at 1 January 2018

Ore Reserve Category		Tonnage (Mt)	Grade Cr_2O_3 (%)	Content Cr_2O_3 (Mt)
Proved Ore Reserves				
	Tailings	-	-	-
Probable Ore Reserves				
	Tailings	2.2	27.6	0.6
Total Ore Reserves				
	Tailings	**2.2**	**27.6**	**0.6**

12.3 Conclusion

SRK has carried out the appropriate review work to satisfy itself that the Ore Reserve can be technically and profitably extracted through the integrated structure of the Kazchrome assets. Consideration has been given to technical aspects, the associated capital and operating costs, and relevant factors including permitting, environmental and social. SRK is satisfied that the technical feasibility and economic viability has been demonstrated, and further work will be undertaken to improve confidence where needed with upside potential available over time.

13 SUMMARY COMMENTS

Kazchrome's integrated business of mining and processing of chrome (and manganese) deposits, and smelter operations, producing a mix of ferroalloy products, has been well established since the 1940s, with a variety of expansions over the years. Chrome mining takes places at two underground and one open pit operations, with the focus in six years' time solely on the DNK underground mine, which is made up of 5 separate deposits.

13.1 Geology and Mineral Resource Estimation

The basis of the Mineral Resource estimate has historically been the GKZ Balance Reserves. SRK has recently reviewed a 3D geological model produced by DMT in 2014. This has highlighted that the GKZ assumptions regarding geological continuity are unlikely to be realistic.

Due to shortcomings in the DMT model itself, SRK does not consider it suitable to be used to report Mineral Resources directly from this model. SRK has used a factoring approach, based on a comparison between the DMT model and the GKZ wireframes, to reduce the tonnages of the GKZ estimate. Grades have remained unchanged. The Company is in the process of updating the geological model for DNK, which will incorporate the results of a geotechnical drilling programme, along with incorporating additional information from the original drilling data, not previously captured. The objective of this work is to increase the confidence in the geological continuity, and hence the Mineral Resources, with the potential to increase reported tonnages. SRK considers that this process will also provide the required technical information to prove the feasibility of a change in mining method.

13.2 Mining

The Ore Reserves at the Yuzhny open pit and Molodezhnaya underground mines will be mined out in 2022 and 2023, respectively. Future production thereafter is based on the continuing and increasing production rate at DNK. The DNK mining method is primarily a gravity caving method, with some 5% from drift and fill. There will be a significant change in mining method as the mine deepens and geotechnical conditions weaken. Drift and fill will account for up to 40% of mining in some years. The gravity caving method is planned to be adapted into a reinforced level block caving method, however a number of risks have been identified in relation with this method. As a result, the Company is undertaking a pre-feasibility study to investigate the suitability of mechanised block caving, which is expected to deliver significant advantages. The Company has also undertaken a number of studies focused on various operational improvements which are scheduled to be implemented.

The DNK production rate was 2.38 Mt in 2017 and is forecast to steadily ramp up to near 5.5 Mt in 2026. Significant primary development and underground infrastructure works have commenced and will be ongoing.

The Cr_2O_3 grades at DNK are lower than at Molodezhnaya at present, being approximately 38% vs 40.5%. However Cr_2O_3 grades at DNK increase with depth, from 38% to 43%.

The main perceived mining risks relate the requirement for a suitable geological block model which incorporates geological structures and geotechnical conditions; the adequacy of development and mining methods near and crossing fault zones; the identification of the preferred caving method for future operations and the implementation thereof; the timely relocation of a surface reservoir; and the dependency on operational improvements. The Company has committed to and is actively addressing these risks.

13.3 Mineral Processing

Donskoy's two main crushing and beneficiation plants, DOF-1 and FOOR, produce coarse, high grade lump and a number of different sized, slightly lower grade concentrates via beneficiation. Two pelletisers process fine concentrates to produce hard chromite pellets for ongoing treatment at AZF and AFP. The combined plants have the capacity to process the 6 Mtpa as per the LoMp. SRK considers that the crushing and beneficiation plants are in a reasonable condition, considering the age of the facilities. Over the last few years additional or new equipment has been installed to improve the concentrate yield and metal recovery. The two pelletisers are relatively new and the equipment utilised is of a high standard. Alternative grate designs and some modifications to the hot pelletiser section in recent years have improved the overall utilisation of the equipment. Projects to improve recovery and efficiency are ongoing.

13.4 Aktobe and Aksu Smelters

A variety of ferroalloy products is being produced at both the Aktobe (AZF) and Aksu (AFP) smelters, both fed with chrome products from Donskoy. Of the three smelting shops at AZF, two are operating by conventional processes producing speciality products, and are planned to cease production by 2023. The four furnaces of smelting Shop 4, commissioned in 2014, are ultra-modern, utilising the most recent technology for cutting edge DC smelting technology. There were risks for Kazchrome in adopting a leading edge technology, due to a slow learning curve and large costs to render the technology fully functional. It is clear that the learning curve was considerably longer than anticipated and three years since commissioning, full capacity has not yet been reached. Further investments and a further two more years are anticipated to be required to reach full capacity. If further delays are encountered, this will impact on available smelting capacity and additional capital expenditure.

AFP is one of the world's largest ferroalloy plants and over the 20 years its output has steadily increased through expansions and productivity. Four main smelting shops produce HCFeCr and a variety of ferrosilicon products, all through conventional processes. Future expansion relies on the refurbishments to the furnaces of Shop 4, the first one to be completed in 2018. AFP focuses on bulk, commodity products rather than refined, speciality products, and whilst the apparent flexibility to switch products randomly on the furnaces is a large benefit of the plant, this inevitably implies that the furnace design would not be optimal for a particular product and that certain efficiencies are lost in lieu of flexibility.

13.5 Environmental and Social

No significant environmental and social risks that could stop the operation, or significantly affect the value, of the Donskoy and Tur mining operations were identified during SRK's review. Donskoy does have an opportunity to more accurately define and plan for the bio-physical and social implications of the eventual closure of the mine and what this means for the town of Khromtau, so that appropriate financial and human resources can be allocated.

SRK notes that with no regulatory requirement to investigate, and if necessary remediate, the potential Cr(VI) pollution at the smelter operations, Kazchrome is not currently obligated to address this issue. However, SRK does consider there to be a significant risk that at some point in the future this situation could change.

Whilst SRK has estimated high level closure costs for the various sites, which are in excess of the Company's current AROs (which do not require demolition and rehabilitation of the processing plants and other ancillary infrastructure) , the actual cost of remediation, especially at the smelters, is currently unknown as there is insufficient monitoring of soil and groundwater to understand the extent of pollution at the sites, who the key contributors are, and how this could be remediated. Should soil or groundwater contamination clean up be required, closure costs could be significantly higher.

13.6 Economic Assessment

SRK has prepared an audited LoMp to assess the economics of the Company's projected production plan as supporting the declared Ore Reserves.

SRK has verified the technical inputs, consisting of the mining tonnages and grades, the processing feed and production of fines, lump and pellets, and the smelters' production of FeCr and associated products. Stockpiling of RoM and smelter feed are required to meet the projected FeCr production profile. SRK has applied the product pricing forecast by the Company to generate revenues.

SRK has considered the operating and capital costs required to meet the LoMp. SRK has made minor adjustments, in discussion with the Company. The operating costs are driven by the smelters, accounting for over 50% of costs, notably due to the high power consumption. As a result, the operating costs will be sensitive to material increases in the unit cost of power. A programme for expansion capital has been detailed until 2026; thereafter all capital is captured within sustaining capital costs. Over the next 10 years, Donskoy accounts for approximately 60% of capital costs, and the smelters 40%. The Donskoy costs are primarily driven by the DNK mine.

SRK's findings are that the Company's projected production until 2027 is achievable. The economic assessment demonstrated the annual positive cashflow and overall economic viability of the Ore Reserve.

13.7 Mineral Resource and Ore Reserve Statement

Kazchrome has in situ Measured and Indicated Mineral Resources of 187.7 Mt at a grade of 50.4% Cr_2O_3, containing 94.6 Mt of Cr_2O_3, and Inferred Mineral Resources of 34.0 Mt at a grade of 47.9% Cr_2O_3, containing 16.3 Mt of Cr_2O_3. An additional historical Tailings Indicated Mineral Resource of 2.2 Mt at 27.65 Cr_2O_3, containing 0.6 Mt of Cr_2O_3 have been stated. Kazchrome has multiple paths for increasing its Mineral Resource base. Current plans to improve the quality of the geological and grade models and underlying database, along with potential exploration and technical developments in deep mining methods all provide upside potential.

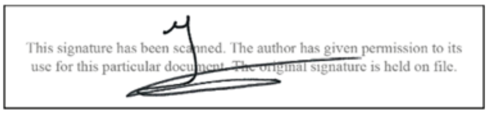
Proved and Probable Ore Reserves for the Donskoy deposits have been stated of 179.9 Mt at a grade of 42.0% Cr_2O_3, containing 75.6 Mt of Cr_2O_3. In addition to these, historical Tailings Probable Ore Reserves of 2.2 Mt at 27.65 Cr_2O_3, containing 0.6 Mt of Cr_2O_3 have been stated.

ERG has committed to a number of studies to be undertaken as described in the CPR, if the results of these change any of the assumptions made for the derivation of Ore Reserves, changes will be made to future Ore Reserve estimates.

13.8 Closing Comment

SRK has carried out the appropriate review work to satisfy itself that the Ore Reserve can be technically and profitably extracted through the integrated structure of the Kazchrome assets. SRK is satisfied that the technical feasibility and economic viability has been demonstrated, and further work will be undertaken to improve confidence where needed with upside potential available over time.

For and on behalf of SRK Consulting (UK) Limited



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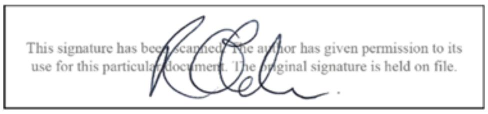

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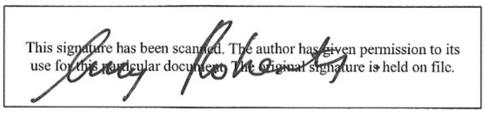

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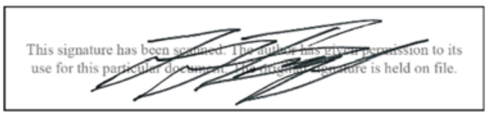

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Glossary – Mineral Resources and Ore Reserves

Ore Reserves	The economically mineable part of an Indicated, and in some circumstances, a Measured Mineral Resource. It includes diluting materials and allowances for losses which may occur when the material is mined. Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction could reasonably be justified. Ore Reserves are sub-divided in order of increasing confidence into Probable Ore Reserves and Proved Ore Reserves. A Probable Ore Reserve has a lower level of confidence than a Proved Ore Reserve but is of sufficient quality to serve as the basis for a decision on the development of the deposit.
Proved Ore Reserves	The economically mineable part of a Measured Mineral Resource. It includes diluting materials and allowances for losses which may occur when the material is mined. Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction could reasonably be justified. A Proved Ore Reserve represents the highest confidence category of reserve estimate. The style of mineralisation or other factors could mean that Proved Ore Reserves are not achievable in some deposits.
Probable Ore Reserves	The economically mineable part of an Indicated, and in some circumstances, a Measured Mineral Resource. It includes diluting materials and allowances for losses which may occur when the material is mined. Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction could reasonably be justified. A Probable Ore Reserve has a lower level of confidence than a Proved Ore Reserve but is of sufficient quality to serve as the basis for a decision on the development of the deposit.
Mineral Resource	A concentration or occurrence of material of intrinsic economic interest in or on the Earth's crust in such form, quality and quantity that there are reasonable prospects for eventual 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. Mineral Resources are sub-divided, in order of increasing geological confidence, into Inferred, Indicated and Measured categories.
Measured Mineral Resource	
	That part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence. It is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drillholes. The locations are spaced closely enough to confirm geological and grade continuity.
Indicated Mineral Resource	
	That part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence. It is based on exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill-holes. The locations are too widely or inappropriately spaced to confirm geological and/or grade continuity but are spaced closely enough for continuity to be assumed.

Inferred Mineral Resource

That part of a Mineral Resource for which tonnage, grade and mineral content can be estimated with a low level of confidence. It is inferred from geological evidence and assumed but not verified geological and/or grade continuity. It is based on information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drillholes which may be limited or of uncertain quality and reliability.

Abbreviations

AFP	Aksu Ferroalloy Plant
AROs	asset retirement obligations
AZF	Aktobe Ferroalloy Plant
BCT	block caving trial
CNPC`	Chinese National Petroleum Company
CPR	Competent Persons' Report
CRIRSCO	Committee for Mineral Reserves International Reporting Standards
DC	direct current
DMT	DMT Group
Donskoy	Donskoy Mining and Processing Combine
DPA 1998	Data Protection Act 1998 of the United Kingdom
E&S	environmental & social
EEC	JSC Eurasian Energy Corporation
EIA	environmental impact assessment
EMP	Environmental Measurements (Management) Plan
ERG	Eurasian Resources Group Sarl
EUGEML	Eastern Urals Geological Exploration Mission Laboratory
FeSi	ferrosilicon
GIIP	good international industry practice
JORC Code	The 2012 Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves as published by the Joint Ore Reserves Committee of the Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and Minerals Council of Australia
H&S	health and safety
HCFeCr	high-carbon ferrochrome
HMS	heavy media separation
Kazmarganets	Kazmarganets Mining Enterprise
KAZRC	The 2016 Kazakhstani Association for Public Reporting of Exploration Results, Mineral Resources and Mineral Reserves
KZT	Kazakhstan Tenge
LCFeCr	low-carbon ferrochrome
LoMp	life of mine plan
LTI	lost time injuries
LTIFR	lost time injury frequency rate
MACs	maximum allowable concentrations
MCFeCr	medium-carbon ferrochrome
NATM	New Austrian Tunnelling Method
OVOS	environmental impact assessment
PEK	industrial environmental monitoring programme
PFS	pre-feasibility study

RLBC	reinforced level block caving
RMR	Rock Mass Rating
RoM	run-of-mine
SEC	U.S. Securities and Exchange Commission
SEDEX	synsedimentary-exhalative
SP	Social development
SPZ	sanitary protection zones
SRK	SRK Consulting (UK) Limited
TEPs	Technical Economic Parameters
USD	United States Dollar
YP	Youth policy

APPENDIX

A TABLE 1 JORC CODE (2012)

Section 1 Sampling Techniques and Data

Criteria	JORC Code explanation	Commentary
Sampling techniques	• *Nature and quality of sampling (e.g. cut channels, random chips, or specific specialised industry standard measurement tools appropriate to the minerals under investigation, such as down hole gamma sondes, or handheld XRF instruments, etc.). These examples should not be taken as limiting the broad meaning of sampling.* • *Include reference to measures taken to ensure sample representivity and the appropriate calibration of any measurement tools or systems used.* • *Aspects of the determination of mineralisation that are Material to the Public Report.* • *In cases where 'industry standard' work has been done this would be relatively simple (e.g. 'reverse circulation drilling was used to obtain 1 m samples from which 3 kg was pulverised to produce a 30 g charge for fire assay'). In other cases more explanation may be required, such as where there is coarse gold that has inherent sampling problems. Unusual commodities or mineralisation types (e.g. submarine nodules) may warrant disclosure of detailed information.*	**Donskoy** - Not applicable, the deposits occur at depth, and so surface sampling is not applicable. In addition, all data used to support the mineral Resource Statements were produced through drilling methodologies **Kazmarganets** - Not applicable, all data used to support the mineral Resource Statements were produced through drilling methodologies
Drilling techniques	• *Drill type (e.g. core, reverse circulation, open-hole hammer, rotary air blast, auger, Bangka, sonic, etc.) and details (e.g. core diameter, triple or standard tube, depth of diamond tails, face-sampling bit or other type, whether core is oriented and if so, by what method, etc.).*	**Donskoy** - All drilling was using diamond methods. Approximately 125 km of drilling had been completed, at either 93 or 76 mm diameter core size. **Kazmarganets** - Drilling was using diamond methods. Approximately 22,914 m of drilling at Tur. The core diameter is not recorded.
Drill sample recovery	• *Method of recording and assessing core and chip sample recoveries and results assessed.* • *Measures taken to maximise sample recovery and ensure representative nature of the samples.* • *Whether a relationship exists between sample recovery and grade and whether sample bias may have occurred due to preferential loss/gain of fine/coarse material.*	**Donskoy** - Core recovery is reported to have an average of 80% in the mineralised intersections **Kazmarganets** - Core recovery is reported to have an average of 85% in the mineralised intersections
Logging	• *Whether core and chip samples have been geologically and geotechnically logged to a level of detail to support appropriate Mineral Resource estimation, mining studies and metallurgical studies.* • *Whether logging is qualitative or quantitative in nature. Core (or costean, channel, etc.) photography.*	**General**– As part of the GKZ drilling campaigns, extensive logging, sampling and recording of the features of the core was undertaken. Little, if any, core was kept for reference purposes.

Criteria	JORC Code explanation	Commentary
	• *The total length and percentage of the relevant intersections logged.*	
Sub-sampling techniques and sample preparation	• *If core, whether cut or sawn and whether quarter, half or all core taken.* • *If non-core, whether riffled, tube sampled, rotary split, etc. and whether sampled wet or dry.* • *For all sample types, the nature, quality and appropriateness of the sample preparation technique.* • *Quality control procedures adopted for all sub-sampling stages to maximise representivity of samples.* • *Measures taken to ensure that the sampling is representative of the in situ material collected, including for instance results for field duplicate/second-half sampling.* • *Whether sample sizes are appropriate to the grain size of the material being sampled.*	**Donskoy** - The drill core was sampled at 2 and 5 m intervals depending on the ore type. Little, if any, core was kept for reference purposes. **Kazmarganets** - The drill core was sampled at 0.5 m intervals. Half core samples were sent for analysis. No core was retained for reference purposes.
Quality of assay data and laboratory tests	• *The nature, quality and appropriateness of the assaying and laboratory procedures used and whether the technique is considered partial or total.* • *For geophysical tools, spectrometers, handheld XRF instruments, etc., the parameters used in determining the analysis including instrument make and model, reading times, calibrations factors applied and their derivation, etc.* • *Nature of quality control procedures adopted (e.g. standards, blanks, duplicates, external laboratory checks) and whether acceptable levels of accuracy (i.e. lack of bias) and precision have been established.*	**General** – SRK was advised that the same sampling and quality assurance programmes were followed at both operations and that all core samples used in grade estimation were sampled and analysed according to GKZ protocols. Core samples are analysed using wet chemistry techniques, initially in approved state laboratories, and later in the mine laboratories. As part of well-established protocols, there are routine internal checks within the mine laboratory that included analysis of manganese and iron government certified standards; re-assays of pulps; and submission of 5% of pulps to external laboratories for analysis. The grade of the samples was assayed at the Eastern Urals Geological Exploration Mission Laboratory (“EUGEML”). Internal control checks on Cr_2O_3 grades at the laboratory indicated that the error was on average less than 0.7%. External control assays were undertaken at the Central Laboratory of Western Kazakhstan and the results were within 2% relative of the EUGEML results. SRK considers that this difference is not material for the type of mineralisation.
Verification of sampling and assaying	• *The verification of significant intersections by either independent or alternative company personnel.* • *The use of twinned holes.* • *Documentation of primary data, data entry procedures, data verification, data storage (physical and electronic) protocols.* • *Discuss any adjustment to assay data.*	**Not applicable** – all deposits are currently being mined, and are subject to a yearly reconciliation and monitoring system

Criteria	JORC Code explanation	Commentary
Location of data points	• *Accuracy and quality of surveys used to locate drill holes (collar and down-hole surveys), trenches, mine workings and other locations used in Mineral Resource estimation.* • *Specification of the grid system used.* • *Quality and adequacy of topographic control.*	**Donskoy** - The drillholes were surveyed using downhole inclinometry at regular intervals, indicating partly significant drill-hole deviation in deeper holes. **Kazmarganets** – The drillholes were typically drilled vertically, and for relatively shallow lengths (less than 100 m) and so were not surveyed.
Data spacing and distribution	• *Data spacing for reporting of Exploration Results.* • *Whether the data spacing and distribution is sufficient to establish the degree of geological and grade continuity appropriate for the Mineral Resource and Ore Reserve estimation procedure(s) and classifications applied.* • *Whether sample compositing has been applied.*	**Donskoy** – Drilling was completed on a grid of 80 x 120 m, with infill drilling to 60 x 80 m spacing. **Kazmarganets –** At Tur, drilling patterns were based on section lines 200 m apart, with drill holes along the section lines between 50 to 100 m apart. Infill drilling included section lines 70 to 100 m apart, with drill holes on section at a 50 m spacing.
Orientation of data in relation to geological structure	• *Whether the orientation of sampling achieves unbiased sampling of possible structures and the extent to which this is known, considering the deposit type.* • *If the relationship between the drilling orientation and the orientation of key mineralised structures is considered to have introduced a sampling bias, this should be assessed and reported if material.*	**General** – SRK does not consider the drillhole sampling methods used to have introduced any significant bias into the grade and tonnage estimation procedures
Sample security	• *The measures taken to ensure sample security.*	**General** - The Mineral Resource estimates were conducted during the Soviet era, using methodologies consistent with the State reporting system in use at the time. Little or no core exists from the drilling campaigns undertaken.
Audits or reviews	• *The results of any audits or reviews of sampling techniques and data.*	**General –** SRK has been involved with the on-going audit and re-Statement of Mineral Resources and Ore Reserves since 2007

Section 2 Reporting of Exploration Results

Criteria	JORC Code explanation	Commentary
Mineral tenement and land tenure status	• *Type, reference name/number, location and ownership including agreements or material issues with third parties such as joint ventures, partnerships, overriding royalties, native title interests, historical sites, wilderness or national park and environmental settings.* • *The security of the tenure held at the time of reporting along with any known impediments to obtaining a licence to operate in the area.*	**Donskoy**- The Donskoy mines are operated according to the terms and conditions of the contract MG No. 110 issued on 3 March 1997 and valid to 21 March 2041. **Kazmarganets** - Mining operations at Tur operate under the terms and conditions of sub-soil contract No. 380, valid to 7 October 2021.
Exploration done by other parties	• *Acknowledgment and appraisal of exploration by other parties.*	**General -** The exploration and subsequent Mineral Resource estimates were conducted during the Soviet era, using State run Geological surveys, rather than by private individuals or companies
Geology	• *Deposit type, geological setting and style of mineralisation.*	**Donskoy**- The chromite pods within the Donskoy deposits consist of dense to massive chromite ($(Fe,Mg)(Cr,Al,Fe)_2O_4$), which is a chromium-rich mineral. The pods are typically elongated and continuous for several hundred metres along plunge and have variable thicknesses, averaging approximately 50 m. The contact between the chromite pods and the host serpentinite is typically either very sharp or gradational over 1 to 2 m, which is marked by fine disseminations of chromite. Most of the mineralisation is classified as 'Massive', which represents over 90% of the chromite. The grain size is typically between 2 and 20 mm. Two further mineralisation types are present, namely 'disseminated' and 'porphyry', which are currently excluded from the GKZ estimates due to the typically low grade. The main distinguishing feature between the disseminated and porphyry types is the grain size, with porphyry mineralisation typically having chromite agglomerations of between 0.5 to 10 cm diameters, with individual 1 mm size chromite grains. A number of south-dipping normal faults offset the pods by as much as 300 m vertically and 80 m laterally. Six deposits are included in the current declaration of Mineral Resources: • Molodezhnaya: The deposit lies 15 km north-northeast of Khromtau and consists of 25 pods, three of which contain or contained a significant tonnage. The No 22 deposit is the largest, is located at a depth of between 420 and 600 m below surface and is currently being mined by underground mining methods. The pod has a strike length of approximately 1,500 m, a maximum width of over 300 m and a maximum thickness of 140 m. The average thickness is approximately 50 m. The dip of the pod is approximately 40° towards the southwest. The average in situ grade is greater than 51% Cr_2O_3.

Criteria	JORC Code explanation	Commentary
		Within Molodezhnaya, additional exploration within the Dubersai area has resulted in this deposit being added to the Mineral Resources. Dubersai lies below the Molodezhnaya open pit, and will be accessed from there. The mineralisation is approximately 300 m long, 100 m vertical thickness, and lies close to surface. • Almaz-Zhemchuzhina: The deposit is located 2 km southwest of Khromtau and comprises 15 individual pods, four of which contain significant tonnages. The depth of the pods varies from 140 m in the north to over 1,350 m in the south. The lenses are relatively thick, being typically between 25 to 100 m, and extend down-plunge for considerable distances (up to 1.6 km). Numerous faults divide the pods, which can make the shape more difficult to mine. The grades of the larger lenses are typically greater than 50% Cr_2O_3. • Millionnoye: The deposit consists of two north-south striking lenses with a strike length of 760 m and 540 m respectively. The average width of the lenses is 180 m, with a thickness of between 25 to 75 m. These lenses have been explored to a depth of 1,000 m, and the deposit is open at depth. • Pervomaiskoye: The deposit consists of four lenses with comparatively complex shapes, which have also been intersected by a number of significant faults. The average in situ grade of the main lens is 45% Cr_2O_3. • No 21: This deposit is located some 4 km east of the Millionnoye pit and consists of 11 lenses. Two lenses are substantial, although thin compared with those in the other deposits, being between 8 and 50 m thick. Where several lenses are stacked together and create a mineable unit, the average in situ grade of 46.8% Cr_2O_3 is diluted by the waste interburden. The stacked lenses are described as complicated in form and variable in orientation. • Zapadny: Further to the 4 main DNK mine deposits additional exploration in the Western area (Zapadny) has o been completed. This has resulted in this deposit being added to the Balance Reserves. The deposit lies approximately 0.5 km from Millionnoye. The deposit is relatively fragmented, forming small discrete pods of mineralisation over a vertical height of approximately 150 m. The true thicknesses of the pods are between 2 and 50 m. Mineralisation has been drilled over a strike length of approximately 250 m. • Yuzhny: The deposit lies 12 kilometres north-northeast of Khromtau and is mined by open pit methods. The deposit consists of several chromite pods, which have a generally shallow dip. The pods vary in

Criteria	JORC Code explanation	Commentary
		size from a few metres up to 15 m in thickness. The average in situ grade is approximately 48% Cr_2O_3. The Almaz-Zhemchuzhina, Millionnoye, Pervomaiskoye, No 21 and Zapadny deposits form the resource base of the DNK mine. **Kazmarganets** – The manganese deposits at Tur are present in strata-controlled beds, but in a sub-horizontal orientation. Two zones containing economically significant grades have been defined across an area of 1,500 by 1,600 m, which are cut by minor faults. The thickness of each of the two zones ranges from 0.5 to 15 m. In some areas, these two zones merge into one where both units can be mined together. Manganese grades for these zones range from 10% to 56% Mn. Bedding in the pit area is slightly undulating with fold amplitude of about 180 m. The principal manganese minerals are pyrolusite, vernadite and psilomelane. Two mineralisation textures have been recognized: hard laminated or bedded mineralisation, and loose earthy mineralisation. High-grade manganese is associated with lower iron grades of less than 5% whilst lower grade manganese is associated with iron grades of up to 10%.
Drill hole Information	• *A summary of all information material to the understanding of the exploration results including a tabulation of the following information for all Material drill holes:* o *easting and northing of the drill hole collar* o *elevation or RL (Reduced Level – elevation above sea level in metres) of the drill hole collar* o *dip and azimuth of the hole* o *down hole length and interception depth* o *hole length.* • *If the exclusion of this information is justified on the basis that the information is not Material and this exclusion does not detract from the understanding of the report, the Competent Person should clearly explain why this is the case.*	**General** - Listing this material would not add any further material understanding of the deposit and Mineral Resource. Furthermore, no Exploration Results are specifically reported.
Data aggregation methods	• *In reporting Exploration Results, weighting averaging techniques, maximum and/or minimum grade truncations (eg cutting of high grades) and cut-off grades are usually Material and should be stated.* • *Where aggregate intercepts incorporate short lengths of high grade results and longer lengths of low grade results, the procedure used for such aggregation should be stated and some typical examples of such aggregations should be shown in detail.* • *The assumptions used for any reporting of metal equivalent values*	**Not applicable -** No Exploration Results are specifically reported.

Criteria	JORC Code explanation	Commentary
	should be clearly stated.	
Relationship between mineralisation widths and intercept lengths	• *These relationships are particularly important in the reporting of Exploration Results.* • *If the geometry of the mineralisation with respect to the drill hole angle is known, its nature should be reported.* • *If it is not known and only the down hole lengths are reported, there should be a clear statement to this effect (eg 'down hole length, true width not known').*	**Not applicable -** No Exploration Results are specifically reported.
Diagrams	• *Appropriate maps and sections (with scales) and tabulations of intercepts should be included for any significant discovery being reported These should include, but not be limited to a plan view of drill hole collar locations and appropriate sectional views.*	**General** - various maps, sections and diagrams are included in the main body of the report. These are not reproduced here, as including this material would not add any further material understanding of the deposit
Balanced reporting	• *Where comprehensive reporting of all Exploration Results is not practicable, representative reporting of both low and high grades and/or widths should be practiced to avoid misleading reporting of Exploration Results.*	**Not applicable -** No Exploration Results are specifically reported.
Other substantive exploration data	• *Other exploration data, if meaningful and material, should be reported including (but not limited to): geological observations; geophysical survey results; geochemical survey results; bulk samples – size and method of treatment; metallurgical test results; bulk density, groundwater, geotechnical and rock characteristics; potential deleterious or contaminating substances.*	**Not applicable –** No further information relevant to the geology and Mineral Resources of the deposits is reported.
Further work	• *The nature and scale of planned further work (eg tests for lateral extensions or depth extensions or large-scale step-out drilling).* • *Diagrams clearly highlighting the areas of possible extensions, including the main geological interpretations and future drilling areas, provided this information is not commercially sensitive.*	**General** – Exploration, focussing on near surface targets is currently underway. This includes testing of geophysical anomalies identified during the Soviet era. All drilling is being completed by contractors, namely Kazgeology, and as at November 2017, approximately 10% of the drilling had been completed.

Section 3 Estimation and Reporting of Mineral Resources

Criteria	JORC Code explanation	Commentary
Database integrity	• *Measures taken to ensure that data has not been corrupted by, for example, transcription or keying errors, between its initial collection and its use for Mineral Resource estimation purposes.* • *Data validation procedures used.*	**Donskoy** – The Mineral Resource estimates were conducted during the Soviet era, using methodologies consistent with the State reporting system in use at the time. These methodologies were paper based. Later, a digital database was developed by Viogem, DMT, and ERG personnel. This database was used as a basis for grade and tonnage estimates completed in 2014. **Kazmarganets -** The Mineral Resource estimates were conducted during the Soviet era, using methodologies consistent with the State reporting system in use at the time. These methodologies were paper based, and so no digital database exists for any of the deposits.
Site visits	• *Comment on any site visits undertaken by the Competent Person and the outcome of those visits.* • *If no site visits have been undertaken indicate why this is the case.*	**Donskoy** – Site visits were conducted by the SRK in November 2017 **Kazmarganets** – Site visits were conducted by the SRK in February 2012
Geological interpretation	• *Confidence in (or conversely, the uncertainty of) the geological interpretation of the mineral deposit.* • *Nature of the data used and of any assumptions made.* • *The effect, if any, of alternative interpretations on Mineral Resource estimation.* • *The use of geology in guiding and controlling Mineral Resource estimation.* • *The factors affecting continuity both of grade and geology.*	**Donskoy** – see above (Section 2) **Kazmarganets** - see above (Section 2)
Dimensions	• *The extent and variability of the Mineral Resource expressed as length (along strike or otherwise), plan width, and depth below surface to the upper and lower limits of the Mineral Resource.*	**Donskoy** – see above (Section 2) **Kazmarganets** - see above (Section 2)
Estimation and modeling techniques	• *The nature and appropriateness of the estimation technique(s) applied and key assumptions, including treatment of extreme grade values, domaining, interpolation parameters and maximum distance of extrapolation from data points. If a computer assisted estimation method was chosen include a description of computer software and parameters used.* • *The availability of check estimates, previous estimates and/or mine production records and whether the Mineral Resource estimate takes appropriate account of such data.*	**Donskoy** – Resources were estimated from cross-sections. Geological cross-sections were drawn showing drill-holes, sample grades and the interpretation of the geological boundaries and features. Separate outlines were made for very low grade (off-balance), average grade and high-grade (balance) resources according to the following GKZ estimation criteria: • Minimum grade for 'off-balance' resource 10% Cr_2O_3; • Minimum grade for 'balance' resource 30% Cr_2O_3; • Minimum grade for 'high-grade balance' resource 45% Cr_2O_3;

Criteria	JORC Code explanation	Commentary
	• *The assumptions made regarding recovery of by-products.* • *Estimation of deleterious elements or other non-grade variables of economic significance (e.g. sulphur for acid mine drainage characterisation).* • *In the case of block model interpolation, the block size in relation to the average sample spacing and the search employed.* • *Any assumptions behind modelling of selective mining units.* • *Any assumptions about correlation between variables.* • *Description of how the geological interpretation was used to control the resource estimates.* • *Discussion of basis for using or not using grade cutting or capping.* • *The process of validation, the checking process used, the comparison of model data to drill hole data, and use of reconciliation data if available.*	• Minimum mineralisation thickness 2.5 m for 'off-balance', increasing to 5 m for 'balance' material; and • Minimum thickness of waste interburden 4 m. The area of each grade category and classification category was calculated on each section and the volume of ore between two sections for each ore type was calculated by multiplying the average of the area of each ore-type for the two sections by the distance between the two sections. The Cr_2O_3 and other grades of each resource block were determined by taking a length weighted average of the sample values within that block. The tonnage of each resource block was estimated by multiplying the volume by the specific gravity which was based on the chromium oxide grade using a regression formula derived from the chromium oxide grades in the density samples. The density of the ore averages 3.6 tonnes per cubic metre. SRK has applied a factoring approach to the GKZ estimates to reflect the revised interpretation presented by DMT. The DMT wireframes were based on the grade data, with some minor geological interpretation to guide the manual wireframing process. The GKZ estimates are still used as a basis of the declared Mineral Resources, to reflect the high quality work completed at that time. **Kazmarganets –** Mineral Resources are estimated using manual sectional estimation techniques. The Mineral Resources are based on an estimate that was completed by an independent technical institute using data collected by drilling completed before 2002. The most recent resource estimate for both mines was approved by GKZ in 2002. Contours of a mineralisation were determined using 7.5% Mn cut-off grade at Tur with a minimum thickness of the mineralisation of 1.0 m, and maximum waste interburden of 2.0 m. At Tur, material with an iron content greater than 25% is consigned to an "iron ore" stockpile and is not sent for processing. Computerised geological block models and wireframe outlines have been developed by Kazchrome and a Kazakh consulting group in 2004. This block model is currently used for grade control and for building a detailed model of mineralisation based on new drilling and pit mapping. This model is specifically not used for the reporting or declaration of the Mineral Resource Statements.
Moisture	• *Whether the tonnages are estimated on a dry basis or with*	**Donskoy** – All tonnages are reported as dry tonnages

Criteria	JORC Code explanation	Commentary
	natural moisture, and the method of determination of the moisture content.	**Kazmarganets** – All tonnages are reported as dry tonnages
Cut-off parameters	• *The basis of the adopted cut-off grade(s) or quality parameters applied.*	**Donskoy** – see above (estimation and modelling) **Kazmarganets** –see above (estimation and modelling)
Mining factors or assumptions	• *Assumptions made regarding possible mining methods, minimum mining dimensions and internal (or, if applicable, external) mining dilution. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider potential mining methods, but the assumptions made regarding mining methods and parameters when estimating Mineral Resources may not always be rigorous. Where this is the case, this should be reported with an explanation of the basis of the mining assumptions made.*	**Donskoy** – see above (estimation and modelling) **Kazmarganets** –see above (estimation and modelling)
Metallurgical factors or assumptions	• *The basis for assumptions or predictions regarding metallurgical amenability. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider potential metallurgical methods, but the assumptions regarding metallurgical treatment processes and parameters made when reporting Mineral Resources may not always be rigorous. Where this is the case, this should be reported with an explanation of the basis of the metallurgical assumptions made.*	**Donskoy** – see above (estimation and modelling) **Kazmarganets** –see above (estimation and modelling)
Environmental factors or assumptions	*Assumptions made regarding possible waste and process residue disposal options. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider the potential environmental impacts of the mining and processing operation. While at this stage the determination of potential environmental impacts, particularly for a greenfields project, may not always be well advanced, the status of early consideration of these potential environmental impacts should be reported. Where these aspects have not been considered this should be reported with an explanation of the environmental assumptions made.*	**General** - SRK is unaware of any environmental factors which would preclude the reporting of Mineral Resources
Bulk density	• *Whether assumed or determined. If assumed, the basis for the assumptions. If determined, the method used, whether wet or dry, the frequency of the measurements, the nature, size and representativeness of the samples.*	**General** – Density measurements are taken as per GKZ protocols, and all tonnage estimates are reported as dry tonnes.

Criteria	JORC Code explanation	Commentary
	• *The bulk density for bulk material must have been measured by methods that adequately account for void spaces (vugs, porosity, etc.), moisture and differences between rock and alteration zones within the deposit.* • *Discuss assumptions for bulk density estimates used in the evaluation process of the different materials.*	
Classification	• *The basis for the classification of the Mineral Resources into varying confidence categories.* • *Whether appropriate account has been taken of all relevant factors (i.e. relative confidence in tonnage/grade estimations, reliability of input data, confidence in continuity of geology and metal values, quality, quantity and distribution of the data).* • *Whether the result appropriately reflects the Competent Person's view of the deposit.*	**Donskoy** - The deposit was classified as having a geological complexity rating of 2 according to GKZ standards (that is, large and generally continuous deposits). Consequently, C2 resources are defined by a grid spacing of 80 x 120 metres, whilst C1 resources, and B resources in the central thicker parts of the larger deposits, are defined by a grid spacing of 80 x 60 metres. At the end of the exploration drilling stage, estimates of deposit tonnage and grades were made based on methods stipulated by the GKZ for large podiform chromite deposits. Mine plans and the cut-off grade were developed by appropriate technical institutes. The estimates were checked and adopted by the GKZ and the mineral inventory at each deposit was recorded on the State Balance, categorised by geological confidence. Low-grade and difficult areas to mine, usually at the fringes of the lenses, or otherwise non-viable parts of the deposits were recorded as 'off-balance'. In determining how to reclassify the GKZ resource estimates using the guidelines of the JORC Code, SRK assessed the continuity of mineralisation and the data spacing as defined by each of the B, C1 and C2 resource categories. Having reviewed these areas and how the robustness of the original interpretation is normally substantiated by later infill drilling, SRK considers the B category in the larger, thicker deposits to be equivalent to Measured Mineral Resources and the C1 category to be equivalent to Indicated Mineral Resources. As Donskoy only plans to mine resources with a C1 category or better, the C2 category applies to extensions and smaller lenses with very few sample borehole intersections resulting in low confidence estimates, which SRK considers to be appropriate for Inferred Mineral Resources. The only exception to this is at Molodezhneya, where additional drilling in the lower parts of the deposit has improved the understanding of the geological and grade continuity. This means that material classified as C2 has been re-classified as Indicated Mineral Resources. **Kazmarganets –** Mineral Resources are classified on the basis of drill hole spacing as per the standard GKZ guidelines for manganese mineralisation.

Criteria	JORC Code explanation	Commentary
		At Tur, oxide resources defined by section lines spaced 70 to 100 m apart and drill spacing along each section at 50 m are classified as C1 category, whilst oxide resources delineated by section lines spaced 200 m apart and drill spacing along each sectional line at 100 to 200 m are classified as C2 category. In summary, SRK reclassified C1 material as Indicated Mineral Resources and C2 material as Inferred Mineral Resources.
Audits or reviews	• *The results of any audits or reviews of Mineral Resource estimates.*	**General –** SRK has been involved with the on-going audit and re-Statement of Mineral Resources and Ore Reserves since 2007.
Discussion of relative accuracy/ confidence	• *Where appropriate a statement of the relative accuracy and confidence level in the Mineral Resource estimate using an approach or procedure deemed appropriate by the Competent Person. For example, the application of statistical or geostatistical procedures to quantify the relative accuracy of the resource within stated confidence limits, or, if such an approach is not deemed appropriate, a qualitative discussion of the factors that could affect the relative accuracy and confidence of the estimate.* • *The statement should specify whether it relates to global or local estimates, and, if local, state the relevant tonnages, which should be relevant to technical and economic evaluation. Documentation should include assumptions made and the procedures used.* • *These statements of relative accuracy and confidence of the estimate should be compared with production data, where available.*	**Donskoy** – see above (classification section) **Kazmarganets** –see above (classification section)

Section 4 Estimation and Reporting of Ore Reserves

Criteria	JORC Code explanation	Commentary
4.1 Mineral Resource estimate for conversion to Ore Reserves	• *Description of the Mineral Resource estimate used as a basis for the conversion to an Ore Reserve.* • *Clear statement as to whether the Mineral Resources are reported additional to, or inclusive of, the Ore Reserves.*	**Donskoy** • SRK adjusted Form 8 resources converted to JORC are combined with a spreadsheet from site detailing all deposits split by level and showing the conversion from B+C1 resources to reserves. • SRK has applied a factoring approach to the GKZ estimates to reflect the revised interpretation presented by DMT. The DMT wireframes were based on the grade data, with some minor geological interpretation to guide the manual wireframing process. The GKZ estimates are still used as a basis of the declared Mineral Resources, to reflect the high quality work completed at that time. • Mineral Resources are reported inclusive of the Ore Reserves. **Kazmarganets - Tur** • SRK adjusted Form 8 C1 and C2 resources converted to JORC Mineral Resources are reported inclusive of the Ore Reserves
4.2 Site visits	• *Comment on any site visits undertaken by the Competent Person and the outcome of those visits.* • *If no site visits have been undertaken indicate why this is the case.*	**Donskoy** • Most recent visit by the CP was in July 2017, before that February 2016 **Kazmarganets – Tur** • Most recent visit by the CP was in February 2012, before that February 2007 • Updated information has been obtained for the 2016 production year. The basic parameters of the project have not changed.
4.3 Study status	• *The type and level of study undertaken to enable Mineral Resources to be converted to Ore Reserves.* • *The Code requires that a study to at least Pre-Feasibility Study level has been undertaken to convert Mineral Resources to Ore Reserves. Such studies will have been carried out and will have determined a mine plan that is technically achievable and economically viable, and that material Modifying Factors have been considered.*	**Donskoy** • Operating mine site, two underground mines, one open pit. TEO Proyekt (equivalent to PFS) has been undertaken and updated several times. New TEO Proyekt was developed for the deeper levels and SRK part of the project team undertaking a technical study at PFS level on the DNK mine to convert to mechanised block caving. • Mining plan is deemed appropriate, planned production levels have mostly been achieved over the last 7 years. Improvements are planned to increase the production levels of DNK Phase 1 and are deemed appropriate. **Kazmarganets – Tur** • Operating mine site, one open pit. TEO Proyekt undertaken before production commenced

Criteria	JORC Code explanation	Commentary
		• Mining plan is deemed appropriate, planned production levels have mostly been achieved over the last years
4.4 Cut-off parameters	• *The basis of the cut-off grade(s) or quality parameters applied.*	**Donskoy** Separate outlines were made for average grade and high-grade (balance) resources according to the following GKZ estimation criteria: • Minimum grade for 'balance' resource 30% Cr_2O_3; • Minimum grade for 'high-grade balance' resource 45% Cr_2O_3; • Minimum mineralisation thickness 2.5 metres; and • Minimum thickness of 'off-balance' or waste interburden 4 metres. **Kazmarganets – Tur** • Contours of a mineralisation were determined using 9% Mn cut-off grade with a minimum thickness of the mineralisation of 0.5 m, and maximum waste interburden of 0.5 m. • At Tur, material with an iron content greater than 25% is consigned to an "iron ore" stockpile and is not sent for processing.
4.5 Mining factors or assumptions	• *The method and assumptions used as reported in the Pre-Feasibility or Feasibility Study to convert the Mineral Resource to an Ore Reserve (i.e. either by application of appropriate factors by optimisation or by preliminary or detailed design).* • *The choice, nature and appropriateness of the selected mining method(s) and other mining parameters including associated design issues such as pre-strip, access, etc.* • *The assumptions made regarding geotechnical parameters (eg pit slopes, stope sizes, etc), grade control and pre-production drilling.* • *The major assumptions made and Mineral Resource model used for pit and stope optimisation (if appropriate).* • *The mining dilution factors used.* • *The mining recovery factors used.* • *Any minimum mining widths used.* • *The manner in which Inferred Mineral Resources are utilised in mining studies and the sensitivity of the outcome to their inclusion.* • *The infrastructure requirements of the selected mining methods.*	**Donskoy** • General modifying factors determined per orebody split into levels. DGOK is using proprietary software to determine block caving modifying factors • Mining methods are deemed appropriate: block caving, cut and fill mining and open pit mining. Block caving, ground conditions poor, grade control: XRF near shaft, pre-production development: scraper drives and undercut draw bells. Cut and fill mining, grade control: sampling of faces. Open pit, grade control: grade control drilling • No economic optimization as all on-Balanced ore has to be mined. Economic evaluation was undertaken by client when the original resources were determined • Modifying factors presented in main body of report per area, by mining method • No minimum mining widths are used. • Inferred (C2) not used in the base case mining schedule apart from Molodezhnaya, where C2 material has been upgraded to Indicated to reflect later exploration • Infrastructure already existing or planned and costed. Phase 2 shaft and level construction continuing

Criteria	JORC Code explanation	Commentary
		Kazmarganets - Tur • General modifying factors for open pit mining • Open pit mining methods, production rates and modifying factors are deemed appropriate • No economic optimization as all on-Balanced ore has to be mined. Economic evaluation was undertaken by client when the original resources were determined • Modifying factors presented in main body of report per area • Minimum thickness of the mineralisation of 0.5 m, and maximum waste interburden of 0.5 m. • Inferred (C2) not used in the base case mining schedule, used in upside schedule and makes a significant impact for the Phase 2 of DNK • Infrastructure already existing or planned and costed.
4.6 Metallurgical factors or assumptions	• *The metallurgical process proposed and the appropriateness of that process to the style of mineralisation.* • *Whether the metallurgical process is well-tested technology or novel in nature.* • *The nature, amount and representativeness of metallurgical test work undertaken, the nature of the metallurgical domaining applied and the corresponding metallurgical recovery factors applied.* • *Any assumptions or allowances made for deleterious elements.* • *The existence of any bulk sample or pilot scale test work and the degree to which such samples are considered representative of the orebody as a whole.* • *For minerals that are defined by a specification, has the ore reserve estimation been based on the appropriate mineralogy to meet the specifications?*	**Donskoy** • Two processing plants in operation, well suited to the style of mineralization • Well tested, standard DMS and gravity separation process • Several product streams, metal balance hard to understand. SRK has applied an overall chrome recovery which aligns with the DGOK values • Single mineral (Chromite), no deleterious elements present • N/A, operating mine • N/A, mineralogy not varying by much over the life of mine. **Kazmarganets - Tur** • One processing plants in operation, well suited to the style of mineralization • Well tested, standard crushing, screen and scrubbing processes • Material with an iron content greater than 25% Fe is consigned to an "iron ore" stockpile and is not sent for processing. (Fe grade normally around 7-10%) • N/A, operating mine • N/A, mineralogy not varying by much over the life of mine.

<table>
<tr><th>Criteria</th><th>JORC Code explanation</th><th>Commentary</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>4.7 Environmental</td><td>The status of studies of potential environmental impacts of the mining and processing operation. Details of waste rock characterisation and the consideration of potential sites, status of design options considered and, where applicable, the status of approvals for process residue storage and waste dumps should be reported.</td><td>Donskoy
Subsidence, well controlled, Waste rock inert transported to existing dumps. Water contained and used in processing plants.
A reservoir is located near/above the future subsidence zone which is planned to be re-located before Phase 2 production starts
Kazmarganets - Tur
Waste rock transported to existing dumps. Water contained and used in processing plants. Closure costs provided.</td></tr>
<tr><td>4.8 Infrastructure</td><td>The existence of appropriate infrastructure: availability of land for plant development, power, water, transportation (particularly for bulk commodities), labour, accommodation; or the ease with which the infrastructure can be provided, or accessed.</td><td>Donskoy
Surface and underground infrastructure in place for existing operations.
Sufficient land available for Phase 2 infrastructure (access to Western shafts)
Kazmarganets - Tur
No additional infrastructure required.</td></tr>
<tr><td>4.9 Costs</td><td>The derivation of, or assumptions made, regarding projected capital costs in the study.
The methodology used to estimate operating costs.
Allowances made for the content of deleterious elements.
The source of exchange rates used in the study.
Derivation of transportation charges.
The basis for forecasting or source of treatment and refining charges, penalties for failure to meet specification, etc.
The allowances made for royalties payable, both Government and private.</td><td>Both operations
Capital costs as provided by site, correlated with development and production plan
Operating costs are forecasted based on historicals, taking into account forecasted changes in operating practices.
No deleterious elements present
Long term exchange rate fixed at 315 KZT per USD
Client (transport to local smelter via rail)
No external TC/RCs.
Mineral extraction tax payable as per State rules</td></tr>
<tr><td>4.10 Revenue factors</td><td>The derivation of, or assumptions made regarding revenue factors including head grade, metal or commodity price(s) exchange rates, transportation and treatment charges, penalties, net smelter returns, etc.
The derivation of assumptions made of metal or commodity price(s), for the principal metals, minerals and co-products.</td><td>Prices provided by the Company, in line with 2017. Expressed in nominal terms
<table><tr><th>(USD/t product)</th><th>2018</th><th>2019</th><th>2020</th></tr><tr><td>Chrome Ore</td><td>90</td><td>90</td><td>90</td></tr></table></td></tr>
</table>

Criteria	JORC Code explanation	Commentary
		Akzhar Conc 240 245 249 Aksu HC FeCr 1,368 1,385 1,416 Aktobe HC FeCr 1,361 1,362 1,380 Aktobe LC FeCr 2,775 2,883 2,929 Aktobe MC FeCr 2,746 2,799 2,843 Aksu FeSiCr 40 1,347 1,382 1,408 Aksu FeSiCr 48 1,154 1,275 1,308 Aksu FeSiMn 1,090 1,131 1,161 Aksu FeSi 75 1,005 1,030 1,057 Aktobe FeSi 15 1,800 1,800 1,800
4.11 Market assessment	• *The demand, supply and stock situation for the particular commodity, consumption trends and factors likely to affect supply and demand into the future.* • *A customer and competitor analysis along with the identification of likely market windows for the product.* • *Price and volume forecasts and the basis for these forecasts.*	**Donskoy** • All mining products are processed by the ERG smelters in Aktobe and Aksu, final sales products a variety of ferroalloys. Existing market. • No major competitors • Forecasts provided by ERG **Kazmarganets - Tur** • All mining products are processed by the ERG smelter in Aksu. • No major competitors • Forecasts provided by ERG
4.12 Economic	• *The inputs to the economic analysis to produce the net present value (NPV) in the study, the source and confidence of these economic inputs including estimated inflation, discount rate, etc.* • *NPV ranges and sensitivity to variations in the significant assumptions and inputs.*	**Both operations, both points** SRK has carried out the appropriate review work to satisfy itself that the Ore Reserve can be technically and profitably extracted through the integrated structure of the Kazchrome assets.
4.13 Social	• *The status of agreements with key stakeholders and matters leading to social licence to operate.*	**Both operations** • Existing mine, complying with local regulations
4.14 Other	*To the extent relevant, the impact of the following on the project and/or on the estimation and classification of the Ore Reserves:* • *Any identified material naturally occurring risks.* • *The status of material legal agreements and marketing*	**Donskoy** • None identified • No issues expected

Criteria	JORC Code explanation	Commentary
	arrangements. • *The status of governmental agreements and approvals critical to the viability of the project, such as mineral tenement status, and government and statutory approvals. There must be reasonable grounds to expect that all necessary Government approvals will be received within the timeframes anticipated in the Pre-Feasibility or Feasibility study. Highlight and discuss the materiality of any unresolved matter that is dependent on a third party on which extraction of the reserve is contingent.*	• Mineral extraction licence valid until 2041. SRK expects that the licence will be renewed and has therefore not cut the production plan to that year and fully utilises all reserves. **Kazmarganets - Tur** • None identified • No issues expected • Mineral extraction license valid at until October 2021, life of mine extends up to 2020.
4.15 Classification	• *The basis for the classification of the Ore Reserves into varying confidence categories.* • *Whether the result appropriately reflects the Competent Person's view of the deposit.* • *The proportion of Probable Ore Reserves that have been derived from Measured Mineral Resources (if any).*	**Donskoy** • Based on the Form 8 classification (B and C1 can be converted into Reserves). • Yes, based on proposed mining methods and modifying factors • 28% from B class resources (Measured) **Kazmarganets - Tur** • Based on the Form 8 classification (C1 and C2 can be converted into Reserves). • Yes, based on proposed mining methods and modifying factors • 0% from B class resources (no Measured Resources available)
4.16 Audits or reviews	• *The results of any audits or reviews of Ore Reserve estimates.*	**Both operations** • Yearly review of Resources and Reserves. The production schedule has been modified based on detailed schedules from site combined with the resources/reserves sheet per area.
4.17 Discussion of relative accuracy/confidence	• *Where appropriate a statement of the relative accuracy and confidence level in the Ore Reserve estimate using an approach or procedure deemed appropriate by the Competent Person. For example, the application of statistical or geostatistical procedures to quantify the relative accuracy of the reserve within stated confidence limits, or, if such an approach is not deemed appropriate, a qualitative discussion of the factors which could affect the relative accuracy and confidence of the estimate.* • *The statement should specify whether it relates to global or local estimates, and, if local, state the relevant tonnages,*	**DGOK, covering all points:** • The Reserves have been based on the historical GKZ resources, which were based on sections. The tonnages produced so far have been in line with these estimations. For the most recent report, SRK has applied a factoring approach to the GKZ estimates to reflect the revised interpretation presented by DMT. The DMT wireframes were based on the grade data, with some minor geological interpretation to guide the manual wireframing process. The GKZ estimates are still used as a basis of the declared Mineral Resources, to reflect the high quality work completed at that time.

Criteria	JORC Code explanation	Commentary
	which should be relevant to technical and economic evaluation. • *Documentation should include assumptions made and the procedures used.* • *Accuracy and confidence discussions should extend to specific discussions of any applied Modifying Factors that may have a material impact on Ore Reserve viability, or for which there are remaining areas of uncertainty at the current study stage.* • *It is recognised that this may not be possible or appropriate in all circumstances. These statements of relative accuracy and confidence of the estimate should be compared with production data, where available.*	• The resources at Molodezhnaya and 10th Anniversary mine (“DNK”) have been modelled by DMT and show to a minor degree the faulting affecting the orebodies. An update of the database is in progress which is to form the basis of a new geological model. • Historical mining has mostly achieved the planned tonnages and grades and therefore no adjustment was undertaken for the modifying factors. **Kazmarganets – Tur, covering all points:** • The Reserves have been based on the historical GKZ resources, which were based on sections. The planned tonnages so far are in line with these estimations. • Computerised geological block models and wireframe outlines have been developed for both deposits by Kazchrome and a Kazakh consulting group in 2004. This block model is currently used for grade control and for building a detailed model of mineralisation based on new drilling and pit mapping. • Historical mining has mostly achieved the planned tonnages and grades