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IRON ORE HOLDINGS LTD

Iron Valley

Acid & Metalliferous Drainage Assessment and Management Strategy DRAFT

1 Introduction

1.1 Purpose

This management strategy for the assessment and management of acid and/or metalliferous drainage (AMD):

- Describes the methodology and outcomes of a preliminary assessment of the potential for AMD and possible environmental outcomes, using existing information prepared as part of the prefeasibility study (PFS).
- Describes the geochemical testing program that will be undertaken to further quantify the potential for AMD prior to development, in keeping with government guidelines (see below).
- Outlines the management objectives and controls that will be implemented to reduce the potential for AMD, including contingency responses.
- Describes the monitoring program that will be used to demonstrate that management objectives are being (or capable of being) achieved.

1.2 Scope

The management strategy has been prepared to satisfy the requirements of the WA Department of Mines and Petroleum (DMP), in particular the following guidelines:

- Environmental Notes on Mining – Acid Mine Drainage (2009)
- Guidelines for Preparing Mine Closure Plans (2011).

The management strategy applies to the following project areas throughout the life of the project (including post-closure):

- Mine pits (voids)
- Waste rock dumps
- Water management system (drainage).

2 Management objectives

The management objectives for AMD at Iron Valley are:

- To minimise the risk of AMD impacting on the receiving environment, both during and after the mining process.
- To ensure adequate and reliable information on AMD risk is made available for mine planning and development.
- To ensure leading practice approaches are followed for managing AMD risk.
- To ensure the effectiveness of the AMD management strategy is verified through monitoring and appropriate and timely responses are initiated if the strategy is not meeting its objectives.

3 Preliminary risk assessment

3.1 Approach

The purpose of this section is to provide a preliminary assessment of the potential for generation of acidic, metalliferous or saline drainage (AMD) from material excavated from within the proposed Iron Valley open cut iron ore mine.

The preliminary assessment relies on the studies conducted by SRK Consulting as part of the Prefeasibility Study (2011).

The assessment is then used to scope further investigations considered necessary to better quantify the AMD risk areas and to develop management measures in response to those risks.

3.2 Risk context

3.2.1 Scale of disturbance

SRK Consultants carried out a conceptual level mine planning exercise as part of the 2011 prefeasibility study (PFS). All planning work was based on the May 2011 resource model.

The proposed minesite is adjacent to an FMG tenement at the northern end of the deposit, with SRK identifying the opportunities for synergy with FMG and the potential for the northern area pits to be mined to their full extent. The volumes of materials used in this description have been based on that scenario.

Potential mine designs and production scheduling was evaluated on the basis of staged mining, as described below and depicted in Figure 1:

- Stage 1 – Central Area Pit Part A, which is the outcropping ore component of the western Central Area of the mine, mined to the bottom of the pit.
- State 2 – Central Area Pit Part B, consisting of the remainder of the Central Eastern Area.
- Stage 3 – Northern Area Pit, which is the area of the deposit located to the north of a dyke structure (see section 3.3) including the satellite ore bodies to the north east of the overall mine.
- Stage 4 – Southern Area Pit, which is the orebody located to the south end of the overall mine.

Based on the SRK mine planning, the total disturbance (pit shell) will be approximately 540 million tonnes (Mt), consisting of ore (170 Mt) and waste rock (370 Mt). Owing to spatial constraints, SRK has estimated that about 55% of the waste rock will be required to be disposed of as backfill into the mine pit. The remaining waste rock (approximately 72 loose cubic metres) will be placed on above-ground waste dumps.

Figure 1: Iron Valley project areas

3.2.2 High-value receptors

Although environmental impact studies are still to be concluded for the Iron Valley project, early assessments have identified the Weeli Wolli Creek (Figure 2) as having very high local and regional environmental values. To a lesser extent, the Marillana Creek is also of importance, as both creeks flow directly to the Internationally-significant Fortescue Marshes. These high-value receptors have the potential to be negatively impacted by AMD if sufficient volumes of contaminated surface water or groundwater are discharged from the Iron Valley project.

Figure 2: Marillana and Weeli Wolli Creeks and Fortescue Marsh

3.3 Geological setting

3.3.1 Regional Geology

The Iron Valley Project is hosted by the Precambrian iron formations of the Hamersley Ranges. The regional area is topographically rough, semi arid with a sparse population centred on a few key mining towns. The regional geology of the area is well documented and has been mapped by the WA Geological Survey at a scale of 1:250,000.

The regional structure of the Project is an anticline of the Brockman Iron Formation which plunges in a southerly direction. The major structures are trending northeast/southwest. The majority of the mineralisation is within the eastern limb of this anticline and is confined to the Upper Joffre Member. In addition, there is mineralisation within the core of the anticline, confined to Dales Gorge Member.

There are a series of folding structures outcropping on the hills with fold axes trending in the northeast/southwest direction. A dolerite dyke centrally bisects the deposit into 2 blocks and runs in a northeast/southwest direction.

3.3.2 Project geology

There are two major types of mineralisation encountered in the drill holes within the Iron Valley Project area: Tertiary Detrital and Bedded Mineralisation.

The Tertiary Detrital mineralisation is further divided in to three sub groups:

- Tertiary Immature Detrital (TDI) - coarse to medium size fragments of Hematite, Goethite-Hematite and Maghemite with minor to major percentages of Chert fragments partially cemented within the red clay matrix;
- Tertiary Mature Detrital (TDM): coarse to medium size fragments of Hematite, Goethite-Hematite and Maghemite within a matrix of red clays;
- Tertiary Canga (TC): major Hematite, Goethite-Hematite and Maghemite fragments cemented within Goethite and Vitreous Goethite matrix, with or without traces of Silica and Clay.

The majority of bedded mineralisation within the Project area is confined to the Joffre and Dales Gorge Members. However, there are lenses of bedded mineralisation confined to Weeli Wolli Formation.

3.4 Regional experience

The Iron Valley Project is part of the Hamersley Range and is located among a group of other iron ore mining projects, including those listed in Table 1 below. Other projects include BHP Billiton Yandi/Marillana and MinRes Phil's Creek, however information relating to AMD was not available publicly.

As shown in Table 1, the AMD risk level for two of the four mining projects in the area is low to negligible.

Table 1: Iron ore projects surrounding Iron Valley

Iron Ore Project	Distance to Iron Valley	AMD Risk Level & Management
RTIO Yandicoogina	9	Low (99%-ile for total sulphur >0.02%) RTIO 2011
Brockman Resources Marillana	14	Negligible (99%-ile for total sulphur > 0.07%) GCA 2009

3.5 Results of exploration drilling

An assessment of the geological database was conducted by SRK (2011). The geological database was derived from exploration and other drilling programs and contained data for 31, 271 individual drillcore samples. Of these, data were extracted for 25, 251 samples which had values assigned for both lithology and sulphur. These samples were associated with 421 unique drill hole identification numbers. The assay data comprised of SiO_2, Al_2O_3, TiO_2, CaO, MgO, K_2O, Fe, Mn, P, S, As, Ba, Cl, Co, Cr, Cu, Ni, Pb, Sn, Sr, V, Zn and Zr. For the purposes of sample categorisation, SRK used a cut-off grade of 50% Fe to define a boundary between waste and ore grade material. Using this cutoff, 18, 314 samples classify as waste, with the remaining 6,937 being classified as ore. SRK highlight that these numbers may not be representative of the final proportional volumes for each lithological type.

3.5.1 Total sulphur analysis

Acid mine drainage is associated largely with the oxidation of reduced sulphur compounds, such as pyrite, following disturbance and exposure to the atmosphere. While not all sulphur present in geological samples is in a reduced (reactive) state, a conservative estimate of acid generating potential (i.e. risk) can be ascertained by presuming that all sulphur present in a sample is oxidisable (Maximum Potential Acidity – MPA). Such an approach is also made more conservative by presuming an absence of acid neutralising capacity (ANC) in the same sample.

The general recognised investigation level for reduced (reactive) sulphur content is 0.1-0.3% by mass – the more porous the material (such as sand) the lower the investigation level.

Sulphur distribution - by lithology

Less than 0.5% of the drillcore samples had Total Sulphur values higher than 0.3% (as determined by ICPOES analysis), with the majority of these associated with the sediments beneath the base of mining (Table 2).

Table 2: Sulphur distribution across lithology types

Lithology Group	Ore (% S)				Waste (% S)			
	n=	Min	Mean	Max	n=	Min	Mean	Max
Igneous Felsic	*0*	n/a	n/a	n/a	*32*	0.0005	0.003	0.01
Igneous Mafic	*13*	0.003	0.005	0.01	*1787*	0.0005	0.009	0.37
Miscellaneous	*41*	0.002	0.009	0.03	*7*	0.005	0.016	0.04
Regolith-Canga	*170*	0.003	0.021	0.44	*114*	0.003	0.113	1.50
Regolith-Detrital	*337*	0.004	0.022	0.35	*742*	0.0005	0.038	1.29
Regolith-General	*102*	0.003	0.024	0.26	*3880*	0.0005	0.025	2.70
Regolith-Pisolite	*9*	0.01	0.020	0.04	*119*	0.006	0.026	0.91
Sediment-Chemical	*5659*	0.0005	0.014	0.29	*7137*	0.0005	0.010	3.48
Sediment-Clastic	*606*	0.001	0.013	0.41	*4496*	0.0005	0.027	7.80

The minimum and maximum sulphur concentrations recorded in ore grade material were 0.0005% and 0.44% S respectively. The minimum value, representing a less than detection limit concentration, was recorded in a sample from the Sediment-Chemical category and is a sample also classified as mineralised banded iron formation (BIF).

The Sediment-Chemical group contains the largest number of ore-grade samples (5659) and sub-divides into chert, BIF and mineralised-BIF, with the latter being dominant (4976 samples). The maximum ore-grade sulphur concentration of 0.44 % S was recorded in a sample from the Regolith-Canga grouping, in a sample classified as canga.

In waste grade samples, the minimum and maximum S concentrations of 0.0005% and 7.8% S were both recorded in samples classified as Sediment-Clastic, the lithological grouping dominated by shale, with 4275 shale samples from the group total of 4496. The below detection limit minimum value was also recorded in samples from the groupings Igneous-Felsic, Igneous-Mafic, Regolith-Detrital, Regolith-General and Sediment-Chemical.

Sulphur distribution – by mineral zone

The distribution of sulphur values in distinct zones at Iron Valley was also investigated. The zones were defined as Northern (Stage 3), Central (Stage 1 & 2) and Southern (Stage 4). The boundary between Northern and Central is defined by a dyke structure and the Central – Southern boundary is a geographical break in the drillhole locations. The collar locations of the drillholes used in each zone are presented in Figure 3.

Table 3 presents the distribution of Total Sulphur concentrations in the three zones. The data indicate that the Southern zone generally exhibits lower sulphur concentrations than the other zones. Although the maximum sulphur concentration of 7.8% S was recorded in a waste-grade sample from the Central zone, the highest average total S concentrations in both ore and waste materials were recorded in the Northern zone.

Table 3: Sulphur concentrations in Iron Valley geographic zones

Zone	Ore (% S)				Waste (% S)			
	n=	Min	Mean	Max	n=	Min	Mean	Max
Northern	*3381*	0.0005	0.016	0.41	*8591*	0.0005	0.021	4.77
Central	*2902*	0.001	0.014	0.44	*6431*	0.0005	0.020	7.80
Southern	*654*	0.001	0.013	0.08	*3292*	0.0005	0.012	0.50

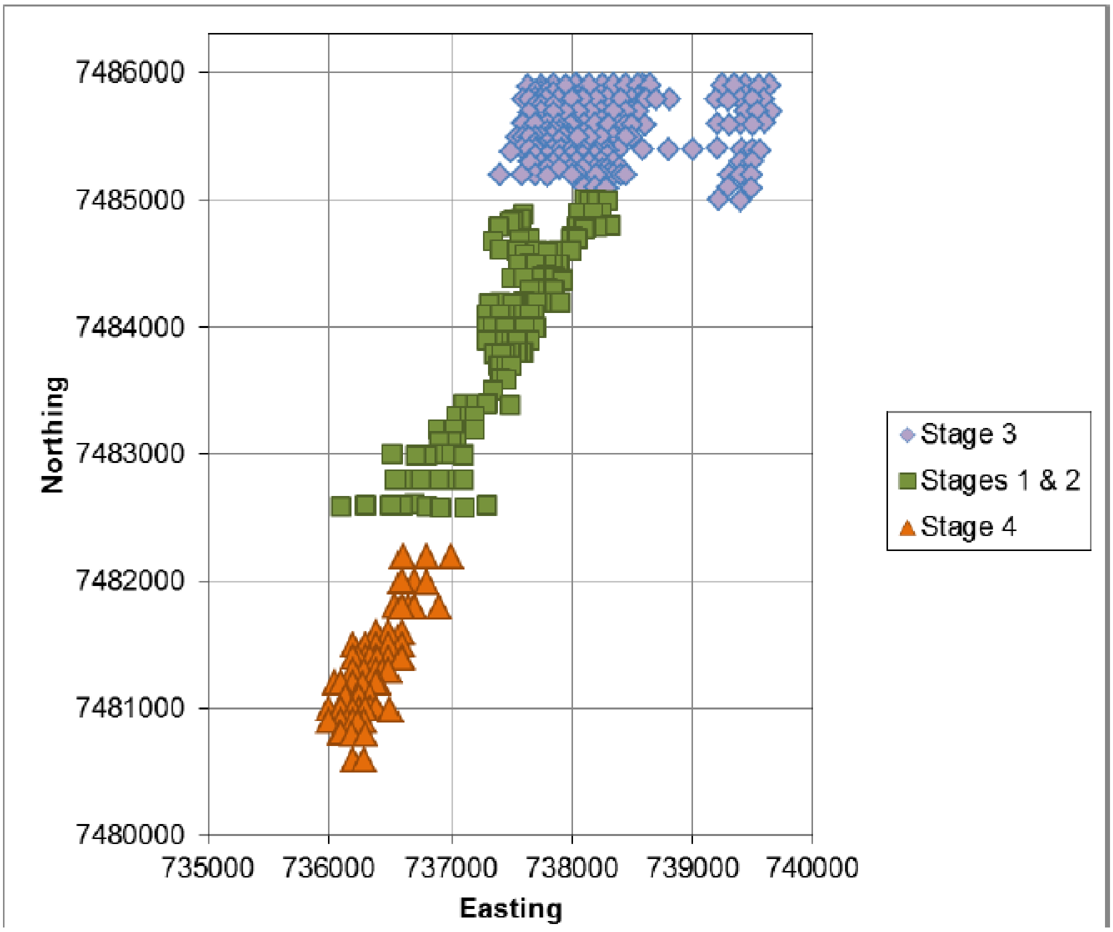

Figure 3: Collar locations for drillholes used in sulphur assessment

3.5.2 Base and heavy metal composition

The potential for materials to release deleterious concentrations of metals to the hydrosphere on weathering is commonly linked to the potential for acid generation, as many metals are more mobile under acidic conditions. However, as this is not always the case, long term leaching experiments are commonly carried out to define both acid production potentials and metals release rates under weathering conditions. Thus far, no leaching experiments have been carried out for Iron Valley samples. Although the leaching potential of individual metals cannot be defined based on the current data, the relative enrichment of metals can be investigated. This is commonly carried out during geochemical characterisation using the geochemical abundance index (GAI) method. The extent of enrichment is reported as the GAI which relates the actual concentration with the global crustal abundance on a log 2 scale. The GAI is expressed in 7 integer increments (i.e. 0 through to 6), where a GAI of 0 indicates the element is present at a concentration similar to, or less than, average crustal abundance; and a GAI of 6 indicates an approximate 100-fold, or greater, enrichment above average crustal abundance. As a general rule, a GAI = 3 or greater signifies enrichment that warrants further examination. Average GAI values calculated for Iron Valley lithological groups presented in Table 4. The data indicate that in terms of average values, only As and Sn are enriched relative to the global crustal abundance, with both being enriched at average values of GAI = 2 or 3.

Table 4: Geochemical Abundance Index (GAI) values for Iron Valley samples

Lithology Group	n=	Average GAI - Ore										
		As	Ba	Co	Cr	Cu	Ni	Pb	Sn	Sr	V	Zn
Igneous Felsic	*0*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Igneous Mafic	*13*	2	0	0	0	0	0	0	2	0	0	0
Miscellaneous	*39*	2	0	0	0	0	0	0	2	0	0	0
Regolith-Canga	*104*	3	0	0	0	0	0	0	3	0	0	0
Regolith-Detrital	*270*	3	0	0	0	0	0	0	2	0	0	0
Regolith-General	*71*	3	0	0	0	0	0	0	2	0	0	0
Regolith-Pisolite	*9*	3	0	0	0	0	0	0	2	0	0	0
Sediment-Chemical	*4498*	3	0	0	0	0	0	0	2	0	0	0
Sediment-Clastic	*586*	3	0	0	0	0	0	0	2	0	0	0
Lithology Group	***n=***	**Average GAI - Waste**										
		As	**Ba**	**Co**	**Cr**	**Cu**	**Ni**	**Pb**	**Sn**	**Sr**	**V**	**Zn**
Igneous Felsic	*2*	2	0	0	0	0	0	0	3	0	0	0
Igneous Mafic	*1623*	2	0	0	0	0	0	0	3	0	0	0
Miscellaneous	*7*	2	0	0	0	0	0	0	2	0	0	0
Regolith-Canga	*44*	3	0	0	0	0	0	0	2	0	0	0
Regolith-Detrital	*549*	3	0	0	0	0	0	0	2	0	0	0
Regolith-General	*2579*	3	0	0	0	0	0	0	2	0	0	0
Regolith-Pisolite	*119*	3	0	0	0	0	0	0	2	0	0	0
Sediment-Chemical	*5882*	3	0	0	0	0	0	0	2	0	0	0
Sediment-Clastic	*4100*	3	0	0	0	0	0	0	2	0	0	0

Although preliminary indications are that the majority of Iron Valley waste materials are not likely to be problematic in terms of AMD, this would require further detailed investigation including both short- and long-term laboratory test work to determine acid neutralisation capacities and define solute release under weathering conditions. The programme of further investigations (Section 4) will cover these requirements.

4 Further investigations

4.1 Approach

Prior to the commencement of significant earthworks for the Iron Valley Project, the AMD potential for ore and waste rock materials will be more comprehensively ascertained. The investigations will target each rock material type, including both grade and waste materials, in order that those materials can be adequately classified according to AMD risk and appropriate management controls prescribed.

Sampling of rock materials will also take into account the variability in each rock type (based on previous Total Sulphur assays) and the overall volume disturbed. The sampling program will be developed by a suitably qualified advisor and will fulfil the requirements of the DMP guidelines.

The samples will be geochemically tested in a laboratory using both static and kinetic tests to characterise the current and long-term geochemical characteristics of the waste materials. The following characteristics will be assayed:

- pH
- electrical conductivity
- acid-base accounting (the difference between maximum potential acidity (MPA) and acid neutralising capacity (ANC)
- multi-element composition.

5 Management controls

5.1 Purpose of this section

This section is included in the strategy as a starting point for the future development of the systems that may be necessary to acceptably manage ARD risk at the Iron Valley project. However, the selection and scaling of ARD management controls and safeguards/contingencies, cannot be undertaken until the completion of the detailed ARD investigations.

5.2 Best practice review

The purpose of this section is to outline the current management practices being employed to effectively manage hazards to the environment associated with AMD.

5.2.1 Avoidance

The AMD investigation/materials classification process may identify materials that can be avoided during mine planning and optimisation.

5.2.2 Dry covers

According to DMP guidance (2009), the most common type of dry cover is the impermeable barrier, such as a multi layer barrier. The objectives of a dry cover system are to minimise the influx of water and provide an oxygen barrier. Apart from these functions, dry covers should be resistant to erosion and should provide support to vegetation. Selective placement of reactive waste materials and their encapsulation with benign waste materials is the preferred AMD management practice during mining operations (DITR 2007).

5.2.3 Neutralisation

The degree of contamination resulting from the oxidation of waste rock materials depends on the buffering capacity of the system (other materials and/or water). If there is significant alkalinity available, the acidity released during sulphide oxidation will be neutralized. At near neutral pH, aqueous metals tend to precipitate as hydroxide. Metals may also adsorb onto surfaces of these newly formed precipitates.

The utilization of limestone (crushed $CaCO_3$) and similar alkaline reagents has proven to be at least effective in increasing the pH and thereby precipitating and immobilizing metals (DMP 2009).

5.2.4 Collection and treatment (drainage)

Inflow to mine pits from rainfall or dewatering may be unsuitable for discharge to the environment if it has come into contact with reactive materials and become contaminated with excess acidity or metals. Similarly, stormwater runoff or seepage from waste rock dumps may also contain elevated consternations of contaminants. In such situations, there are numerous systems for collecting and treating the affected water prior to release to the environment. Treatment may either be active or passive, with the common attributes of a passive treatment system are no or minimal requirements for active (electric or diesel) pumping, and no requirement for remote-powered addition of chemical reagents (DITR 2009).

6 Monitoring and review

The environmental monitoring program for the Iron Valley project will include routine screening of ARD indicators to ensure that both the detailed assessment and chosen management controls (if required) continue to be valid and/or effective.

Regardless of the project phase (exploration through to operations) there are a number of issues that the monitoring program will need to address. Key points to consider for the monitoring program include:

- the nature of the material being handled, including volumes and reactivity
- likely composition of leachate generated from the material
- likely downstream receptors and baseline concentrations of significant analytes
- turnover of material including rate and the ability of personnel to access the material
- sampling technique, preparation and preservation requirements
- maintenance of sample integrity and chain of custody
- reference to appropriate guideline limits turnaround times for both the material being mined and analyses
- representative sample size
- government regulations and licensing requirements (DITR 2009).

7 References

DITR 2009. *Managing Acid and Metalliferous Drainage.* Department of Industry, Tourism and Resources.

DMP 2009. *Environmental Notes on Mining – Acid Mine Drainage* Department of Mines and Petroleum.

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RTIO 2011 *Yandicoogina Closure Study Report*. Rio Tinto Iron Ore July 2011.

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