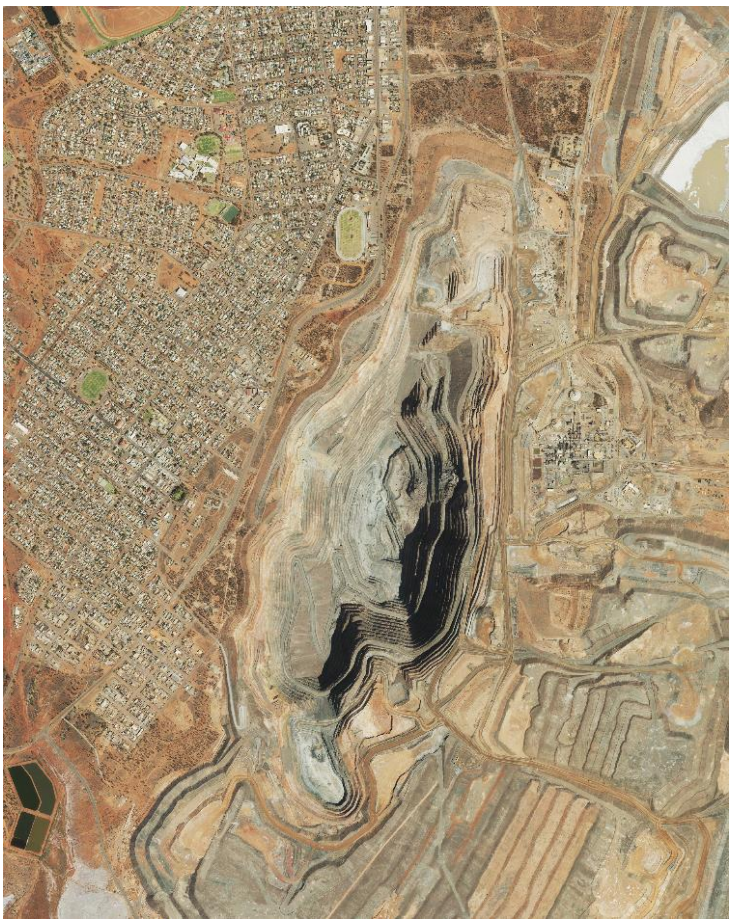
Report Prepared

For

Kalgoorlie Consolidated Gold Mines Pty Ltd

Flyrock Control for Fimiston South Project, Stage 2 (Ivanhoe Cutback)

Final Report



August 2022.

blastechnology

Executive Summary

This report considers the flyrock risks associated with blasting in the south west sector of the proposed Fimiston South, Stage 2 pit also known as Ivanhoe Cutback. The Stage 2 pit brings blasting activities between 100 and 150 metres closer to some properties and infrastructure than that which was anticipated for the Stage 1 pit. The Stage 2 development also means that the 400 metre Setback for Mining Activities is extended by the same distance towards the Boulder town centre.

The Blast Clearance radius of 200 metres from the nearest blasthole for the Stage 2 pit includes no residential properties, but it does include some KCGM-managed properties on both sides of the Goldfields Highway, the closest of which are approximately 85 to 120 metres from the nearest blasthole. Until mining on benches above the -150 mRL bench is complete, some or all of those properties will be included in the blast clearance procedures, and will require additional blast guards.

Properties are not considered at significant risk if the probability of one or more flyrock fragments landing inside the property boundary is less than 10^{-7}, or 1 in ten million. Of the property boundaries included in this study, only one shows a probability greater than 10^{-7}, and the structure on that KCGM-managed property is scheduled for demolition. A small section of the Goldfields Highway (200 metres long) also has a very low probability of around 0.0001%.

The proposed blasthole charging configurations, if appropriately controlled with respect to minimum stemming length, are incapable of projecting rock fragments more than approximately 161 metres. The charge configuration with the greatest potential for flyrock projection is the 165 mm production charge involving 3.5 metres of stemming and the Adv 10 explosive expected to be used in transitional material on the -90 mRL bench. The modelling in this report assumes no such holes will be drilled closer than 60 metres to the top-of-pit footprint, on the -90 mRL bench, and no closer than approximately 104 metres to the nearest KCGM-managed property.

Analysis of historical charges obtained from the Orica BlastIQ database shows a maximum stemming length charging error of 0.5 metres. That is, actual stemming lengths can be shorter than design lengths by up to 0.5 metres. This maximum error has been incorporated into the study when considering flyrock risk.

The 400 metre Setback for Mining Activities (SMA) currently encompasses no non-KCGM-managed properties zoned Residential according to the Town Plan. According to a DME recommendation endorsed by State Cabinet in December 1991, KCGM is required to purchase all such properties. Since 1991 KCGM has purchased all premises that are zoned 'Residential' under the Town Planning Scheme and are located within the SMA. Written consent of the owner and occupier (in some cases the original owner) of the premises has been obtained. The company is permitted to enter into arrangements to allow occupants of such properties to remain living in the area subject to strict adherence to safety requirements. Properties located between the 200 metre blast clearance distance and the 400 metre SMA are not considered to be at risk from flyrock, provided that the mine maintains its current record of quality control during blasting.

Blasting in the Stage 2 cutback comes within approximately 165 metres of the Western Power sub-station. The compound will require evacuation whenever any blasthole is closer than 200

metres, though this will impact very few of the blasts fired near the designed pit edge. The probability of flyrock landing within this compound is less than 10^{-7}.

Blasting in the Stage 2 cutback comes within approximately 130 metres of the Goldfields highway. Based on current wall control charge configurations, the probability of flyrock landing on the Golden Highway is less than 10^{-7}, except for a small section of length 200 metres where the probability is estimated to be around 0.0001%. However, there is a section of the highway approximately 700 metres long, that lies within the 200 m blast exclusion zone around the western-most pit extent which will require road closure for a small number of blasts.

High voltage power lines, both KCGM and Western Power, should be considered for burial if closer than 120 metres to the top-of-pit footprint.

Report to Kalgoorlie Consolidated Gold Mines Pty Ltd

Flyrock Potential and Control
Fimiston South Project, Stage 2 (Ivanhoe Cutback)

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Flyrock Potential and Control
Fimiston South Project, Stage 2

1. INTRODUCTION

Blastechnology was commissioned by Kalgoorlie Consolidated Gold Mines Pty Ltd (KCGM) to prepare a component of the Environmental Impact Assessment, required for the approvals process for the proposed Fimiston South, Stage 2 project, relating to blasting practices and flyrock safety.

Ministerial Statement 782, dated 29 Jan 2009, required that mining in the Fimiston Open Pit maintains a minimum 400 m Safety Exclusion Zone (SEZ) offset, also called the Setback for Mining Activities (SMA), from properties zoned "Residential", and the Request to Modify the Authorised Extent with the Approved Development Envelope dated 2018 requests a minimum personnel blast clearance distance of 200 metres in line with the Golden Pike Development Approval. The blast clearance distance of 200 metres was implemented to maintain both public and mine-operator safety from flyrock ejections during blasting in the open pit.

The preparation of documents for environmental approval is being managed by AECOM Australia Pty Ltd from its Perth offices. The Scope of Work provided to Blastechnology, dated 25 Sep 2019, by AECOM is:

> *A report is required which addresses the following sub-sections below.*
>
> *The scope will be initiated with the with the latest pit shell using the current operational assumptions of the FS project. This information will be supplied by KCGM.*
>
> *The Scope of Work for the Stage 2 development includes:*
>
> - *Review & summarise current blasting practices in relation to potential flyrock risk*
> - *Identify affected properties, public spaces, facilities and infrastructure with reference to the current 200 metre blast clearance distance and 400 metre Setback for Mining Activities*
> - *Identify zones within the proposed Stage 2 mining area in which changes will be required to current standard blasting practices*
> - *Define appropriate flyrock control and mitigation strategies for all sections of the proposed Stage 2 mining area.*

The following data have been obtained from KCGM in relation to the review:

- CAD data including Cadastral files "FS_CAD_KCGM_Properties.DXF", "FS_CKB_TPS1_General_Residential.DXF", & "FS_Permitting_FlyrockImpactArea-Map_June21.pdf", top-of-pit footprint file "s38_footprints.dxf", life-of-mine pit shell file "s38_lom_pit.dxf", and KCGM Infrastructure file "KCGM Infrastructure.dxf".
- Excel spreadsheet file "KCGM_OP_drill_pattern_parameters.xlsx" containing current blast design and charging parameters.
- Blast video files obtained for the Stage 1 review for 100 blasts fired in the Fimiston Open Pit, between elevations -60 and -590m, including production and trim blasts, covering the period 26 Nov, 2018 to 29 Dec, 2020
- 100 data files obtained for the Stage 1 review from the Orica/KCGM BlastIQ database containing quality control records for 100 blasts in all sectors of the KCGM pit on a hole-by-hole basis, covering the period 08 May to 28 December, 2020
- Safe Operating Practice BLA 31, Loading Blastholes

In addition, the following summaries were prepared on site by Blastechnology after review of KCGM blasting records:

- Excel file "Cratering Incidence from Video Review.xlsx", providing a subjective assessment of the control over ejections during blasting for each of the 100 blast videos reviewed.

The review of practices in this report is based upon the data reviewed, and discussions with site personnel including the Blasting Supervisor, Blast Design Engineer, Drill & Blast Superintendent, Senior Mining Engineer and the Environment Superintendent. It assumes that practices noted during discussions and in the information provided are representative of the site's typical range of blasting practices.

The proposed Stage 2 final pit shell, its surrounding property boundaries and infrastructure, the 200 m blast clearance boundary, and the 400 metre Setback for Mining Activities boundary are presented in Figure 1.

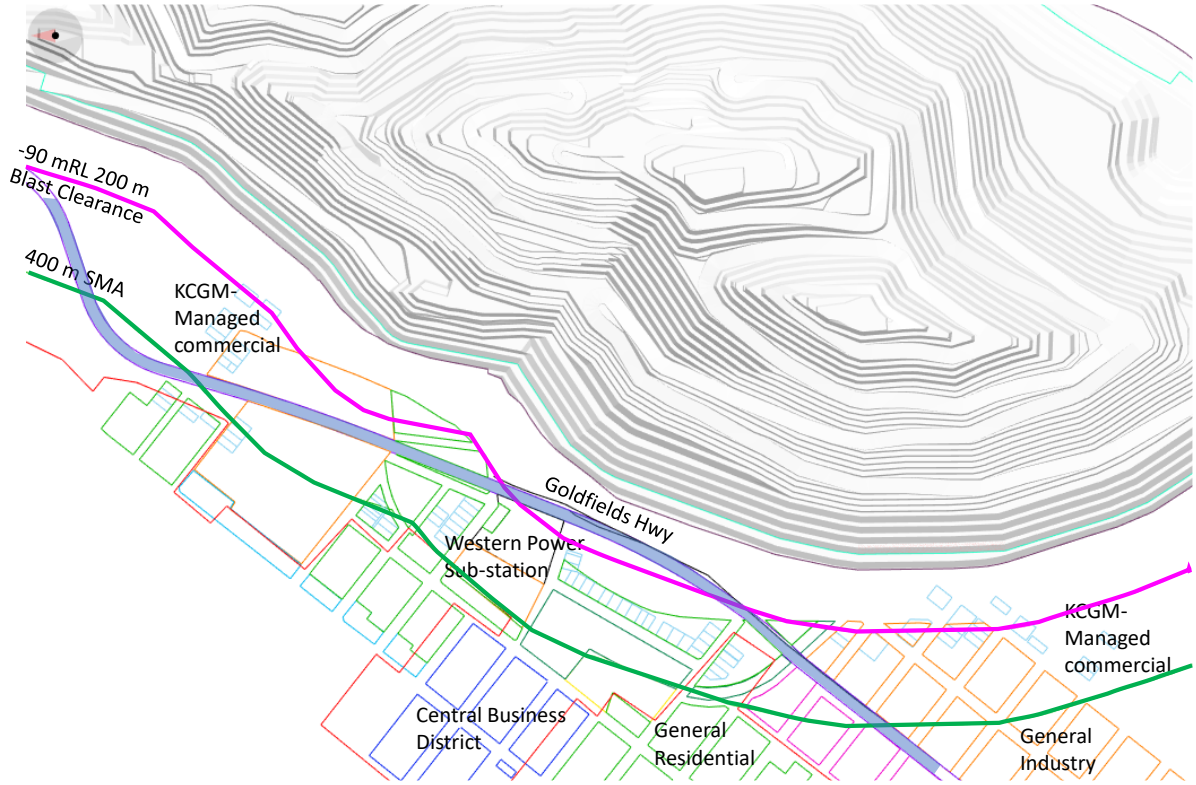

Figure 1. Plan view of south western portion of Fimiston Open Pit showing Stage 2 final pit shell, and nearby properties. Also shown are the 200 metre blast clearance contour from -90 mRL, and the 400 metres SMA contour.

2. CURRENT BLASTING PRACTICES

2.1 Pattern Design

Pattern design at KCGM uses an up-to-date terrain model to determine collar elevation and correct hole length for every hole. Patterns are designed by KCGM personnel in Vulcan, and the designs are passed to the drills which are equipped with high precision GPS systems for accurate collar locations. When the on-board GPS systems are not functioning, surveyors mark the collar locations using a combination of spot survey points, tape measures and paint marks on the bench floor. Holes are not re-surveyed after drilling.

Mining is currently occurring in the Morrison cutback with 10 metre benches and a combination of 115, 127 and 165 mm diameter blastholes. Of relevance to the flyrock potential, different blast designs are used for wall-control (trim) and production blasting. The current charging configurations for the different types of blastholes and blast patterns are shown in Figure 2 below.

Figure 2. Row nomenclature and charge configurations used in Transitional material, Fimiston Open Pit, and in flyrock modelling.

Burden and spacing are advised to be fixed in production blasts for each hole diameter, with the explosive type and density varying according to rock strength. Production powder factor is in the range 0.5 kg/m^3 with ANFO as the predominant explosive in softer rock conditions, to 0.7 kg/m^3 with Advantage 11 as the predominant explosive in the harder rock conditions such as the sulphides.

Holes are charged to a specified stemming length using Orica Mobile Manufacturing Units (MMU's) which are configured to also capture actual charge weights, actual hole depths and actual stemming lengths on a hole-by-hole basis, using the BlastIQ system on board the trucks.

Initiation is sometimes electronic (areas of high vibration sensitivity), and sometimes non-electric, though there does not appear to be a standard timing design for either initiation system. In this report, timing is not considered to affect the maximum flyrock projection distance, though it can affect the probability of a flyrock incident occurring. Initiation design is performed using the Orica ShotPlus software.

Stemming is an excellent quality screened aggregate material (Figure 3) with fragments in the approximate range 16 to 25 mm, loaded using a small front end loader in accordance with a specific Safe Operating Practice. In this report, the type of stemming material does not affect

the maximum flyrock projection distance, though it can affect the probability of a flyrock incident occurring.

Figure 3. Stemming materials used in all KCGM blasts.

2.2 Design Implementation

Computer-based designs are transferred electronically to the high precision GPS-guided drill rigs. When the guidance systems are non-functional, hole locations are marked with paint using an in-pit survey system. Once holes are drilled, hole depths are dipped and recorded approximately 24 hours prior to charging, and those hole depths are used to calculate the expected hole-by-hole charge loads. Hole-by-hole charge loads are then conveyed to the MMU operator at the time of charging.

Explosive column rise is measured during loading, in accordance with a specific Standard Operating Procedure. In general, holes are charged to a specified stemming length rather than to a specified charge weight, though truck operators require approval before loading an amount more than 10% greater than the design charge weight. Actual charge weight may therefore be less than, or greater than the designed charge weight, depending on actual hole length and hole condition. A review of almost 33,000 holes from one hundred blasts throughout the pit (oxide and transitional materials, production, buffer, and batter in 115, 127 and 165 mm diameters) from the BlastIQ database produces the variability in actual vs design charge weights shown in Figure 4.

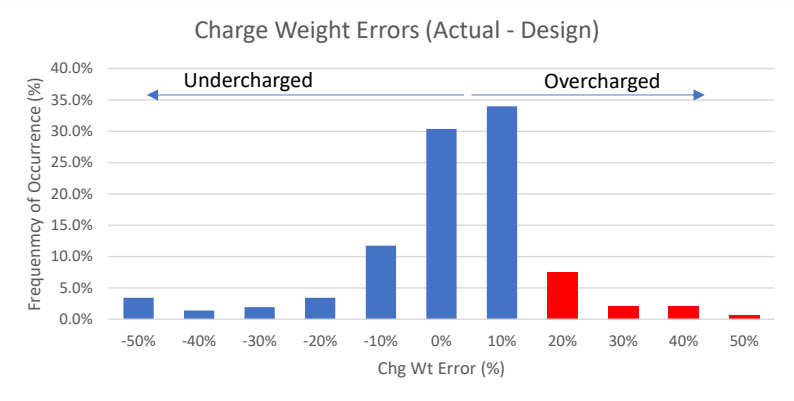

Figure 4. Instances of overloading and underloading of blastholes from 100 blast records.

Of the almost 33,000 holes previously analysed, around 12% show overloading by more than 10% with respect to the theoretical charge weight. This does not necessarily signify that stemming lengths are shorter than design, since it is very common for holes to exhibit an effective diameter a little larger than the nominal diameter, especially in the softer rock types.

Of principal relevance to this flyrock review are the instances of loaded blastholes in which stemming length is shorter than design, especially the larger production blastholes. Figure 5 presents the variability in actual stemming lengths, as obtained from the analysis of almost 33,000 holes, from which it is concluded that stemming lengths tend to be longer than the nominal values. Figure 5 shows, for 165 mm holes with a design stem length of 3.9 metres, approximately 10% of holes have an actual stemming length in the range 3.4 to 3.9 metres, and fewer than 1% of holes with stemming lengths short by more than 0.5 metres. The statistics for 127 mm production holes with a nominal stemming length of 3 metres are very similar.

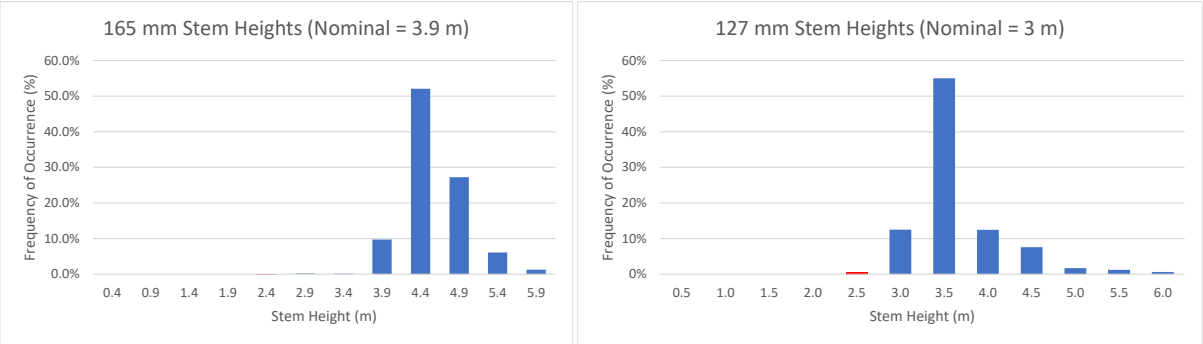

Figure 5. Typical stem height variability for production blastholes based on data from 100 blasts, from the Orica BlastIQ database.

2.3 Observations of Flyrock

A detailed review of flyrock reports and incidents, and blast video records, was conducted by Blastechnology for the Stage 1 Fimiston South project, dated February, 2021. The author is advised that no flyrock incidents have occurred in 2021, so that the mine has maintained its record of a zero incidence of flyrock projection outside the mining area.

The Feb 2021 report focused on collar ejections since these are the flyrock sources representing the greatest risk to structures and public accessways located to the west of the Stage 2 Pit. While flyrock ejections may also occur from the free face and are capable of travelling large distances, such ejections from the proposed Stage 2 pit will always be directed towards the centre of the pit. When blasting on the western wall, free-face flyrock is therefore directed away from public areas and infrastructure.

3. PROXIMITY TO PROPERTY & INFRASTRUCTURE

Blasting is not expected to be required until the -90 mRL bench has been formed, at which stage the blast designs of Figure 2 will be deployed. Each of the hole and charge configurations in Figure 2 has its own unique flyrock "signature". No blastholes of diameter greater than 127 mm will be deployed in the trim blasts nearest to the pit limits, with the first row of fully-charged 165 mm diameter production blastholes not drilled closer than approximately 70 metres to the Stage 2 footprint. Figure 6 presents the general blasthole layout as well as the designed crest line for the -90 mRL bench, and used for the flyrock modelling.

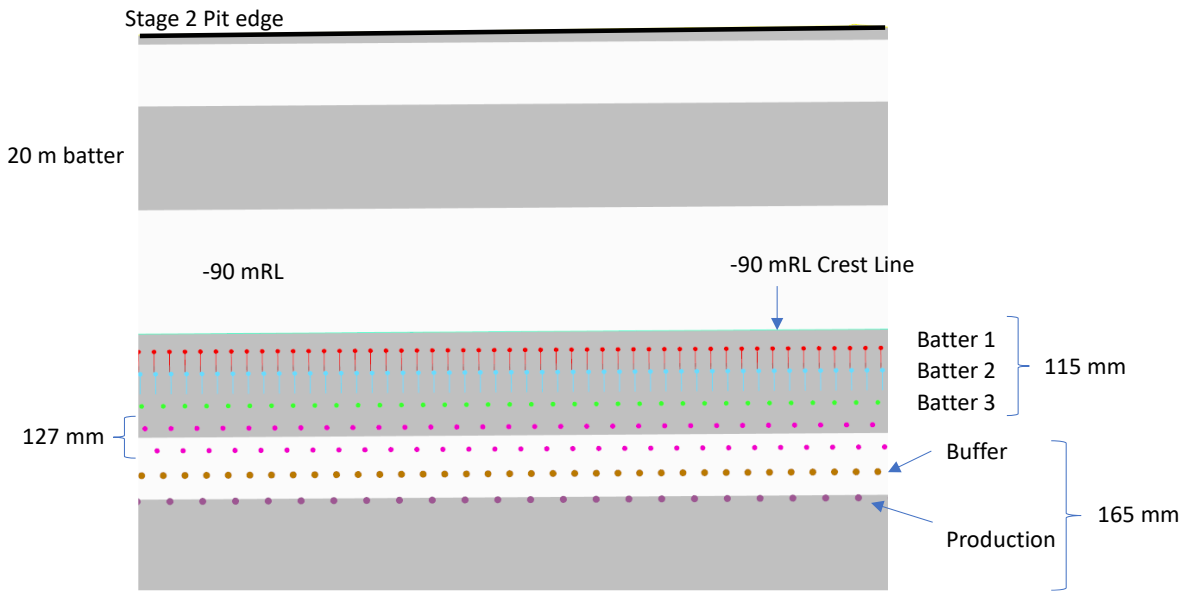

Figure 6. Schematic of drilling geometry for blasts drilled from -90 mRL bench, Fimiston South, Stage 2.

Table 1 lists the minimum separation distances of the different hole types in Figure 6 from property boundaries and infrastructure, based on Cadastral data provided by KCGM, and highlights the different sensitive receivers lying inside the 200 m blast clearance distance (pink shading). Note that the minimum displayed distances are plan distances.

Table 1. Minimum separation distances of properties from Stage 2 blasting. Pink-shaded cells indicate properties inside the 200 metre blast clearance distance from -90 mRL.

Type of Structure	Batter 1, 115 mm Min. Dist.	Batter 2, 115 mm Min. Dist.	Batter 3, 115 mm Min. Dist.	127 mm Prod'n Min. Dist.	165 mm Buffer Min. Dist.	165 mm Prod'n Min. Dist.
General residential	268 m	272 m	277 m	280 m	283 m	288 m
KCGM Managed commercial	84 m	88 m	93 m	96 m	99 m	104 m
KCGM Managed residential	221 m	225 m	230 m	233 m	236 m	241 m
WP Sub-station	165 m	169 m	174 m	177 m	180 m	185 m
Park & Recreation	182 m	186 m	191 m	194 m	197 m	202 m
General Industry	185 m	189 m	194 m	197 m	200 m	205 m
Service & light industry	314 m	318 m	323 m	326 m	329 m	334 m
Central Business District	516 m	519 m	525 m	528 m	531 m	535 m
Public Purpose area	456 m	460 m	465 m	469 m	472 m	476 m
Mixed Business	590 m	594 m	599 m	602 m	605 m	610 m
Goldfields Highway	130 m	134 m	139 m	142 m	145 m	150 m
WP HV Lines	130 m	134 m	139 m	142 m	145 m	150 m
WP to KCGM Connection	0 m	0 m	0 m	0 m	0 m	0 m
KCGM Power Lines	0 m	0 m	0 m	0 m	0 m	0 m

4. FLYROCK MODELLING, STAGE 2

Flyrock modelling in this report uses the model found in the Paradigm blast modelling software package, which requires no calibration factors and can be applied to holes of any diameter and charge configuration in any rock type. The modelling considers worst-case projection distances based on the charging designs provided by KCGM, and also considers the probability that one or more flyrock fragments could be projected to each of the sensitive receivers/areas. The Paradigm model also provides estimates of the probability of flyrock landing within any defined area, and in this report flyrock risk is considered to be zero if the probability of one or more fragments landing with a defined area is less than 10^{-7}, or one in ten million.

4.1 Flyrock Range from Proposed Charge Configurations

Table 2 presents the blasthole diameter and charging details for holes used in the modelling for both trim blasts and production blasts fired in the upper sections of the Fimiston South, Stage 2 pushback. The details were obtained from a spreadsheet provided by the mine, and discussions with the site's drill and blast supervisor. Also shown in the same table are the maximum flyrock projection distances for each combination of hole diameter and charge configuration, based on nominal, or design, stemming lengths. Projection distances are worst-

case distances, with average ranges generally not greater than approximately one quarter of the worst-case distances.

Table 2. Charging configurations proposed for Fimiston South, Stage 2 project, and their maximum flyrock projection distances.

Zone	Morrison										Flyrock
Transition	Material	Height	Subdrill	Burden	Spacing	prod. Diam.	stem height	product	hole charge	P. factor	Range
	Production holes	10 m	1.1 m	4.1 m	5.3 m	165 mm	3.5 m	HA/1.0D	164 kg	0.75	161 m
	Buffer holes	10 m	1.1 m	4.1 m	3.5 m	165 mm	5.0 m	HA/1.0D	130 kg	0.91	84 m

GB Trim	hole angle	length	hole diam.	Spacing	Burden	stem height	Airdeck	product	hole charge	Flyrock Range
Batter row 1	60	12.1 m	115 mm	2.5 m	3.0 m	3.0 m	3 m	ANFO/0.8	50 kg	48 m
Batter row 2	70	9.6 m	115 mm	2.5 m	3.0 m	3.0 m	0 m	ANFO/0.8	55 kg	74 m
Batter row 3	90	11.1 m	115 mm	3.5 m	3.6 m	3.0 m	0 m	ANFO/0.8	67 kg	74 m
Production	90	11.1 m	127 mm	3.5 m	3.0 m	3.0 m	0 m	ANFO/0.8	83 kg	95 m

Probabilities of projection greater than 200 metres are effectively zero (less than 10^{-7} or one in ten million) for each of the specified charging configurations, based on nominal stemming heights. If stemming length is reduced by 0.5 metres in any hole, due to an uncorrected charging error, the probability of a projection distance greater than 200 metres increases to around 1 in 350,000 for that hole. Table 2 indicates that the greatest flyrock risks come from the 165 mm production holes charged with a 1.0 g/cc product (transition material expected to be encountered at -90 mRL) , and with 3.5 metres of stemming, and a worst-case flyrock range of 161 metres. For a 165 mm diameter hole with the same explosive product, but with only 3 metres of stemming (i.e. with a charging error of 0.5 metres), the maximum range would increase to 210 metres, though the probability of projection more than 200 metres is 1 in 350,000, or 0.0003%.

Table 3 is an extended version of Table 1, but also shows the estimated probability, expressed as a percentage, that one or more rock fragments from any single blasthole, will be projected more than the separation distance to each sensitive site. Where a zero probability is displayed, the estimated probability is less than 1×10^{-7}. If the probability is higher than 1×10^{-7}, the cell is highlighted in grey shading.

Table 3. Minimum blast separation distances and probability of flyrock projection beyond each receiver. Properties inside the 200 m blast clearance are shaded red, and non-zero flyrock projection probabilities are shaded grey.

Type of Structure	Batter 1, 115 mm		Batter 2, 115 mm		Batter 3, 115 mm		127 mm Prod'n		165 mm Buffer		165 mm Prod'n	
	Min. Dist.	Prob.	Min. Dist.	Prob.	Min. Dist.	Prob.	Min. Dist.	Prob.	Min. Dist.	Prob.	Min. Dist.	Prob.
General residential	268 m	0.0%	272 m	0.0%	277 m	0.0%	280 m	0.0%	283 m	0.0%	288 m	0.0%
KCGM Managed commercial	84 m	0.0%	88 m	0.0%	93 m	0.0%	96 m	0.0%	99 m	0.0%	104 m	0.04%
KCGM Managed residential	221 m	0.0%	225 m	0.0%	230 m	0.0%	233 m	0.0%	236 m	0.0%	241 m	0.0%
WP Sub-station	165 m	0.0%	169 m	0.0%	174 m	0.0%	177 m	0.0%	180 m	0.0%	185 m	0.0%
Park & Recreation	182 m	0.0%	186 m	0.0%	191 m	0.0%	194 m	0.0%	197 m	0.0%	202 m	0.0%
General Industry	185 m	0.0%	189 m	0.0%	194 m	0.0%	197 m	0.0%	200 m	0.0%	205 m	0.0%
Service & light industry	314 m	0.0%	318 m	0.0%	323 m	0.0%	326 m	0.0%	329 m	0.0%	334 m	0.0%
Central Business District	516 m	0.0%	519 m	0.0%	525 m	0.0%	528 m	0.0%	531 m	0.0%	535 m	0.0%
Public Purpose area	456 m	0.0%	460 m	0.0%	465 m	0.0%	469 m	0.0%	472 m	0.0%	476 m	0.0%
Mixed Business	590 m	0.0%	594 m	0.0%	599 m	0.0%	602 m	0.0%	605 m	0.0%	610 m	0.0%
Goldfields Highway	130 m	0.0%	134 m	0.0%	139 m	0.0%	142 m	0.0%	145 m	0.0%	150 m	0.0001%
WP HV Lines	130 m	0.0%	134 m	0.0%	139 m	0.0%	142 m	0.0%	145 m	0.0%	150 m	0.0%
WP to KCGM Connection	0 m	100%	0 m	100%	0 m	100%	0 m	100%	0 m	100%	0 m	100%
KCGM Power Lines	0 m	100%	0 m	100%	0 m	100%	0 m	100%	0 m	100%	0 m	100%

The KCGM power lines are at greatest risk, since they pass directly over the Stage 2 cutback area. There is also a connection line from the Western Power to the KCGM HV line that crosses the cutback area, which will require mitigation. Other assets within flyrock range and at various levels of risk are considered to be some KCGM-managed commercial properties, the Western Power HV powerline running along the Goldfields Highway, and a 265 metre section of the highway within 140 metres of the -90 mRL footprint.

4.2 At-Risk Properties & Infrastructure

Importantly, there are no residential structures or properties lying inside the 200 metre blast clearance zone for the Stage 2 cutback. Table 3 identifies a number of other assets at varying levels of potential flyrock risk, that is, assets lying within the worst-case flyrock projection distance of various blasthole configurations proposed for use in the Stage 2 pushback. Each will be discussed in greater detail in the following sections, commencing with those assets with the greatest potential flyrock risk.

4.2.1 KCGM Powerlines

Since these power lines pass directly over the proposed Stage 2 mining area, the probability of damage is considered to be effectively 100%. Mitigation or management methods are therefore required to protect this asset.

4.2.2 Goldfields Highway

Blasting in Stage 2 occurs within approximately 130 metres (plan distance) of the Goldfields highway, and within approximately 150 metres (plan distance) of the 165 mm production blastholes which have a worst-case flyrock projection distance of 161 metres (Table 2). Taking the elevational differences into account, the probability of one or more fragments landing on the roadway is approximately 1 in 840,000 for full compliance with design stemming lengths,

increasing to 0.03% for holes if stemming lengths reduced by 0.5 metres. Approximately 700 metres of the highway lie within the 200 m blast clearance distance.

4.2.3 KCGM-Managed Commercial Properties

Some of these properties, near the southern end of the cutback, are located as close as 81 metres to the Stage 2 blasting (-90 mRL) footprint, bringing them within approximately 104 metres of the 165 mm production blastholes. The elevation of natural surface is taken to be an average of -65 mRL, and to be -90 mRL for the blasthole collars.

Two shaded properties (Figure 7) lie within the worst-case flyrock projection plan footprint. Taking into consideration the 25 metre difference in elevation between the blasthole collars and the structures on natural surface, the probability of one or more fragments landing in the red-shaded area is 0.05%, assuming compliance with stemming lengths, increasing to 1% if all stemming lengths are short by 0.5 metres. The corresponding probabilities for the yellow-shaded property are zero and 0.02%. Since both properties lie within the 200 m blast clearance zone, and all personnel will be evacuated during blasting, the flyrock risks are associated purely with potential damage to company-owned structures or equipment inside the boundaries.

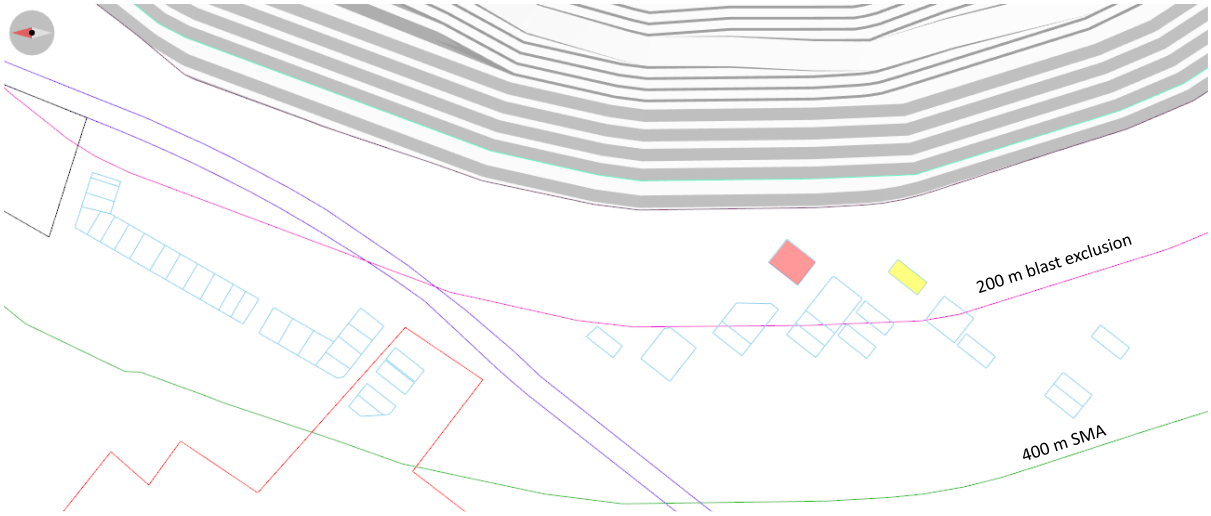

Figure 7. KCGM-managed commercial properties within Stage 2 worst-case flyrock footprint (shaded), and within the 200 metre blasts exclusion zone.

Blastechnology is advised that the red-shaded structure in Figure 7 is to be demolished prior to the commencement of blasting in the Stage 2 pit.

4.2.4 Western Power High Voltage Lines

These high voltage lines run along the eastern side of the Goldfields Highway with a 250 metre section of the lines lying within the worst-case flyrock footprint of the 165 mm diameter production blastholes, assuming full compliance with design stem lengths. While the lines have a minimum separation distance of approximately 114 metres from the nearest 165 mm diameter

production blasthole, the probability that one or more rocks will pass within +/- 1 metre of the lines is less than 10^{-7} after accounting for the elevational difference between the lines (assumed to be -60 mRL) and the blasthole collars (-90 mRL). If the stemming length reduces to 3 metres for all holes, the risk of damage remains essentially zero. This asset is therefore considered to be at no significant level of risk from production blasting within Stage 2. The analysis has ignored the connecting spur which runs from the highway and terminates directly over the Stage 2 mining area. The spur line is at high risk and requires mitigation.

4.3 Flyrock from Pre-Split blasting

Figure 8 presents a vertical section view of the Stage 2 western wall profile, characterised by 50 degree batter angles for benches above the -170 mRL level, changing to 60 and then to 83 degree batters for benches below that elevation.

Discussions with the KCGM Drill & Blast Superintendent indicate some pre-splitting will occur in transitional material, and will involve the use of stemming, for overpressure control purposes, and a charge configuration as shown in Figure 9 below. Modelling of flyrock from stemmed pre-split holes is possible with the Paradigm flyrock model, and the calculated maximum range for the charge configuration of Figure 9 is 50 metres. Pre-split blasting is therefore not considered to be a flyrock risk for the Fimiston South, Stage 2 project.

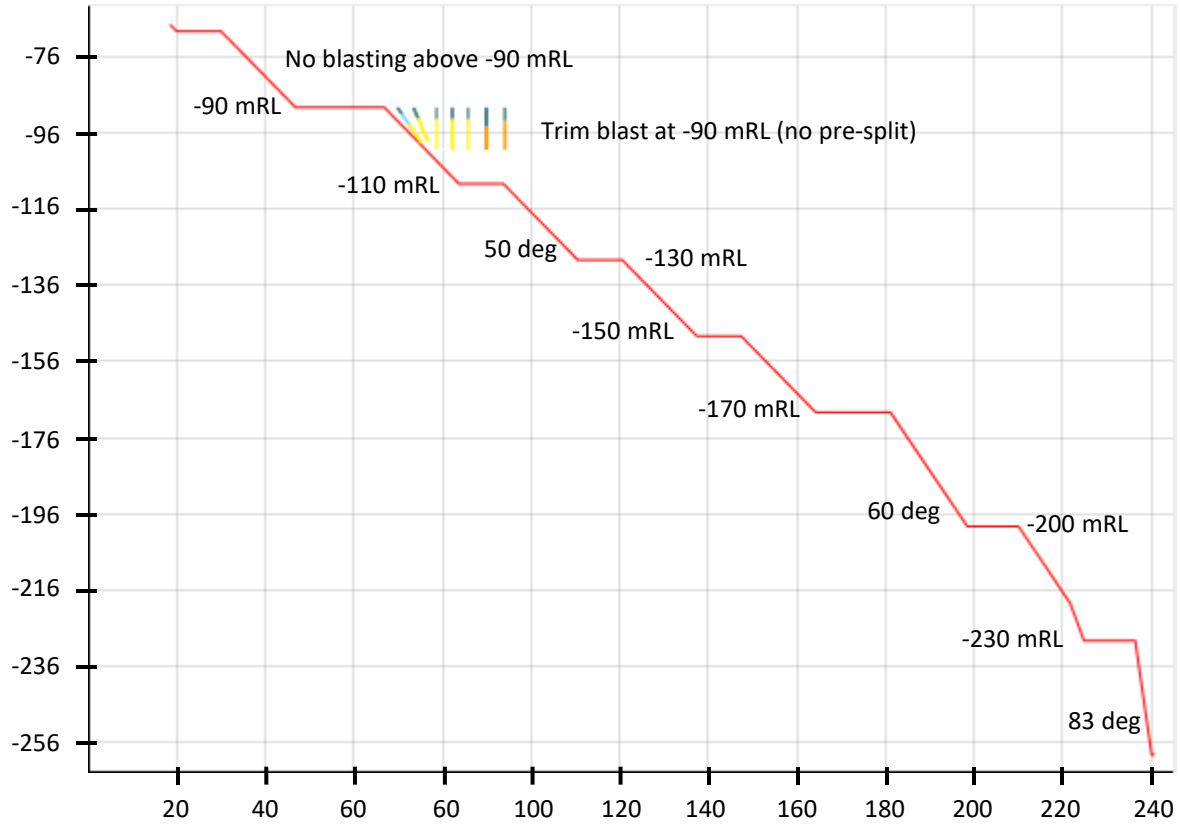

Figure 8. Vertical section through western wall, showing Stage 2 design shell, and bench-face angles down to -260 mRL.

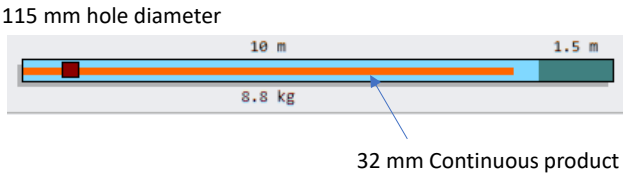

Figure 9. Pre-split charge configurations for benches above the -170 level.

5. BLAST CLEARANCE DISTANCE

Historically, since the commencement of the Golden Pike pushback, the blast clearance distance has been 200 metres from the nearest blasthole. While this distance is greater than the worst-case flyrock projection distance for holes charged to design specifications, it is considered a prudent distance based on the maximum potential stemming length error during charging, shown in Section 2.2 to be approximately 0.5 metres.

At 200 metres distance, there are a few potentially-occupied properties lying inside the clearance area when applied to the trim blasts on the western wall of the pushback, as illustrated by the shaded areas in Figure 10. These areas will require evacuation for only a small number of blasts fired in very specific areas near to the western wall of the cutback.

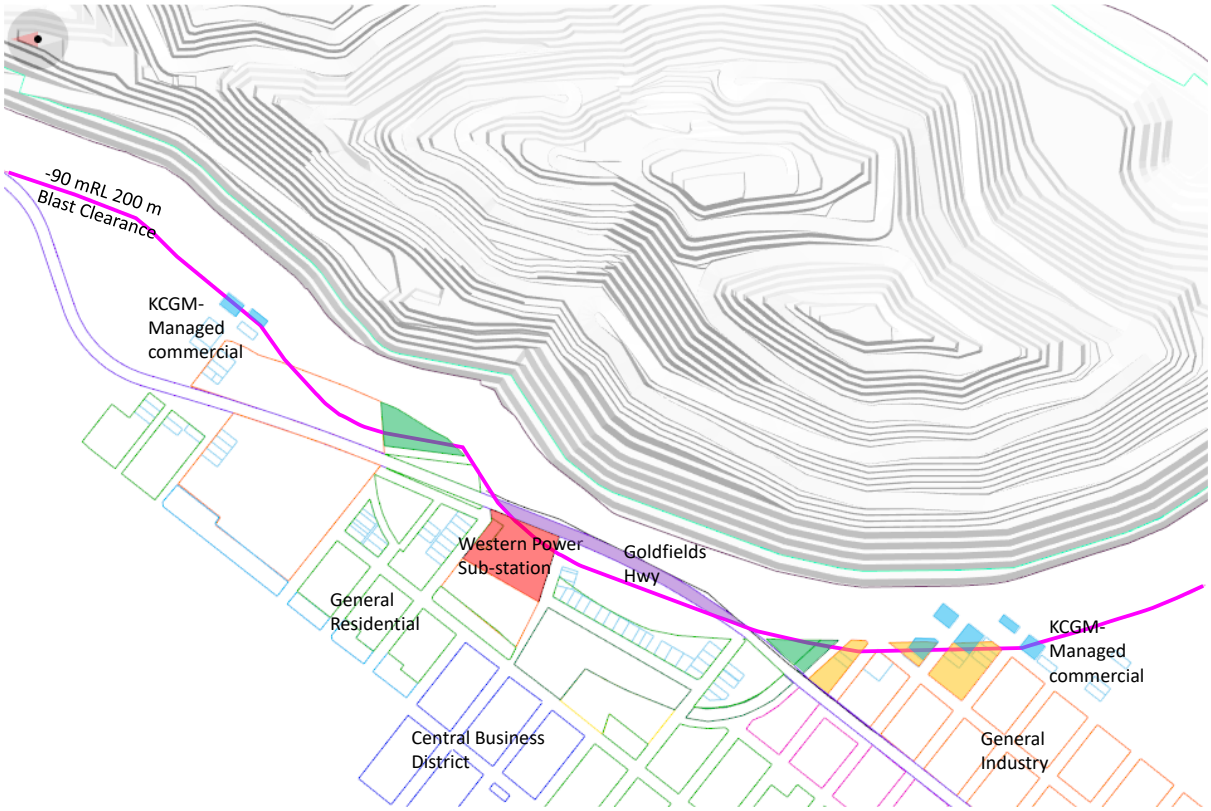

Figure 10. Properties (shaded) lying wholly, or partially, inside the 200 m blast clearance distance of -90 mRL footprint.

While these highlighted areas lie wholly, or partially, inside the 200 metre blast clearance area for blasts fired against the western wall of the Stage 2 Fimiston South pit, most lie outside the flyrock risk zone, as discussed in Section 4.2 above, for 165 mm production holes with at least 3.5 metres of stemming. It is not until the -150 mRL bench that plan distances to all highlighted properties exceed 200 metres for all subsequent blasts fired in the proposed pushback. At the -130 mRL bench, all properties except two of the KCGM-managed properties lie outside the 200 m blast clearance zone.

Two options therefore exist for blasts fired between the elevations of -70 and -150 mRL, within 200 metres of potentially-occupied properties to the west of the proposed pushback – evacuation of all affected areas, or a temporary relaxation of the 200 metre clearance zone in conjunction with tighter controls over quality control during charging. Evacuation of a large number of areas will require the use and coordination of numerous blast guards, and will increase the risk of reportable breaches of blast clearances. Appropriate quality control procedures are discussed in Section 7.

While covering the blasts to prevent flyrock is a theoretical third option for blasting with a clearance distance less than 200 metres, it is considered neither safe nor practical for the Stage 2 pushback, due to the average size of blasts (~170 holes), and the potential for misfires. Misfires are considered a greater risk to public and mine-worker safety than flyrock from trim and production blasting.

6. FLYROCK ZONING, STAGE 2

Flyrock zoning of the Stage 2 mining area is undertaken based on worst-case projection distances, not on the blast clearance distance. Table 3 shows that the only blasthole type of real concern for flyrock beyond the Stage 2 footprint is the 165 mm diameter production blasthole charged with 3.5 metres of stemming and a 1.0 g/cc (or higher) density product, and Figure 7 showed the KCGM-managed properties at risk. The red-shaded areas of Figure 11 represent the affected zones within the Stage 2 blasting area in which 165 mm diameter blastholes will place some of the KCGM-managed commercial properties, and a section of the Goldfields Highway, at a low level of risk from flyrock. The southern zone extends down to the -130 mRL bench, and the northern zone affects only a small part of the -90 mRL bench of the Stage 2 cutback.

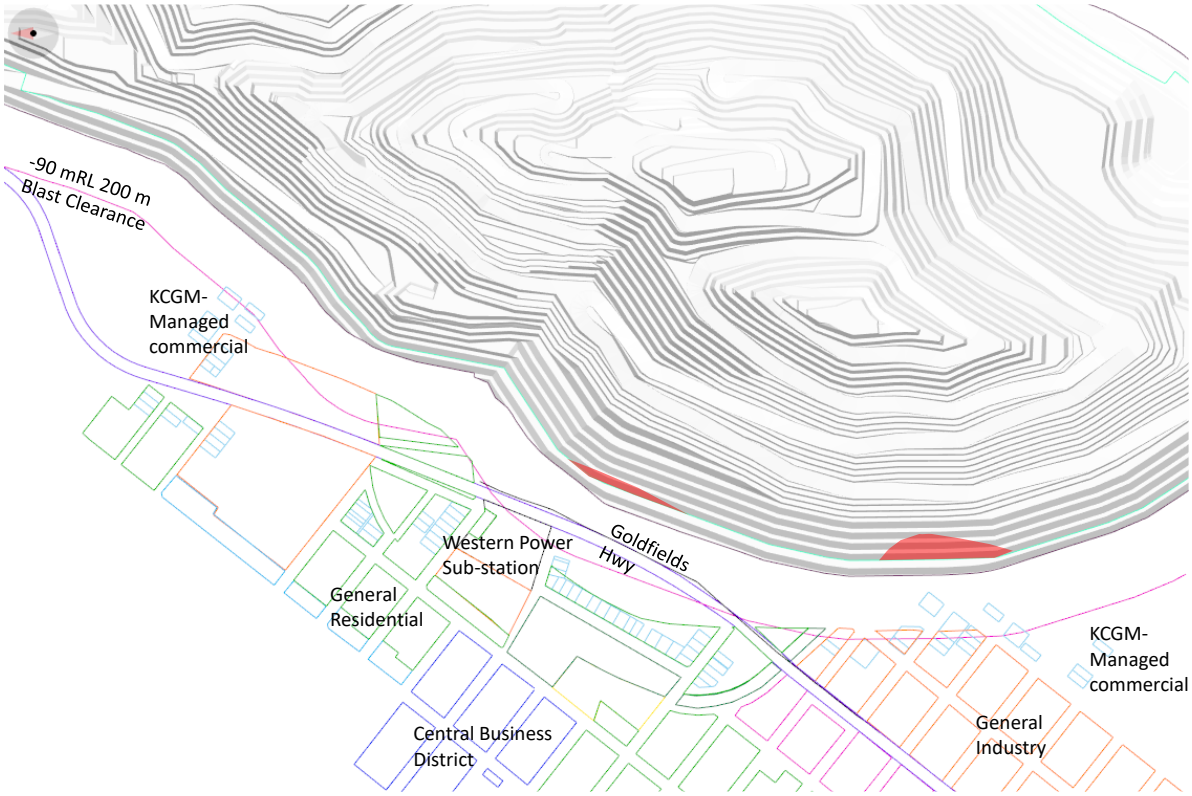

Figure 11. Zoning of the Stage 2 mining area representing areas where 165 mm diameter production holes are capable, under worst-case conditions, of projecting flyrock into properties.

7. SETBACK FROM MINING ACTIVITIES

The Setback from Mining Activities (SMA), previously referred to as the Safety Exclusion Zone (SEZ) appears to have been applied to the Fimiston Open Pit by the State Mining Engineer in 1992, and was set at 400 metres. The purpose of the SMA included the protection of residential properties from possible flyrock from blasting operations. Section 10-1 of Ministerial Statement No 782 states "*The proponent shall not undertake active mining operations within 400 metres of a property zoned Residential under the Town Planning Scheme without the written consent of the owner and occupier of that property.*" The same document further defines "active mining" as "*any method of working by which earth or any rock structure …. is disturbed*…", and is interpreted in this report to extend outwards by 400 metres from the top-of-pit footprint.

A summary of the SEZ and its genesis was prepared by Gary Lye (undated) titled "Current SEZ Situation". In that summary, it is stated that no permanent residential dwellings were to remain within the SEZ, though commercial and industrial properties could stay within the zone provided that they were vacant at the time any blasting occurred. Later in the same document, Gary Lye refers to the DME recommendation endorsed by State Cabinet in December 1991, stating "*In line with a cabinet decision any residential properties occurring within the SEZ are to be purchased by KCGM, who may enter into arrangements with the occupants of those*

premises, allowing residents to remain living in the area subject to strict adherence to safety requirements to ensure nobody is injured during blasting activity.".

The SEZ has not changed since 1992 and, based upon the Fimiston Ministerial Statement No. 782, it seems that KCGM must purchase all residential properties within a 400 metre radius of the top-of-pit footprint and obtain written permission from occupants for blasting to occur at times required by the mine. Under those circumstances, it is considered not necessary to vacate residential, commercial, or industrial premises located between 200 and 400 metres of blasting operations. According to the cadastral data obtained for this study, the only General Residential properties inside the SMA are KCGM-managed, as shown in the red-shaded zone in Figure 12.

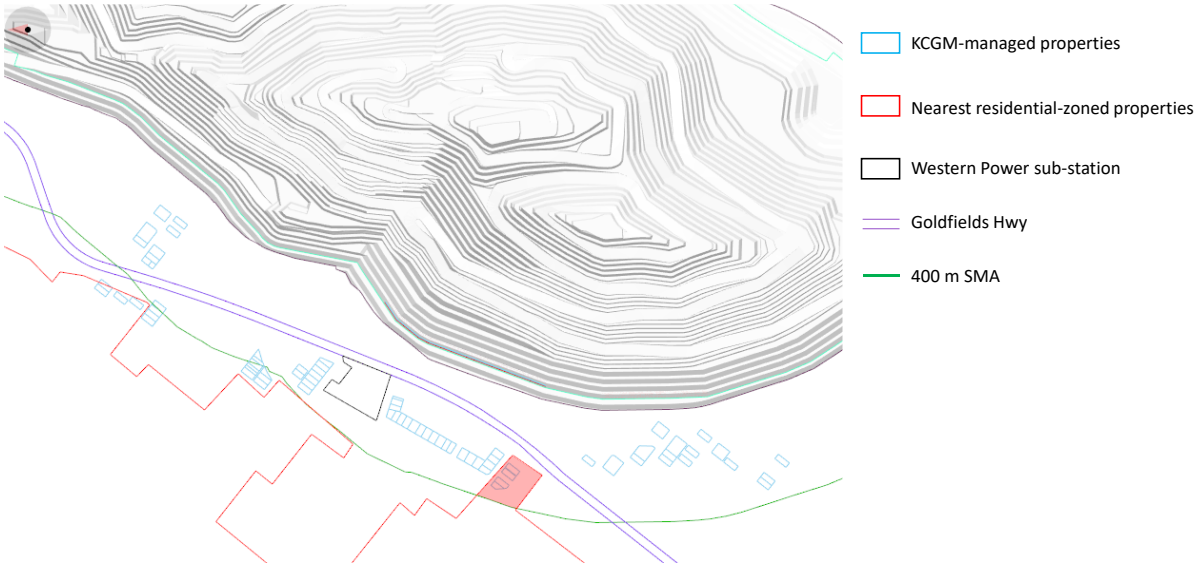

Figure 12. General residential zoned areas within the 400 metre SMA.

8. FLYROCK MITIGATION RECOMMENDATIONS

The report has highlighted the difficulty in operating with a 200 metre blast clearance zone when blasting close to the western limits of the Stage 2 Fimiston South cutback. A clearance to this distance will require a large number of blast guards to ensure evacuation of all possible affected areas, and will increase the risk of a reportable breach. At the same time, the 200 metre clearance distance provides an appropriate buffer to compensate for potential charging errors which result in stemming columns shorter than design by as much as 0.5 metres.

The KCGM mining lease and other KCGM infrastructure on the western side of the highway are currently bounded by a security fence to prevent unauthorised access. This fence should be strictly maintained and inspected while mining benches within the 200m exclusion zone, notably where the benches are above the -150mRL.

The following mitigation recommendations are made, focused on flyrock awareness and predictability:

1. Using best-available modelling, define minimum stemming requirements for all blasthole charges (production, buffer batter, deep, short), in all sections of the pit, taking

into account realistic error bands for stemming length which are supported by a tight and sustainable quality control process on the bench, and recorded data.

2. Adjust the blast clearance map based on flyrock shroud intersection with the pit topography to ensure safety of operators working at lower bench elevations.
3. Integrate flyrock modelling into the blast design, review, and approval processes. This will require that the mine conduct a risk analysis to determine an appropriate factor of safety to be applied to the estimated maximum flyrock range, and to establish a safe clearance radius.
4. Identify the conditions under which closure of the Goldfields Highway will be required. This could be based on the 200 metre blast clearance radius, or perhaps on a quantitative risk analysis considering site-specific charging error statistics.
5. Bury exposed electric cables (KCGM and Western Power) within 120 metres of the top-of-pit footprint.
6. Regularly review the BlastIQ data relating to actual stemming length, and request that the system report a stemming length compliance KPI for each blast, prior to firing. The blasting supervisor or senior shotfirer should consult the KPI prior to firing, and in critical areas, flyrock modelling should be conducted prior to firing, using as-charged hole conditions.
7. Undertake daily review of blast video records, at least in the high-risk flyrock zones, identifying extent and intensity of cratering. Identify triggers for investigations and for changes to stemming practice. Include video review statistics in Post Blast Reports, and have regular post-blast reviews involving designers, superintendents, supervisors and blast crew. A recommended practice is to include a review of the previous day's blast videos at the blast crew's pre-start meeting each day.

Appendix A

Images & Flyrock Ratings from Blast Video Records

Zero Cratering Incidence (some face ejections), Intensity Rating 1: 110-1714.mp4

Less than 5% Cratering Incidence, Intensity Rating 3: 80-1707B-09B.mp4

Approx. 10% Cratering Incidence, Intensity Rating 3: 90-1703B04_B07A.mp4

Approx. 20% Cratering Incidence, Intensity Rating 2: 90-1707c.mp4

Approx. 50% Cratering Incidence, Intensity Rating 4: 100-1728.mp4

Approx. 100% Cratering Incidence, Intensity Rating 5: 100-1705B.mp4