DUST FALLOUT REPORT

FOR

CITY DEEP OPERATIONS

CROWN GOLD RECOVERIES (PTY) LTD

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Environmental Solutions Provider

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EXECUTIVE SUMMARY

An analysis of the City Deep Operation results indicates that 57% of the levels of dust fallout for the twelve month sampling period from October 2008 to September 2009 fell within the slight category, 25% of the levels fell within the moderate category, 14% of the levels fell within the heavy category and 4% of the dust levels fell within the very heavy category according to DEAT guidelines. most records provided by AER for the 2007 and 2008 monitoring periods are respectively permissible for residential and light commercial activities ($D<600mg/m^2/day$; Band 1) and heavy commercial and industrial ($600<D<1,200mg/m^2/day$, Band 2) according to the SANS 1929:2005 guidelines.

Mining activities at the City Deep Operations tailings dams have however the potential for generating increased dust and subsequently expected to raise levels of particulate mater and air pollution in the area. Thus, the areas most sensitive to potential impacts resulting from increased dust levels will be around the tailings dams. The prevailing winds will carry dust from the proposed tailings dump to areas situated on the south (S) to south-eastern (SE) side.

Conditional to the effective mitigation of impacts associated with mining activities at the tailings facilities, it is therefore anticipated that impacts on air quality will have a negative impact of medium to high significance and short-term duration on the local area. It is not expected that mining activities associated with the City Deep plant will have a substantial detrimental effect on the surrounding environment. Although overall impacts are not expected to be of long-term duration, it is recommended that Crown Gold Recoveries monitors and manages all mining operations in the area.

Once the material from the City Deep operations tailings complexes have been reclaimed, processed and decommissioned, overall dust fallout levels will decrease and the cumulative impact could improve.

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1 TERMS OF REFERENCE

Digby Wells and Associated (DWA) was commissioned by Crown Gold Recoveries (Pty) Ltd to carry out an environmental air quality impact assessment in support of an EMPR upgrade for the City Deep reclamation activities. The purpose of the study was to assess the impact of the reclamation activities on the ambient dust fallout levels of the area, which is primarily urban district with business and industrial parks. The approach used in investigating the air quality impacts is based on guidelines provided by the South African National Standards (SANS 1929:2005). The following legislation was considered for this survey:

- The National Environmental Management Act (Act no 107 of 1998), NEMA; and
- The National Environmental Management Air Quality Act (Act no 39 of 2004), NEMAQA.

2 INTRODUCTION

A major section of the population resident in Johannesburg and Germiston still relies on combustion of bituminous coal for domestic energy requirements with its associated release of smoke and noxious gases (Annegarn. H, 2008). Major traffic arteries dissect this area and are saturated at peak hours, which lead to daily high levels of vehicle emissions. Winter inversions which trap traffic, domestic and industrial emissions result in the air quality being generally poor, especially during the mornings.

The area is also extensively interspersed with mine tailings residues, which in many cases are being reclaimed or where the vegetative cover has deteriorated, thereby exposing surfaces from which dust emanates. Settleable dust on the Witwatersrand has been measured over a long term by Annegarn et. al. whose results show distinct seasonal variations in dust falls near exposed gold tailings. The dust problem is exacerbated in the Rooikraal area when exceptional winds associated with frontal weather pass over the surrounding maize farming areas.

The main cause of concern to members of the public seems to be the nuisance value of the dust, as well as the perception that mine dust could cause respiratory diseases. In addition, the effect of dust on the health of workers and the public is of concern due to the quartz content of mine tailings (AngloGold, 2002) as well as the presence of a variety of toxic compounds, such as aluminium, arsenic, copper, iron, manganese, lead, zinc, uranium and cyanide that could lead to a variety of health complications (Engineering News, 2006).

With regard to the tailings dams and sand dumps to be re-worked all sites are poorly vegetated and as such are a source of dust with consequent deterioration in air quality when the wind blows. The worst dust problems on the sites occur in spring when the wind velocity increases just before the onset of the summer rainfalls. During the dry season lower wind speeds are experienced and lower dust emissions occur. The radius within which the highest dust fall levels occur around reclamation operations is about 3 km.

An extensive dust fall-out monitoring system was installed by Central Gold Recoveries over the City Deep and Crown Mines areas. Quarterly reports of single bucket samplers, twin bucket directional samplers and anemometer readings are delivered at the meetings of the Dust Monitoring Project Steering Committee. The sampling points have been extended to the City Deep sites and results are shown in

Table 6.

3 PROJECT OVERVIEW

Crown is a wholly owned subsidiary of DRDGold South African Operations (DRDSA). The company reclaims sand dumps and slime dams that were deposited as tailings by mines that once operated in the greater Witwatersrand area. The following three operating plants fall currently under DRDSA:

- Crown Mines;
- City Deep; and
- Knights.

Crown has been responsible for the successful reclamation of 23 sand dumps and slimes dams, most of which have been situated around the City of Johannesburg and Ekurhuleni Metropolitan area. In the past, the company has been able to effectively reclaim dumps in close proximity to buildings and other public infrastructure in a manner which is not significantly disruptive to society. This has allowed for the removal of a source of environmental pollution, the rehabilitation of disturbed areas, and the unlocking of key urban land for development. The City Deep plant treats material from a number of slimes dams and sand dumps in the surrounding area in order to extract gold. Through the treatment of dumps in these areas, Crown has unlocked over 205 ha of land for economic development. The urban location of these dump sites makes the redevelopment of these properties highly valuable.

The land use around the reclamation sites, the plant and the tailings dams are or is planned to be urban. The mine falls theoretically into Acocks Veld Type 61(b), the central variation of the Bakenveld. The air quality in the area is impacted on by the large amounts of traffic, domestic and industrial emissions. The tailings and sand dumps with a poor vegetation cover also contribute to deterioration of air quality when the wind blows.

Existing re-vegetated mine dumps, which are quiet habitats due to being on secure mine property, provide shelter, resting and breeding places for a relatively large number (for an urban area) of small mammals and birds.

Due to the dynamic nature of the air currents and thermal activities on any given day, finer suspended dust (2.5µm - 10µm) will remain airborne almost indefinitely, even in the absence of wind. Particulate larger than this range will settle on a very still day and this material can be collected through various methods, such as the American Society for Testing and Materials (ASTM) standard method for collection and analysis of dust fall utilised in the City Deep Operation areas (Kuhn, 2008). According to the Australian Environment Protection Agency's guidelines for separations distances (2001), a generic buffer zone of 200m – 3,000 meter is set for industrial activities. In addition, dust fall impacts are generally confined to close range (<1 km to 3 km) from the source. This is due to the fact that larger particles, which contribute most to dust fall rates given their mass, are likely to settle out in close proximity to the source (assuming a ground-based source). With the potential impacts of between 500m and 3km, it is likely severity will be moderate on local scale. Severity will also be dependant on the source of the dust, quantity of fallout and nature of the receiving environment.

Based on predominant wind directions in the proposed project area (North and North-West), it is expected that receptors located towards the South (S) and South-East (SE) of the City Deep operation are most likely to be affected by increased ambient dust levels.

Due to the effect of impacts relating to cumulative impacts on air quality in a specific area, the consideration of cumulative impacts in the proposed reclamation project for the City Deep Operation is considered highly significant.

In conjunction with the aforementioned national and international legislation on air quality, it is also important to consider the potential harmful effects of mine dust. There is little information and legislation available that controls the spread of potentially toxic dust from mine dumps. In 2006, the media reported the Department of Minerals and Energy (DME) and environmental legislators appear to have regarded dust from mine dumps, other than asbestos, as constituting mere nuisance dust. However, recent analysis of this dust has revealed the presence of a variety of toxic compounds, such as aluminium, arsenic, copper, iron, manganese, lead, zinc, uranium and cyanide. It is therefore important to acknowledge the gaps in national and international legislation and ensure all aspects are covered in the dust management and monitoring plan (Engineering News, 2006).

4 METHODOLOGY

Windblown settleable dust (fall-out) was monitored using the American Society for Testing and Materials standard method for collection and analysis of dust fall (ASTM D1739). This method utilises a simple device consisting of a cylindrical five litre container half-filled with de-ionised water exposed for one calendar month (30 ±3 days). The water is treated with an inorganic biocide to prevent algae growth in the buckets. The most common reagent used for this is a 5% copper sulphate solution (approximately one millilitre per three litres of bucket water).

The bucket stand comprises a ring that is raised above the rim of the bucket to prevent contamination from perching birds (Figure 3). The bucket holder is connected to a 2.1 meter galvanized steel pole, which is either directly attached to a fence post or can be attached to a galvanized steel base plate, which is buried to a depth of 500 mm. This allows for a variety of placement options for the fallout samplers. Exposed buckets, when returned to the AER laboratories, are rinsed with deionised water to remove residue from the sides of the bucket and the bucket contents filtered through a coarse (>1 mm) filter to remove insects and other course organic detritus.

The sample is then filtered through a pre-weighed paper filter to remove the insoluble fraction, or dust fallout. This residue and filter are dried and gravimetrically analysed to determine the insoluble fraction (dust fallout). The assessment of respirable particulates did not form part of this study.

Figure 1: Single bucket monitoring unit, showing sampling bucket with bird ring and security clamp

Table 1 represents the respective categories for quantifying the levels of fallout dust as per the Department of Environmental Affairs and Tourism (DEAT) standard. In residential areas, a level of 200 to 300 mg/m²/day is considered to be the maximum acceptable level and in rural areas a level of 600 to 700 mg/m²/day based on standards issued to countries abroad.

Table 1: Dust fall categories published by the Department of Environmental Affairs and Tourism (DEAT)

Classification	Dust-fall Average Over 1 Month
Slight	< 250 mg/m²/day
Moderate	250 to 500 mg/m²/day
Heavy	500 to 1,200 mg/m²/day
Very Heavy	> 1,200 mg/m²/day

These dust fall-out guidelines are descriptive without giving any guidance for action or remediation. On the basis of the cumulative South African experience of dust fall-out measurements, Standards South Africa have published two important new standards in terms of air quality underlying limits for dust fall-out rates. In terms of dust deposition standards, a four-band scale evaluation is used (Table 2) as well as target, action and alert thresholds (Table 3).

Table 2: Four-band scale evaluation criteria for dust deposition (After SANS 1929: 2004)

Band Number	Band Description Level	Dust fall rate (D) (mg.m².day, 30 day average)	Comment
1	Residential	D < 600	Permissible for residential and light commercial.
2	Industrial	600 < D <1,200	Permissible for heavy commercial and industrial.
3	Action	1,200 < D <2,400	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.
4	Alert	2,440 < D	Immediate action and remediation required following the first incidence of dust fall rate being exceeded. Incident report to be submitted to the relevant authority.

Table 3: Target, action and alert thresholds for dust deposition (After SANS 1929: 2004)

Level	Dust fall rate (D) (mg.m^2.day, 30 day average)	Averaging Period	Comment
Target	300	Annual	N/A
Action Residential	600	30 days	Three within any year, no two sequential months.
Action Industrial	1200	30 days	Three within any year, not sequential months.
Alert Threshold	2,400	30 days	None. First incidence of dust fall rate being exceeded requires remediation and compulsory report to the authorities.

A project or operation may submit a request to the authorities to operate within Band 3 (action band, as outlined in Table 2) for a limited period, provided that this is essential in terms of the practical operation of the enterprise (for example the final removal of a tailings disposal) and provided that an appropriate control technology is applied for this duration. No margin of tolerance should be granted for operations that result in dust fall rates, which fall within alert band (Band 4) as specified in Table 2 and Table 3.

Exceptions pertaining to these standards include the following:

- Dust fall that exceeds the specified rates but that can be shown to be the result as some extreme weather or geological event shall be discounted for the purpose of enforcement and control. Such event might typically result in excessive dust fall rates across an entire metropolitan region, and not be localised to a particular operation; and
- Natural seasonal variations, for example the naturally windy months each year, will not be considered extreme events for this definition.

In addition to this baseline report, a report must be compiled every three months detailing all findings and includes a full assessment of the results along with conclusions and recommendations for future monitoring on site. These reports should form part of the dust monitoring programme and highlight any negative impacts on the air quality due to the mining operations as well as determine the sources of the impacts. The reports will determine possible actions which can be used to mitigate any negative impacts.

Table 4: Description of the site topography of areas related to the City Deep Operations

Slimes dam/Sand dump ID	GPS coordinates	Site location
3A17	26°13’44.54’’S 28°04’10.53’’E	700m east of Wemmerpan
3L45	26°13’44.54’’S 28°04’10.53’’E	700m east of Wemmerpan
4A9	26°13’44.54’’S 28°04’10.53’’E	Heriotdale, adjacent to Cleveland rd on the eastern side and 150m south of the M2
4L25	26°13’44.54’’S 28°04’10.53’’E	Heriotdale, adjacent to Cleveland rd on the eastern side and 150m south of the M2
3A19	26°12’57.71’’ 28°05’34.60	Situated on the south east corner of Chilvers st and the M2

5 DUST FALLOUT RESULTS

5.1 2008 – 2009 Dust Assessment

The DEAT guidelines have been colour coded to highlight the areas of concern for the City Deep Operation in Table 5. DME has accepted these values as the reference levels for dust deposition for the purposes of EIAs and EMPs.

Table 5: The colour coded dust fall categories published by the Department of Environmental Affairs and Tourism (DEAT)

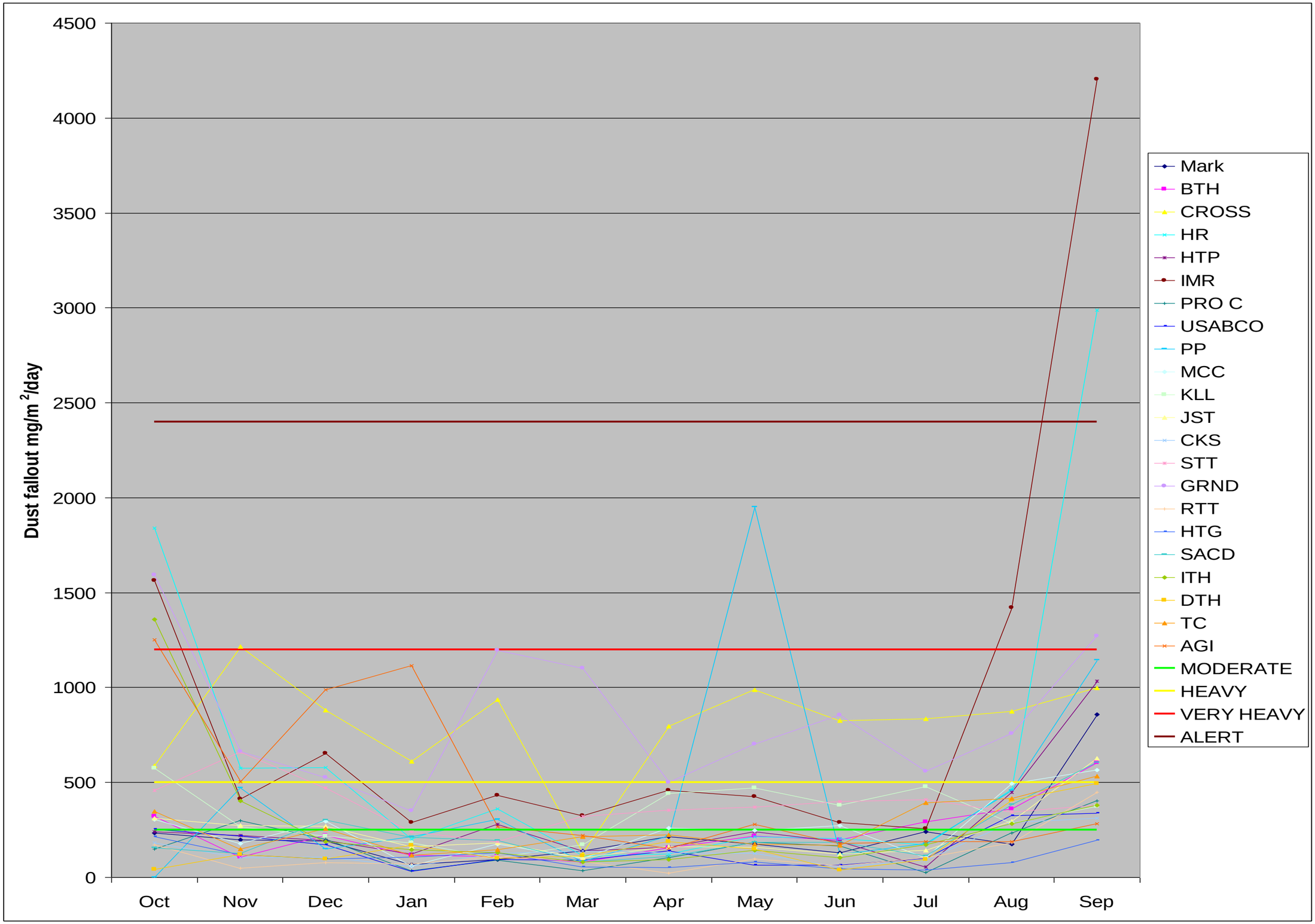
Classification	Dust-fall Average Over 1 Month
Slight	< 250 mg/m²/day
Moderate	250 to 500 mg/m²/day
Heavy	500 to 1200 mg/m²/day
Very Heavy	> 1200 mg/m²/day

A years worth of dust fallout results (Oct '08 – Sept '09) were obtained from AER and analysed against the above-mentioned standards and classifications (AER, 2008). In terms of dust deposition standards for this study, the four-band scale evaluation will also be applicable in the assessment phase as well as target, action and alert thresholds. The City Deep Operation may submit a request to the authorities to operate within Band 3 (Action band: 1,200 < 2,400mg/m^2/day) for a limited period, yet no margin of tolerance will be granted for an operations that result in dust fall rates, which fall within Band 4 (Alert band: 2,400mg/m^2/day < D). The dust fallout levels are presented in

Table 6.

Table 6: Results of the dust fallout mg/m^2/day

Period	MARK	BTH	CROSS	HR	HTP	IMR	PRO C	USABCO	PP	MCC	KLL	JST	CKS	STT	GRND	RTT	HTG	SACD	ITH	DTH	TC	AGI
Oct 08	234	322	587	1839	239	1565	148	254	ND	307	575	311	181	458	1594	172	214	156	1359	41	349	1253
Nov 08	198	108	1216	576	221	414	300	217	472	180	268	273	104	660	664	49	119	128	403	120	149	505
Dec 08	191	220	880	578	194	652	201	171	149	297	217	271	106	471	528	79	99	304	187	96	256	989
Jan 09	69	118	612	201	124	289	37	34	215	63	182	163	59	239	352	72	108	212	147	169	118	1114
Feb 09	93	109	936	360	281	431	90	93	306	174	105	181	128	190	1195	111	131	195	129	102	146	266
Mar 09	139	81	127	113	140	324	37	91	84	102	173	103	140	321	1103	86	54	80	81	114	216	220
Apr 09	215	156	798	122	159	457	103	139	218	259	442	164	130	355	501	23	52	112	93	189	223	153
May 09	175	218	987	215	239	425	185	66	1951	246	472	158	127	372	701	99	81	185	144	149	177	279
Jun 09	130	197	826	205	189	290	165	66	119	272	382	123	55	400	856	61	45	186	103	40	170	178
Jul 09	242	292	834	172	54	257	26	100	179	103	477	144	92	409	559	105	39	115	173	94	395	190
Aug 09	177	361	876	466	450	1421	233	324	459	493	287	295	291	345	757	181	78	383	284	406	416	188
Sep 09	858	605	999	2989	1033	4205	403	339	1144	565	374	629	311	379	1271	449	196	605	381	493	534	283


4500
4000
3500
3000
2500
2000
1500
1000
500
0
Dust fallout mg/m 2/day
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Mark
BTH
CROSS
HR
HTP
IMR
PRO C
USABCO
PP
MCC
KLL
JST
CKS
STT
GRND
RTT
HTG
SACD
ITH
DTH
TC
AGI
MODERATE
HEAVY
VERY HEAVY
ALERT

5.2 Review and Discussion of Results

An analysis of the City Deep Operation results indicates that 57% of the levels of dust fallout for the twelve month sampling period from October 2008 to September 2009 fell within the slight category, 25% of the levels fell within the moderate category, 14% of the levels fell within the heavy category and 4% of the dust levels fell within the very heavy category according to DEAT guidelines. Most records provided by AER for the 2007 and 2008 monitoring periods are respectively permissible for residential and light commercial activities ($D<600mg/m^2/day$; Band 1) and heavy commercial and industrial ($600<D<1,200mg/m^2/day$, Band 2) according to the SANS 1929:2005 guidelines.

During the monitoring period from October 2008 to September 2009, Site HR and IMR recorded levels, which falls into the Alert band threshold ($2,400<D\ mg/m^2/day$; Band 4) where immediate action and remediation was required and an incident report should have been submitted to relevant authority. During the monitoring month of October 2008, Site AGI, ITH, IMR, GRND and HR recorded levels which fell into the Action band threshold ($1,200<D<2,400mg/m^2/day$; Band 3). During the monitoring month of November 2008, Site CROSS recorded levels which fell into the Action band threshold. During the monitoring month of August 2009, Site IMR recorded levels which fell into the Action band threshold. During the monitoring month of September 2009, Site IMR and GRND recorded levels which fell into the Action band threshold. In these instances it is recommended that mitigation measures be put in place to avoid re-occurrence of such results. According to the SANS air quality classification system, the situation should be investigated and remediation undertaken if two sequential months lie in the Action band (Band 3) or if it occurs more than three times in one year.

6 IMPACT ASSESSMENT

The following impact assessment is based on potential effects resulting from mining activities relating primarily to the City Deep Operation, with emphasis on the Reclamation activities where most dust generation is expected. The plant is not expected to results in major dust fallout issues.

6.1 Construction Phase

Cause and comment: During the construction of infrastructure and roads and the operation of construction machinery increase in dust will occur; however, no major dust impacts are expected in this area. Preparation and construction activities at the City Deep operation dumps are expected to increase dust levels more severely due to surface and soil disturbances. Although these impacts are temporary, it can be aggravated by strong winds and extreme climate conditions.

Significance: The impact of construction on air quality will be negative but of short-term duration. Moderate impacts are expected in the Tailings areas. Dust generally settles within a radius of approximately 500 metres and thus the extent of the impact will be local, depending on climatic phenomena and wind velocity. Dust levels will be affected by climatic conditions, being higher during dry and windy seasons. The overall significance of the impact on air quality will be slight to moderate and mitigation is required.

6.2 Operational Phase

Cause and comment: During the removal of mine dumps, the transportation of reclaimed material via trucks and other reclamation activities, air pollution will be generated in the form of dust and green house gases such as CO, CO_2 and NO_x. More severe dust impacts are expected at the Tailings dumps due to dust generating activities such as vehicle movement on exposed surfaces and soil disturbances. Dust will also be created from exposed areas if not properly managed through dust control measures. In addition, the exposure of radioactive material and potential toxic chemicals, should it occur, will have a negative impact on air quality by exposing potential receptors (humans and animals) to potentially harmful particles and heavy metals in the environment. Mitigation and management is needed to prevent these impacts from occurring.

Significance: During the operational phases at the City Deep Tailings dams, impacts on dust levels will be negative but of short-to-medium term duration. Dust can settle within a radius of approximately 500 metres and thus the extent of the impact will be local. Dust levels will be affected by climatic conditions, being higher during dry and windy seasons.

The dust fallout levels could result in action band thresholds records (1,200<D<2,400mg/m^2/day) or alert band thresholds (2,400mg/m^2/day<D) that should be managed and controlled. The overall significance of the impact on air quality will be moderate to high and mitigation is required.

6.3 Decommissioning and Post Closure Phase

Cause and comment: During the decommissioning phase, the City Deep plant will be dismantled, which will generate air pollution in the form of green house gases such as CO, CO_2 and NO_x from the machinery used. Dust impacts are expected to be low at the City Deep Operations tailings dumps due to the dumps being fully reclaimed. Mitigation and management is needed to prevent dust impacts from the exposed soils from where the tailings dumps were during the decommissioning activities and after post-closure.

Significance: Dust impact at the City Deep Tailings dumps during decommissioning will be low, owing to the fact that tailings dumps will have been fully reclaimed. During the post-closure phase, surfaces will be re-vegetated and rehabilitated and the dust will start to settle and the impacts will be neutral in the long term. The overall impacts on local extent will be moderately beneficial. The significance of the impact on air quality will therefore be low (negative) and mitigation is required to make sure the impact remains low.

6.4 Cumulative Impacts

As described in section 2.1 (National Legislation) of this report, cumulative impacts should be considered for the overall improvement of ambient air quality. The City Deep Operation is currently considered a causative source of air pollution that contributes to fallout dust area. In combination with additional mining and industrial activities in the regional proximity of the City Deep Operation areas, impacts on ambient air quality and dust levels can be severe.

With the tailings dumps being fully reclaimed, processed and decommissioned, overall dust fallout levels will decrease and the cumulative impact will improve. Ambient dust levels should then measure lower than to pre-reclamation levels.

7 RECOMMENDATIONS AND MANAGEMENT MEASURES

With regards to air quality management for the City Deep Mining Operations, the proposed project aims include:

- To reduce dust emissions from proposed construction, operational and decommissioning activities as much as possible;
- To monitor dust levels in the area and on site; and

It is recommended that the following mitigation measures are implemented:

- Working areas will be sprayed with water whenever necessary;
- Samples will be taken from the monitoring dust buckets monthly and sent to a laboratory for analysis;
- Dirt road surfaces, especially those used by heavy vehicles, will be treated with a dust binding agent. The form of dust-binding agent will determine the type of watering; but allowance will be made for sufficient road spraying;
- Vehicle speeds will be kept below the critical speed required to raise excess dust within the vicinity of the complex;
- In addition to dust suppression and road watering, good housekeeping measures will be practiced in the project area. Light vehicles and equipment will undergo routine cleaning to remove excess dust;
- An air quality monitoring plan will need to be compiled that will determine whether dust-mitigation measures in place are proving effective. If not, upgrading will be required.

The abovementioned measures should be implemented for all phases of the project, including construction, operation, decommissioning and closure.

8 DUST MONITORING PLAN

The dust monitoring network in the vicinity of the Crown Mines, City Deep gold reclamation operations and adjacent areas of Soweto has been operational since 1985. Windblown settleable dust fallout is monitored based on the American Society of Testing and Materials standard method for collection and analyses of dust fallout (ASTM D1739), with certain modifications. This method employs a simple device consisting of a cylindrical 5l container half filled with de-ionised water exposed for one calendar month (30±3days). The water is treated with an inorganic biocide to prevent algal growth in the buckets. The most common reagent used for this is a 5% copper sulphate solution (approximately 1 ml per 3 litre of water bucket).

9 CONCLUSION

Dust assessments by AER indicate that most records for the City Deep Operation falls primarily within the residential (D<600 mg/m^2/day) and industrial thresholds (600 < 1,200 mg/m^2/day), which signify that Crown Gold Recoveries (pty) ltd. is effectively controlling the availability of material for wind mobilisation. However, mining activities at the City Deep Operations tailings dams have the potential for generating increased dust and subsequently expected to raise levels of particulate mater and air pollution in the area. Thus, the areas most sensitive to potential impacts resulting from increased dust levels will be around the tailings dams. The prevailing winds will carry dust from the proposed tailings dump to areas situated on the south (S) to south-eastern (SE) side.

Conditional to the effective mitigation of impacts associated with mining activities at the tailings facilities, it is therefore anticipated that impacts on air quality will have a negative impact of medium to high significance and short-term duration on the local area. It is not expected that mining activities associated with the City Deep plant will have a substantial detrimental effect on the surrounding environment. Although overall impacts are not expected to be of long-term duration, it is recommended that Crown Gold Recoveries monitors and manages all mining operations in the area.

Once the material from the City Deep operations tailings complexes have been reclaimed, processed and decommissioned, overall dust fallout levels will decrease and the cumulative impact could improve.

10 REFERENCES

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Appendix A – Plan of dust monitoring points