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ISSUED FOR REVIEW

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SUBJECT: Jericho Mine Processed Kimberlite Dust Suppression

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1.0 INTRODUCTION

Shear Diamonds (Nunavut) Corp. (Shear) requested EBA, A Tetra Tech Company (EBA) to evaluate options for dust suppression in the processed kimberlite containment area (PKCA) at the Jericho Diamond Mine. This letter presents our preliminary findings and discusses the practicality of the various options.

Dust is being generated from the Processed Kimberlite (PK) in the PKCA due to drying of the material in the facility. The material is being blown outside the PKCA and is settling on the surrounding tundra. . During active mining the PK would normally be covered by additional tailings; however,the mine is presently under care and maintenance and the PK has been allowed to dry and become mobile in wind. The problem appears to be a concern in both summer and winter, as the snow does not build up on the relatively level surface.

The PK surface area is approximately 110,000 m^2 (11 hectares or 27 acres). The PK material slopes upwards from the northwest toe at approximately 2.5% until it reaches the east and south-east dams. Primary wind direction is from the northwest, which means the material is easily transported up-grade and over the dams to the surrounding tundra.

There is no information mapping out where the tailings dust is coming from within the PKCA. There is also no information on the particle size distribution of the dust material or what the particle size distribution within the PKCA looks like.

The dust is expected to be a problem for 1 to 2 years until mine operations are started again (estimated 2012). A short term solution is therefore desired to reduce PK transport to the tundra area surrounding the PKCA.

2.0 DUST SUPPRESSION OPTIONS

The following section presents options for dust control and basic considerations. More in-depth commentary follows in the Discussion section.

2.1 Snow Fencing

The goal of snow fencing is to increase snow cover, thereby preventing dust from being mobilized through winter and extending the snow cover further into spring. The snow fencing may also prevent some dust from blowing during the summer months, particularly for larger particle sizes.

The effectiveness of snow fencing is dependent on sufficient snow falling in a season, although the fencing can accumulate additional snow from the "fetch" distance ahead of the tailings to any major obstacles such as a dam or depression. Even in snow-heavy years, there will still be the potential for dust pickup immediately surrounding the snow fences.

A potential design for snow fences may look something like the following: Assuming 2.4 m high fences, approximately six rows of fences would be needed covering the width of the tailings and placed perpendicular to the prevailing wind direction. The first row of fencing would be located close to the toe of the tailings (maybe 20 m) and subsequent rows would follow every 60 m. Fences should follow proper snow fencing construction, which includes a gap of 10% of the total fence height under the fence, and fence porosity between 40 – 50 %.

2.2 Ditching or Tailings Removal

Removing the higher elevation tailings near the southeast and east dam could reduce the amount of the dust travelling over the dams. The existing PK profile ramps up to the SE at a grade of 2.5% (wind is from the NW) and is approaching the dam crest elevation, which gives few obstacles to dust movement. Excavating the upper beach near the dam crest (estimated 1 – 2 m of excavation) would create a wind break at the dam, which could lower the wind velocity enough to reduce mobilization of the dust. A ditch could have a similar effect, but would be smaller in scale.

The ability of ground movement to significantly reduce overall dust levels is questionable, particularly without source dust mapping information.

2.3 Water

The use of water to control dust is common in mining applications, whether in tailings facilities, underground, surface pits, or milling operations.

2.3.1 Water Application Methods

Mining operations typically spread water using a high-pressure sprinkler system or water trucks. Water trucks are not appropriate for distributing water in this scenario as the surface is not a weight-bearing surface.

Other approaches include flooding with hoses, but this is less efficient from a water usage standpoint and it is difficult to get complete coverage. Concentrated water streams could also lead to significant erosion of the beached PK. .

For the purposes of this memo, it is assumed that the most likely water distribution method is via a high-pressure sprinkler system.

2.3.2 Considerations

The tailings permeability will determine the effectiveness of a water-based dust-control solution. If the top surface is very permeable, the water will quickly drain away and be wasted.

Aside from soil distribution, frequency of watering will depend on temperature and wind. Typical coverage frequencies are every hour, every couple hours, or several times per day.

A goal would be to freeze the upper tailings layer before the onset of winter to create an ice film minimizing dust transport during the winter. Unfortunately, ice sublimation may limit the effectiveness of this and the creation of an ice film would be problematic. Unheated water systems are extremely difficult to maintain as the temperatures approach the freezing point.

Water additives should be considered for any watering program as a means to improve coverage (e.g., by changing surface tension). Any additive will need approvals by the local regulatory agencies.

2.3.3 Sprinklers and Infrastructure

A large infrastructure of high-pressure water sprinklers, hosing, and pumps would be required. This would be costly and there are numerous factors to consider:

- The number of high-pressure sprinklers could be minimized by using the bigger and larger pressure sprinklers. However, this will also mean larger pressure pumps and more uneven coverage. On windy days, when the dust problem is worse, larger sprinklers have less control and the overall performance is diminished because the flow is misted and blown around. However, manually operated water cannons may be faster to deploy and are an option worth further review.
- Areas covered by high-pressure sprinkler systems vary, but 11 hectares could require approximately 40 sprinkler placements to get full coverage. Sprinklers should be placed upwind.
- Any water delivery system is sensitive to the overall water quality. If the water quality is poor, there will be significant, ongoing problems with the pumping, piping, and sprinklers. Costs will be higher for both initial equipment purchase and ongoing maintenance.
- The large water distribution infrastructure would only be useful during the limited summer months. Months in the shoulder seasons can be extremely difficult for operations to keep the lines from freezing.

2.4 Skin-Forming, Dust Suppressant Chemicals

Skin-forming, dust suppressant chemicals work by bonding materials on the upper layer of the target surface. This barrier holds the dust particles in place and prevents movement.

Any chemical can be tried on a smaller area to evaluate its effectiveness before moving to a full-scale application. Because there is no vehicle traffic, a surface-skin bonding agent can provide from 9 to 18 months of dust control and will be more effective for the winter.

Environmental regulatory compliance is a common requirement for dust-suppressant chemicals. As a result, many manufacturers have extensive environmental testing done on their chemicals to meet various regulatory requirements (e.g., fisheries).

3.0 DISCUSSION

A mapping survey of the facility dust sources would be helpful to the application of any suppression method. The dust may originate equally over the entire area, or it may be coming from a specific area or areas on the facility. The particle distribution of a tailings facility is not equal: larger particles fall out faster and fines travel further downslope. If would be helpful to know if there is an area or particle distribution that is causing a large part of the dust problem. For example, if the fines are only coming from the top of the tailings facility nearest the dam, efforts should be focussed there. In this scenario, a large tailings cut or ditch combined with some other method may be most appropriate to deal with the problem area.

The particle distribution across the tailings facility would also be useful to comment on the potential efficiency of some remedial solutions. For example, water will be quickly absorbed in a sandy environment and will be of little use.

Water application on a large area and a northern site is problematic. Expensive infrastructure would need to be built up including pumps, piping, high-pressure sprinklers, and mounting points. A water distribution system is operationally difficult to maintain during shoulder time periods when temperatures frequently dip below freezing. The effect of watering into the late fall may be limited, as the surface ice layer (assuming it can be formed in the difficult operating conditions) may quickly sublimate. Water could be obtained from the Carrot Lake, or Pit Water. There are several questions regarding the water : the water quality, how corrosive, how much potential for scaling. The durability and maintenance requirements of a water system also has to be considered. However, movable or manually operated high pressure water sprinklers or cannons should be reviewed further.

Skin-forming, dust-suppressant chemicals could be a favourable match for the tailings facility. The skin-forming bonding agents get away from the expensive and problematic issues of watering. They are effective in winter, they can cover a large area, and may last over a year due to the lack of vehicular traffic. The only potential barrier to their use is chemical compatibility. However, this is a common requirement and there is extensive environmental testing associated with many of the products to assist the regulatory approvals process. There is a history of using dust-suppressant chemicals in the north [I'm waiting to hear back from a few people on this so I can add more].

Snow fences may provide significant winter protection against blowing dust. However, fences are dependent on snow volumes, particularly near the beginning of the season when not much snow may have fallen. If combined with a water spraying program, a late summer or early fall ice layer may prevent dust from blowing before snow levels accumulate.

The dust control ability of snow fences during summer is questionable and may be aided by more site characterisation or observation. The operating principle of a snow fence is to reduce wind velocity and prevent further movement of creeping and intermittently jumping snow along the surface. In other words, it prevents surface movement of particles; it does not capture large volumes of airborne particles. If a

significant proportion of the dust is already airborne, the snow fences will not be effective in summer. A dust characterisation or site observations may help.

Following from the previous point, knowledge of the mobilized dust distribution is very useful. Is most of the dust travelling up along the ground and rolling over the dam? Or is a large percentage of it airborne? Wind barriers or traps like snow fences and ditching will be much more effective if a large percentage of the dust is being carried along the surface.

4.0 SUMMARY

Dust suppressant chemicals may provide the easiest and most inexpensive solution to dust control at Jericho. Any bonding compound should be checked for chemical compatibility. Depending on the product, this can be easy to check as many products have extensive chemical testing and a history of use in the north. It is understood that regulatory approval may be required for the application of dust suppressants. The timeline to obtain approval is unknown.

Water spraying is a common solution to dust control in mining, but the short northern application season and operational issues associated with running the system in freezing temperatures make it an expensive, labour intensive solution that only addresses dust control for part of the year. Particle distribution should be analysed to determine water spraying effectiveness (i.e., run-off times) if the decision is made to go with this method. The volume of water needed may introduce other environmental concerns such as water quality, impact on the source water environment, and potential tailings run-off. However, movable or manually operated high pressure water sprinklers or cannons should be reviewed further.

Snow fencing could be an effective means of dust control in the winter months. However, it will not prevent all dust from being mobilized and its effectiveness will be compromised in years with relatively little snow, although windblown snow may make up the difference. Its effectiveness in summer is questionable, although it would be aided by dust distribution information and site observations.

Ground movement in the form of ditching or a cut to the uppermost tailings along the dam may serve to reduce dust levels. Any ground movement plans would be aided by a survey identifying the main dust sources, assuming there are discrete sources. Ground movement would need to be combined with other means to form part of an effective dust control strategy.

Any program design could be fine-tuned with information on particle distribution of the blown dust and mapping of the particle distribution across the tailings.

5.0 REFERENCES

Handbook for Dust Control in Mining, NIOSH, IC 9465 Information Circular, 2003.

http://www.cdc.gov/niosh/mining/pubs/pdfs/2003-147.pdf

Snow Fence Guide SHRP-W/FR-91-106. Strategic Highway Research Program, National Research Council. Ronald D. Tabler, Tabler and Associates. http://www.dot.il.gov/blr/l002.pdf