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21 December 2005

Mr. Jim Kulas
Environmental Superintendent
Teck Cominco Alaska Inc.
3105 Lakeshore Drive
Building A, Site 101
Anchorage, AK 99517



**RE: Protocol for Evaluation of Fugitive Dust Sources of Lead and Zinc
at Red Dog Mine - Disposition of Comment from Alaska DEC**

Dear Jim:

Further to a recent telephone conversation with Wayne, we have modified our response to ADEC's questions about terrain data to more clearly reflect what we actually propose to do.

Please don't hesitate to call Jennifer or myself if you have questions.

With best wishes for Christmas and the New Year!

Yours very truly,

SENES Consultants Limited

Douglas B. Chambers, Ph.D.
Vice-President,
Director of Radioactivity and Risk Studies

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Environmental Modelling Specialist

PROTOCOL FOR EVALUATION OF FUGITIVE DUST SOURCES OF LEAD AND ZINC AT RED DOG MINE
DISPOSITION OF COMMENTS FROM ALASKA DEC
(Letter from Chapple to Kulas, dated November 28, 2005)

Page	Subject	DEC Comment	Disposition
1	Table 2.1 Mine Operations	<ul style="list-style-type: none"> We trust TCAI will critically evaluate existing emission factors and make the effort to develop site-specific emission factors where needed. 	<p>AP 42 is proposed as the initial basis for dust estimation; however, as appropriate, effort will be made to develop site-specific/facility specific emission factors based on knowledge of the physical/chemical processes, air monitoring, and other information that may be available from the site or published literature.</p>
		<ul style="list-style-type: none"> We would like to have further discussions about the selected emission factors before they are used in modelling, including the underlying assumptions used in selecting these values ex road silt content. 	<p>The proposed study protocol is, for practical purposes, in two parts. The first deals with characterization of dust emissions and the second with air dispersion modelling.</p> <p>To address the DEC's request for further discussions, we suggest that a draft progress report on dust emissions be prepared and submitted to the DEC for review, and to facilitate discussion.</p> <p>It should be understood that the air dispersion modelling exercise will provide information relating predicted and measured levels that may be useful in a "feedback loop" (statistical evaluation) to further refine dust emission sources.</p>

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2		<ul style="list-style-type: none"> It is not clear whether all fugitive emissions associated with material hauling will be accounted for in the emission inventory. 	An attempt will be made to identify all potential sources of fugitive dust and to compile them in the emission inventory.
	Section 3.2 CALMET	<ul style="list-style-type: none"> There might be an error in the Middle Level Height (line 12) calculation. 	DEC is correct, the value should be 2150.
		<ul style="list-style-type: none"> There is some concern about CALMET and the grid data with regard to how much it simulates reality re deposition on windy days. 	The concern raised by the DEC concerning deposition on windy days will be evaluated. Teom measurement data will be used to assist in this evaluation.
	Section 3.2.1 Meteorology	<ul style="list-style-type: none"> The modeling protocol does not mention the Sled and Anarraq meteorological stations and whether these, or other stations, are located in or near the modeling domain. 	To enhance three dimensional wind-fields, the meso scale data (vertical profiles) on 32 x 32 km grid from the Eta Model will be used to initialize CALMET which will be modified with all surface data available in the CALMET modelling domain. The Sled and Anarraq data will be reviewed for its applicability in developing the wind-fields.
		<ul style="list-style-type: none"> Does TCAI plan to pair the modeled results to the monitoring results on a time and space basis? Pairing in time is inappropriate when comparing values representing different meteorological data years. 	Pairing of measured and predicted levels would only be done when both data are available for the same time intervals.
2	Section 3.2.1 Meteorology	<ul style="list-style-type: none"> Using a constant meteorological data set is appropriate for comparing the effects of emission controls and changes in emission inventories on ambient impacts. This practice, however, introduces a level of potential error when comparing modeled impacts to monitoring data collected during a different meteorological period (due to year-to-year variation in meteorology). Please note this potential error when comparing modeled impacts to monitoring data. 	The uncertainties associated with the use of a constant meteorological data set will be discussed, as will other possible sources of uncertainty.

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2	Section 3.2.1 Meteorology	<ul style="list-style-type: none"> The surface roughness parameter used in the model is a critical factor not to be overlooked as it relates to surface roughness of the snow. 	It is recognized that surface roughness is an important parameter. As appropriate, sensitivity analyses will be carried out to investigate the effect of different assumptions about this (and other) parameters.
2, 3		<ul style="list-style-type: none"> Deposition is comprised of fallout and lateral transfer along the surface perhaps meters or even kilometres away from the initial modeled location of deposition. The modeling protocol does not appear to address this important real world situation. While we do not have specific advice to offer, we believe the phenomena warrants further inquiry and refinement. 	The DEC comment is very interesting and will be investigated. As for DEC, we are uncertain at this time how best to evaluate this aspect; however, tentatively, our experience with dust models based on the physics of sand dunes may offer some insight.
3	Section 3.2.2 Terrain	<ul style="list-style-type: none"> One degree DEM data is probably adequate for the Red Dog topography. However, DEM files sometimes contain very notable errors. Therefore, it is recommended to compare the DEM elevations to a USGS or similar topographic map of the area. Thereafter, correct errors, as needed, and discuss this comparison in the modeling report. 	We propose to use terrain mapping based on a combination of Red Dog data and satellite imagery (SRTM) at 90 m resolution.
		<ul style="list-style-type: none"> The protocol initially mentions the inclusion of only one body of water (the tailing impoundment), but then states that additional wetland and body of water information will be added prior to modeling. It is not clear whether or not the freshwater impoundment (Bons Pond) and the streams around the mine site will be included in the modeling. 	The effect of Bons Pond will be considered. The streams will not be considered directly although the terrain features associated with the streams will.

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3	3.3 CALPUFF Modeling	<ul style="list-style-type: none"> We would appreciate knowing if, or to what extent, the project work will incorporate any new particle size data into the deposition modeling. 	Red Dog site personnel have collected new particle size data and chemical analysis at a number of locations on roadways and for different materials (ore, waste). These data will be considered in both source assessment and deposition modelling.
	3.3.1 Source Parameters	<ul style="list-style-type: none"> The modeling protocol does not provide a discussion on the assumptions related to the selection of emission factors and the assumed efficiency of pollution control measures and equipment. Regarding roadway lead and zinc speciation, the protocol does not provide a discussion on values used for the model as representative of actual conditions for the selected modeled years. Figure 3 of the Protocol report seems to indicate that new road sampling will occur or has occurred. We are uncertain if the lead, zinc and particle size characteristics of the samples indicated in this figure will be used for the modeling. The modeling protocol does not indicate whether the source coordinates are in the same datum as all other coordinates, nor does it indicate which datum will be used in the modeling analysis (e.g., NAD27 or NAD83). The plan does not currently describe the emission release point parameters. 	<p>All assumptions used in the development of dust emissions will be documented.</p> <p>The assumed speciation of road dust will be based on a combination of measured road dust data and on knowledge of current and past production activities, including ore and waste grades.</p> <p>All available data will be considered, including the new road sampling. Red Dog site personnel have collected new particle size data and chemical analysis at a number of locations on roadways and for different materials (ore, waste).</p> <p>As suggested by DEC a common UTM coordinate system (NAD 83) will be used for the modelling exercise.</p> <p>The information that will be used to characterize emission release points is being collected. These will be described.</p>