DE BEERS
A DIAMOND IS FOREVER

File:

October 1, 2001

MVEIRB
200 – 5102 50th Avenue
Yellowknife, NT X1A 2N7

Attention: Joe Acorn

Dear Mr. Acorn:

RE: SNAP LAKE DIAMOND PROJECT
TECHNICAL WATER QUALITY SESSION – JUNE 4-5, 2001

Please find enclosed the documentation of the De Beers Canada Mining Technical Water Quality Discussion Session, June 4-5, 2001. The package includes: abridged transcripts of meeting, copies of technical slide presentation, listing of the "Draft De Beers Items for Consideration" that came out of the discussion. We apologize for the delay in getting this material circulated. Please note that any water quality results or project elements described in these meetings are draft and subject to change upon final design of the proposed mine.

Please do not hesitate to contact me in Yellowknife (867-766-7322) if you require further information.

Sincerely,

SNAP LAKE DIAMOND PROJECT

Robin Johnstone, PhD
Senior Environmental Manager

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HM/RJ/hb
Encl.

DE BEERS CANADA MINING INC.
SNAP LAKE DIAMOND PROJECT

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Copied to:
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M. Lange, DFO
M. Dahl, Environment Canada
A. Wilson, Environment Canada
B. Hudson, RWED
L. Marcinkoski, RWED
J. Acorn, MVEIRB
L. Azzolini, MVEIRB
W. Puznicki, INAC
D. Milburn, INAC
F. Jackson, INAC
S. Bohnet, INAC
K. Lauten, MVLWB

ITEMS RAISED FOR PROPONENT CONSIDERATION coming out of JUNE 4 & 5, 2001 WQ TECH SESSION	How Addressed by De Beers Canada Mining as of Summer 2001
Seepage collection	Design requirements and practicality for seepage collection structure or monitoring structure east of Dam 1 under Engineering review. General issue of volume of seepage will be Included in forthcoming EA.
Metal leaching under alkaline conditions.	Included in forthcoming EA, handled in Geochem modelling
Paste consolidation water/Cryo-concentration	Under consideration for inclusion in EA. Under review for inclusion in Geochem modelling.
Units for kinetic testing mg/l vs mg/kg/week.	Complete – units will be mg/kg/week
Handling of DMS rejected sulphides.	Will not be DMS rejects during mine operations. Investigating current disposal options for rejects from Advanced Exploration Program
Phosphorus in ground water.	Included in forthcoming EA
Changes in H_2O quality with depth (in ground water).	Included in forthcoming EA
Effluent quality sludge composition.	No longer relevant since sludge will be incinerated and not put in landfarm.
Coagulants/flocculants must be carefully considered with respect to BHP's experience with toxicity.	Toxicity tests underway.
General question to government reviewers present in meeting and to De Beers on theoretical acceptance of mixing zone concept and application of toxicity guidelines at end of pipe.	De Beers cannot comment on regulatory acceptance of mixing zone concept. De Beers will consult DFO further on how this specifically applies to the Snap Lake project. Expected to be presented and discussed in next WQ Tech Session meeting
Turbidity from aesthetics view.	Water treatment plant will likely have low turbidity specifcation so turbidity of Snap Lake water from an aesthetic perspective will likely not be an issue. Expected to be presented and discussed in next WQ Tech Session meeting
Geotech investigations into the north pile foundation.	Included in forthcoming EA. Expected to be presented and discussed in next WQ Tech Session meeting
Ice lensing management in the north pile.	Included in forthcoming EA. Expected to be presented and discussed in next WQ Tech Session meeting
Permafrost and ground ice conditions.	Included in forthcoming EA. Expected to be presented and discussed in next WQ Tech Session meeting
Use of coarse kimberlite as construction material and consequences on leaching.	Included in forthcoming EA in Geochem modelling of leach test and in presentation of results of construction strength tests of kimberlite
Comparison with BHP kimberlite.	Included in forthcoming EA
Ensure that representative kimberlite samples with respect to sulphides are included in modelling	Expected to be presented and discussed in next WQ Tech Session meeting. Included in forthcoming EA
Explanation of waste rock requirements vs. quarrying later on.	Included in forthcoming EA
Supplement climate data through contact with Chris Spence and Bob Reid.	De Beers Air Quality consultants to contact Environment Canada
Details on approach/inputs to models needed in order for reviewers to provide concrete input in the absence of final project water quality #'s.	Expected to be presented and discussed in next WQ Tech Session meeting. Will have pre-session handout for review.
Consider other stressors that may/should add to influence cumulative effects. e.g Long range deposition POP's.; Climate change; Multiple stressors e.g. separate discharges	De Beers cumulative effects consultant to contact DIAND consultant to further discuss issues and expect to include some breadth of discussion in forthcoming EA.
Proper presentation of impacts and mitigation input.	Expect that this should be addressed by clear format in forthcoming EA

WATER QUALITY/WATER QUANTITY

TECHNICAL DISCUSSION SESSION

ATTENDEES

June 4, 2001

De Beers Canada Mining:	**De Beer's Consultants:**
Heather Boznianin	Leon Botham
Leslie Green	Ken De Vos
Jack Haynes	Mark Digel
Robin Johnstone	Tom Higgs
Hilary Machtans	Kevin Himboldt
Mike Padula	Rick Schryer
Jeremy Wyeth	Rens Verberg
Department of Fisheries and Oceans:	**Department of Indian Affairs and Northern Development:**
Julie Dahl	Sevn Bohnet
Marc Lange	Francis Jackson
	Donald MacDonald
	Peri Mehling
	Dave Milburn
	Wayne Puznicki
ENVIRONMENT CANADA	**MVEIRB:**
Marc Dahl	Joe Acorn
RWED:	
Brett Hudson	
Lionel Marcinkoski	

MINUTES

WATER QUALITY/WATER QUANTITY

TECHNICAL DISCUSSION SESSION

DATE: Monday, June 4, 2001

TIME: 10:15am

LOCATION: Snap Lake Diamond Project

RE: **WATER QUALITY/WATER QUANTITY TECHNICAL DISCUSSION SESSION**

NAME	COMMENT	ACTION
INTRODUCTION:		
Robin Johnstone	We hope to increase your understanding of the proposed Snap Lake Diamond Project by showing you the site and we are here to listen too. We have been doing a lot of consultation during the process but it has mainly been in the communities and we are cognisant that there has been a gap. This is an opportunity to identify those individuals who are reviewing the EA. The flow of information is going to be through site presentations and the site tour but also the opportunity to meet one-on-one and ask questions. I would like to provide an introduction to people in the room. My name is Robin Johnstone. I am the Senior Environmental Manager for De Beers responsible for projects in the NWT, Snap Lake and Kennady Lake. I am building De Beers' Environmental department and will achieve a standard for them and streamline. Leslie Green, against the wall, is Environmental Manager and leads the Snap Lake Project for participation agreements. Also working for De Beers is Hilary Machtans who provides us with expertise in water quality. We also have Jeremy Wyeth over here. He has been with De Beers for 15 years. Jeremy does mine design. We also have Jack Haynes. He is the Assistant Site Manager. Mike Padula is the Construction Manager and has no shortage of things to deal with. Mike works for amec and is part of the team on site. Also with amec in Vancouver is Tom Higgs, Water Specialist on the Optimization Team working on mine design. From Golder Associates we have the environmental assessment team that	

NAME	COMMENT	ACTION
	is led by Rick Schryer and he is the primary Project Manager. Mark Digel and to his left is Kevin Himboldt. Mark is leading the water quality task as Team Leader and Kevin is assisting him. Leon Botham is with the Saskatoon office of Golder Associates and does process engineering related to kimberlite containment and mine rock storage. Ken De Vos is the Geochemistry Program Task Leader. Rens is from the Seattle office of Golder providing Senior Review on Geo Chem. Heather Boznianin, gently typing away on the keyboard here is taking notes for us. We hope the typing won't be too inconvenient for you. David Milburn is the Water Resources Manager for DIAND and accompanied by Sevn and Francis and working for them is Peri Mehling and Don McDonald. From DFO we have Julie Dahl and Marc Lange. Marc Dahl is here from Environment Canada and Anne Wilson will join us tomorrow. From RWED we have Lionel Marcinkoski and Brett Hudson and from the MVEIRB, we have Joe Acorn and Wayne Puznicki from DIAND. This is the group. I would like to encourage you to talk with each other. My role here today is facilitator. We have timelines today and got squeezed a bit. This is the beginning discussion and discussions will be on going today and tomorrow. We want to answer and get feed back from you. What we are going to try and do is give as many opportunities for you to get the technical information that you are interested in.	
	SLIDES OF PROPOSED PROJECT SHOWN	
	SURFACE AND UNDERGROUND TOUR	
	AFTERNOON PRESENTATIONS (SLIDES INCLUDED IN DISTRIBUTION PACKAGE)	
Robin Johnstone	Jeremy will discuss mining and geology as well.	
MINING/ GEOLOGY:		
Jeremy Wyeth	We discussed some of the things that we are going to see now when we were underground. I explained the difference between a standard or conventional kimberlite pipe and what we have here is the dyke on the right hand side. It is important to water quality. Both Diavik and BHP deal with pipes and we are dealing with a declined dyke. The dyke has less inclusions in the kimberlite. We do have some inclusions from the host rock. We originally anticipated the dyke being very uniform. In a section, we have taken a typical cross section across the property. This is metavolcanic and this area is granite. If we contour that	

NAME	COMMENT	ACTION
	there are areas steeper but on average it is about a 14-degree dip. The schematic that came out of prefeasibility, we went into the portal and down the ramp and continued all the way around. This sketch shows an open-pit on surface, which has since been removed from the project. In the prefeasibility, after De Beers bought the property, we decided to remove that and the whole operation is underground. These drifts going across on strike. We came down today, we went down the ramp and slightly up on the kimberlite and had a slight drift running along below it we saw on the previous slide drifts 20 metres below that. We would take an ore ramp up and put in parallel panel drifts all running on strikes. Mining this deposit involves removing primary and secondary processes with kimberlite. The pillars are 60% of the ore being extracted on primary recovery. This area makes up 10% of the total support area. Eight metres is concrete filled for regional support. Kimberlite would be put up against it and then we would pour the concrete, retreat back and do the same thing with paste fill. That means we can take half of our tailings and put it underground. There are few slides that deal specifically with disposal underground.	
ORE/WASTE ROCK MANAGEMENT:		
Ken De Vos	Give an overview about processed kimberlite management. I'll go over definitions in a general approach and then physical characteristics and options for storage of these types of rocks. What we term "mine rock" through the presentation is rock surrounding the ore body. Processed kimberlite is the ore body extracted for the purpose of diamonds. The approach to management of the mine rock and processed kimberlite is two strategies. One surface and underground disposal to help reduce the surface area or mine footprint. We will try and mitigate any environmental impacts. We will try and manage the rock and minimize the impact on the environment. Metavolcanic rock is of concern environmentally due to the potential for acid generation. Acid generating rock will be disposed of underground or covered with a thickness of non-acid generating kimberlite. Acid mine drainage results from exposure of sulphide bearing minerals to oxygen. There are several control factors for these actions like availability of oxygen, the amount of sulphide mineral present, bacterial	

NAME	COMMENT	ACTION
	mediation is another component to acid generation, which is enhanced by bacteria at low temperatures. Acid generation can be mitigated, slowed or neutralized with other minerals like carbonating minerals, calcium carbonate is very good neutralizing mineral with respect to acidity. Typically where you have an acid potential for production, there is a potential for acidy to be produced. The total rock including kimberlite removed from this mine currently stands at 24 million tonnes. 23 million tonnes will be kimberlite over 22 years. 20 –30% is dilution rock which half will be used for mine backfill and half used for surface disposal on the north pile. Mine rock is one million tonnes, which is two-thirds granite, one-third metavolcanic. Granite will be used for construction and capping. About .35 million tonnes produced in pre-development. A brief overview of the geochemistry program which began in 1999: screening level static testing 1999, kinetic testing 1999, follow-up kinetic testing 2000, Class B static test-work on pile and processed kimberlite, pile/seepage run-off monitoring, site run-off/seepage monitoring. With respect to testing of mine rock and processed kimberlite, after samples were collected with respect to static testing, it was essentially a one time test for characteristics of rock and acid base accounting, metal assay and trace metal composition, mineralogy, short-term leach testing, kinetic testing. Interpretation (influencing factors) that must be taken into account when you look at test results. Full details are in the Geochemistry Baseline Report. Mine rock – granite (chemical characteristics). Granite occurs as massive granite away from metavolcanic or within metavolcanic. Granite occurring in fault zones is treated as acid generating. Pure granite is non-acid generating and located a substantial distance from metavolcanic. The kinetic test work on granite rocks confirms results of static tests. This graph gives the results of the acid base accounting on the granite. With respect to acid production potential, anything less than 10 has 0.82% acid production. There is an area of acid generation and an area of uncertainty. Anything below 10 is low in sulphide and is considered suitable for construction purposes. Mine rock – metavolcanic chemical characteristics. There are a 168 samples conducted on metavolcanic rocks. A significant portion is potentially acid generating. All metavolcanic rock is being considered as acid generating and will be stored in the north pile, covered	

NAME	COMMENT	ACTION
	by a substantial thickness of processed kimberlite. Kinetic test work, confirmation of static test results, pH ranges from neutral to acidic, trace metal concentrations range from low to moderate. A thick level of kimberlite will lessen the chance of oxygen getting to these minerals and causing acid production. Kinetic test work confirms static test results. The range is neutral to mildly acidic. Samples in this area are considered potentially acid generating. This area is uncertain and this one is potentially not acid generating. 0.3 or 8% sulphide cut-off limit is in this area of about 10. There are a few samples that fall above this range of the slide. Those samples were specific massive sulphide zones and not representative of the overall picture of what we see in the metavolcanic picture as a whole. Kimberlite: indicate that processed kimberlite materials are non-acid generating. 29 samples non-acid generating containing significant excess carbonate as calcite, 20% of metavolcanic mixed with 80% processed kimberlite yields a net neutralizing blend. We also completed kinetic test work, which confirmed static test results. Finally, I will give a comparison between Snap Lake and Diavik kimberlite. The main difference is that the Snap Lake kimberlite will not have any inclusions unless it is the current host rock which is granite and all samples to date tested are less than .3% sulphide sulphur. Diavik contains mudstones/siltstones and a greater proportion of fines with up to 3% sulphide sulphur. In conclusion there is minimal potential for acid rock drainage. Better settling characteristics.	
Lionel Marcinkoski	Where does BHP fit in that comparison?	
Ken De Vos	We need data from BHP to make those comparisons and we hope to get that soon.	
Ken De Vos	I did want to point out a couple things that came up on the mine tour. One was the density of the kimberlite density separation circuit. We will look at concentration of sulphides and how to separate them. The other thing I noticed on the mine tour is that there are a couple of areas where we are getting iron staining on kimberlite in only a couple of isolated places. We will look at some of those seeps and try to get a better understanding. Those were the things that I wanted to point out.	
QUESTIONS:		
Leon Botham	The last slide and take a look at your kimberlite samples in jars. The three streams are course grit and fines. Course is about half the total of processed kimberlite by weight.	

NAME	COMMENT	ACTION
	Medium is 25% by weight and fines are the remaining 25% by weight.	
Leon Botham	Fines are the only one with water in the bottle. We have shaken them and in a couple seconds, fines are clear. They do settle quite rapidly.	
Peri Mehling	An area that we would like to know what your approach is on water quality. The information presented is the data collected and the next step is what do you do with that data. I would like to know how you are going to take those steps before the final report so that it is no surprise.	To be discussed the next day.
Peri Mehling	The ice in the settling pond is a water balance issue.	
Peri Mehling	I was looking at the height and whether the dam would have to be raised or not. The other issue is the use of kimberlite material for construction. I want to look at alkaline issues. That is on people's minds.	To be discussed the next day.
	4:40pm - END	

WATER QUALITY/WATER QUANTITY

TECHNICAL DISCUSSION SESSION

ATTENDEES

June 5, 2001

De Beers Canada Mining:	**De Beer's Consultants:**
Heather Boznianin	Leon Botham
Leslie Green	Ken De Vos
Robin Johnstone	Mark Digel
Hilary Machtans	Tom Higgs
Jeremy Wyeth	Kevin Himboldt
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Marc Dahl	Joe Acorn
Anne Wilson	Darren Campbell
RWED:	
Brett Hudson	
Lionel Marcinkoski	

MINUTES

WATER QUALITY/WATER QUANTITY

TECHNICAL DISCUSSION SESSION

DATE: Monday, June 5, 2001

TIME: 8:30am

LOCATION: De Beers Canada Mining Inc. Yellowknife office

RE: **WATER QUALITY/WATER QUANTITY TECHNICAL DISCUSSION SESSION**

NAME	COMMENT	ACTION
Robin Johnstone	Yesterday we finished off with Ken De Vos talking about geochemistry. Maybe we can pickup there, Ken.	
KIMBERLITE CHEMISTRY:		
Ken De Vos	I just wanted to very briefly go over kimberlite chemistry. It is very important. I think it is very important to understand where this chemistry is coming from, how these rocks relate to what will be coming down stream. Just in the type of deposit and the type of rocks we will be producing is completely different than the other two mines. So, I will just summarize the kimberlite because it is the main focus of the rock. The other one million tonnes is mine rock, granite. The kimberlite here is non-acid generating. There is a lower potential for metal release. I will talk about static test work later on. That will follow through the system. In summary, the comparison between Snap Lake and Diavik is that we don't have the same kind of inclusions and we have low sulphur on this site. No mudstones/siltstones, .3% wt sulphide sulphur. Leon will talk about physical characteristics.	
PHYSICAL CHARACTERISTICS OF KIMBERLITE:		
Leon Botham	There will be three streams produced independently in the process plant: course, grits, and fines. We can dispose of these three streams separately or together as a paste. When we use fines we dispose of them as a separate stream. We have done some physical characteristics on materials so far and essentially the testing we have done shows the processed kimberlite ideal for construction and backfill. We are proposing a 3 to 1 cross slope on the berms, which is 7% with a friction angle of 32%. There is a shallow slope. Compaction tests run indicate the material will compact relatively easily and we ran grain size during	

NAME	COMMENT	ACTION
	compaction. It is very strong material. Other testing we have done is determining what kind of settlement we may get in the pile over time as we stack it. We are going to talk a little bit about the disposal plan and I look at disposing the processed kimberlite in two locations, the north pile and paste underground. Mine rock will be disposed in the base of the north pile under processed kimberlite and use of granite as construction material. So, the proposed construction method is perimeter berms of course processed kimberlite. Conventional construction using trucks hauling to the berms. The fine stream or total mix paste will be pumped to the pile. Like a tube of toothpaste, the water will be removed from the processed kimberlite essentially with the paste there is no lead water left. Essentially, there will be 12 million tonnes of processed kimberlite in the north pile. So, this is essentially a cross section of one side of the north pile. The plan is any organic material will be removed down to bedrock or down to competent soil. The course and grits processed kimberlite will then be trucked out and compacted using standard construction methods. The berm will come up and angle this way instead of angling back. The kimberlite will be pumped in and as we raise the berm, ultimately, there will be a one metre thick cap of core granite non-acid material on top.	
Sevn Bohnet	**Q:** What size is the core granite?	
Leon Botham	**A:** Not determined yet but may be finer depending on the effort we want to put in. Ultimately, along the north side of the berm is 20-25 metres. Also, we are proposing perimeter ditches from the north pile.	
Julie Dahl	**Q:** This is just preliminary design?	
Leon Botham	**A:** Yes. There is no problem with this configuration. I'm not sure of exact numbers. The slope here is three to one, 17%-18%. Essentially, if you dumped the material out of the bucket it will form an angle. We ran a series of tests on the fine distraction, the fines and the three fractions all combined. The mode as a slurry and add a load to the top and ultimately all three samples went to the same friction angle of 32%. Consolidation occurs and strength increases. This is what we have modelled for the north pile. The berms will be constructed as raised over time and the piles will be raised.	
Leon Botham	A little bit about the underground disposal. Essentially, there is two types of backfill that will be used filling about 10% of the volume of the mine. The mine rock will be 350,000 tonnes of rock that will go to the base of the north pile. All rock produced underground will be put back underground as backfill. There may also be a deficit of rock underground. This is essentially the	

NAME	COMMENT	ACTION
	schematic of the underground again. The area here is high strength concrete pillars and the processed kimberlite past is remaining here. Are there any questions?	
Marc Dahl	**Q:** Early on in construction there will be excess rock?	
Leon Botham	**A:** Additional rock from quarries at first.	
Leon Botham	Any other questions on basic concepts?	
Lionel Marcinkoski	Are you guys conducting any other testing?	
Leon Botham	Yes.	
Julie Dahl	**Q:** What is going to happen to the physical properties when it changes or freezing?	
Leon Marcinkoski	**A:** The effect of freezing will result in higher strength if it thaws in the active layer of the pile, there will be periods of fluctuation. Once it is contained behind the berm, it is contracted and consolidates or freezes and the strength is not an issue. Any other questions?	
Peri Mehling	**Q:** A general comment - there is a lot of cemented backfill. The work I saw today hasn't looked at metal leaching under alkaline conditions will that come up.	
Rens Verberg	**A:** We are going to look at leachability of the cement as it cures because it is the initial curing stage during which cement is the most leachable. We are concerned about environmental backfill. Contact behind ground water and backfill will be limited to backfill mass. In terms of alkaline, we are getting now the worst-case scenario. It is 1% cement in the backfill.	
Jeremy Wyeth	Two and one-half.	
Rens Verberg	It is a negligible quantity and will look at properties in terms of leachability.	
Peri Mehling	Not the leachability of the cement as the leachability of materials in backfill under alkaline conditions that will be there.	
Ken De Vos	The backfill will act as a hydrologic barrier. There will be some minor amount of consolidation of the backfill that will come out as the material compresses.	
Rens Verberg	The kimberlite has a tremendous buffering capacity. If there is a more alkaline component it will be reduced. Any different form wouldn't be affected by whether kimberlite contains cement or not.	
Marc Digel	Is leach testing on cement or concrete mixtures?	
Rens Verberg	I don't know the distinction.	
Marc Lange	Cement is cement material mixed with rock.	
Rens Verberg	We are planning on just looking at the cement.	
Ken De Vos	The rock is a filler to that cement.	
Marc Digel	You are not just looking at cement without the rock, the whole mixture?	
Rens Verberg	Pure cement, that is the way the testing is set-up.	Note:

NAME	COMMENT	ACTION
		Look at alkaline - leaching added to Items for Considerat ion List
Peri Mehling	**Q:** I missed the densities and strengths of the different components.	
Leon Marcinkoski	**A:** All approach 32% degrees, compaction tests as course 1.6 tonnes per cubic meter, 1.9 and fines 2.1.	
Peri Mehling	You are looking at using some of the course material for construction so you may end up with lower for course and grits?	
Leon Marcinkoski	There are periods when it will strictly be fines pumped as a paste. Course grits and fines will be pumped as paste. Construction will continue using strictly course material.	
Peri Mehling	You have looked at physical characteristics of fines all along?	
WATER MANAGEMENT:		
Leon Botham	Yes. Any final questions on the Waste Management Concept? We are going on next to water management. A brief introduction to the overview of the approach to water management and water quantities that we are expecting. Ken and Mark will discuss that. This is a flow sheet. Today we use a spreadsheet model to predict flows, which allows us to use problematic features if required. The current processed kimberlite containment will be the final point prior to discharge. The north pile inputs are precipitation and the paste material going in to the north pile and in the north pile we will have some consolidation. Outputs will be run-off and collected in perimeter dishes and then there will be a sump proposed and directed to the mine water clarification pump. We have a sump down in this area and overflow directed here later. Here as the berms are constructed, they will be collecting in the dishes and pumped back into the mine water clarification pond. A small pond, collection pond at the northeast corner of north pile and then to the mine water clarification pond and explosive storage, the airstrip runoff and any requirements for collection of that water. We will have the site runoff collected in the clarification pond and at the present time there is no plans for discharge from the process plant. All water will be recycled in the mill. All the mine water will be discharged from the clarification pond.	
Lionel Marcinkoski	**Q:** What is water flow from the mine right now?	
Leon Botham	**A:** Five hundred m^3/day.	
Lionel Marcinkoski	**Q:** What is the arrow from the top left box.	

NAME	COMMENT	ACTION
Ken De Vos	**A:** There will be runoff from the north pile running into the top pile of the lake. That water goes through and flows through the remainder of the system of Snap Lake.	
Leon Botham	**A:** We don't want to mix clean water with runoff from the north pile. The arrows indicate the direction of the water flow from that map. The same around the south side of the pile. The area between the pile and lake go straight to Snap Lake.	
Lionel Marcinkoski	Will that ditch be approaching the water table?	
Leon Botham	No, it will be above the water table.	
Hilary Machtans	IL6 is Inland Lake. Six on this map.	
Leon Botham	So, the lowest part of the pile is about 3 metres above lake level. The lowest point of the berm.	
Lionel Marcinkoski	Does that include the bottom of the ditch?	
Leon Botham	The ditch will be low. We will contain the flow and where we want it to go. This slide summarizes the areas where we will have water coming from. The major component is the underground mine water and flows to the clarification pond and runoff from the north pile. There is an area around the pond with natural runoff. Precipitation into the pond, consolidation water from processed kimberlite deposited into pile. If there are times when there is a problem with the process, there are times they will end up in the water clarification pond. If we take the paste as it is deposited, we will have minimum lead water out of the tailings. You squeeze the processed kimberlite below. We have preliminary results estimates about 15% of the total water in the processed kimberlite will be squeezed out in consolidation. We have modelling going on right now to determine what will actually happen. I also have losses from the mine water clarification pond including recycle to the process plant with minimal amount of seepage from the two ponds, which is being corrected, and ultimately discharge to Snap Lake.	
Ken De Vos	We are in a preliminary stage and we find as we work underground that the current estimate is now about 9,800 cubes per day at year five in the project increasing to 26,000 m3/day after year 20. Estimates currently undergoing refinement as part of Advanced Exploration Program. Hydraulic conductivity is used to estimate the flow of water into the mine. Boreholes are used to measure hydraulic conductivity of granite in three directions. Other boreholes are used to measure hydraulic conductivity of the faults and the metavolcanic rock. So, as I mentioned the mine water model is currently being developed and will stimulate flows and ultimately flow into the overall site management model and we will know more on that as mine exploration proceeds.	

NAME	COMMENT	ACTION
Leon Botham	I think we covered most of this. Essential, again, the idea will be for the north pile to contour the surface, runoff where we would like it to go and develop the pile to progressively close during the life of the mine. Maybe year ten it will be closed out and at that point we will direct flows where we would like it to go. Ultimately, report to the mine water clarification pond with runoff near this watershed and clarification pond with site runoff. This slide is essentially to give an indication with proportions to inflows and losses to the system. Inflows, north pile runoff, plant site runoff, precipitation to the north pond, clarification. The north pile runoff is about 5% and consolidation water .6% percent. Losses out of the pond evaporation, seepage and reclaim and discharge. Discharge 95% out of the pond. Year 20, mine water increases and discharges increases appropriate.	
Lionel Marcinkoski	How much freezing of the paste do you believe will be happening in the clarification pond?	
Leon Botham	After the AEP, the only processed kimberlite that will go into the clarification pond will be what will be suspended in runoff and will be deposited in the pond.	
Leslie Green	There will be no exclusive paste definition in the mine water clarification pond.	
Leon Botham	The process upset flows will be relatively clean water from thickeners and overflow.	
Leon Botham	We will come back to a figure that you can actually read and see where some of the water is going. We have the north pile, the mine water clarification pond, and the site mine appropriately placed under the lake and the airstrip over here. There will be runoff from the pile and some water will collect in the sump and drained to the clarification pond. Runoff from the site will be directed to ditches around the site and on to the perimeter around the pond and discharge from the mine. The green area here is the area where the sewage treatment plant will go. I want to go back as well and talk about the mine water clarification pond. There is a slurry discharge of fine processed kimberlite going out through the plant and into the pond. They will be deposited at the north end of the pond and into dam two. Coming from underground will be sediment flow and in general, the only thing that will go in that pond is water.	
Anne Wilson	**Q:** Will solids in there remain in there?	
Leon Botham	**A:** We haven't really thought of that. It is about 3,000 cubic metres so far and it is not a major issue at the present time. We may be required to go in and dredge at a later date.	
Sevn Bohnet	**Q:** Will the existing dams be as they are now or is there a potential to raise both dams?	

NAME	COMMENT	ACTION
Leon Botham	**A:** There is a potential to raise the dams now. The plan for the dams if they are to be raised is… I'll draw a sketch here. This is essentially the original ground level at the base of the pond. Overburden was excavated out and fractured rock excavated out to a point where we reached impact rock. The bottom was then backfilled and an HPDE liner placed in. Another layer was brought up and sand was brought up and the erosion protection was put on. If we raise the dam, we uncover the liner in this area and raise the fill and add new liner on the top and raise the dam. There are currently estimates of seepage out of the facility where for the current period the numbers are believed 15 and 100 cubic metres per month based on preliminary investigations done at the time of the mine water clarification pond. There is monitoring, I believe, some freeze back along damn two where we have the processed kimberlite. At dam one, there will still be some seepage and we have not at this point put plans in place.	
Anne Wilson	**Q:** Is the seepage related to the dams?	
Leon Botham	**A:** It is primarily under the dams. If the impact rock there is still fracture ones and a limited amount of seepage through a dam. Thermisters that have been installed around the site indicate an active layer around the site at depth around the area at –2 celsius, which is fairly cold. Every spring the upper area thaws and the winter, it freezes back. The trend will continue in areas of the north pile and once we have a layer of processed kimberlite on the ground, it acts as an insulating area for fines and in the winter there is freezing from the top down.	
Marc Dahl	**Q:** Is the active area 2-6 metres? Is it going to freeze? The dams?	
Leon Botham	**A:** As long as there is water against the dams, the area with contact water, this area will not freeze because water is a source of heat and this area will freeze. The rock at that depth is fairly impermeable.	
Julie Dahl	**Q:** You say you have seepage. Are you anticipating needing to rely on some feedback?	
Ken De Vos	**A:** It is going to be difficult to control. There will be some seepage and the volume will depend on the water. If we become concerned, we will install a collection system.	
Julie Dahl	**Q:** If you have any seepage at all right now, you are at the point where you need some sort of seepage collection system. You have a certain rate and anticipate that to increase?	
Leon Botham	**A:** That is something we will put in for consideration.	
Ken De Vos	Something to keep into consideration is the quality of the seepage relative to the bogs around the system as well.	
Julie Dahl	Then have a method to collect and test it and let it go to the lake.	

NAME	COMMENT	ACTION
Leon Botham	There is a perimeter around dam one. We haven't noticed anything in our monitoring so far. It is being monitored.	
Leslie Green	Monthly.	
Hilary Machtans	To clarify, we haven't noticed any observable quantities. There is probably some there but we can't collect it. For future consideration, we should quantify the water quantity and make a decision.	
Julie Dahl	I think right now if there were seepage, I would question why you are not having some sort of collection ditch downstream of the dam and collecting it and sampling it. Concentrate it in one area and confirm.	
Peri Mehling	How do you know there is seepage now?	
Leon Botham	We have to make some assumptions based on investigation results. There is an active layer around the lake. There was some discharge Wherever there is discharge there will be a certain depth of discharge. With the dam being constructed, your cutting off discharge from the pond from that stream. Based on results of hydraulic conductivity testing, there would be a certain range of seepage. It is not that we know there is seepage but we anticipate it.	
Hilary Machtans	There is theoretical seepage.	
Ken De Vos	No system will be perfect with respect to stopping seepage. To look at seepage in bedrock, you would have to know where all the fractures are in bedrock. The water quality is based on processed kimberlite and baseline geochemistry program. It is neutral water and you are not pushing sediments through. That is water that they already have a permit to discharge. When we talk about the quality, we have that data. In terms of collecting a sample, it is very difficult. We don't see the seepage and we could look at some of the baseline geochemistry and incorporate it with the current discharge.	
Julie Dahl	My point is that it is your responsibility to be in control. If there is a way that you can control it, there are projects with collection ponds and it is something you should be concerned about.	Added to Items for Considerat ion List.
Peri Mehling	Metal leaching, alkaline conditions, seepage collection.	Added to Items for Considerat ion List.
Peri Mehling	Water quality associated with pore water expulsion in the north pile.	
Marc Digel/ Anne Wilson	Cryoconcentration is what the technical term is..	Added to Items for Considerat

NAME	COMMENT	ACTION
		ion List.
Sevn Bohnet	Ice lensing management and the north pile.	Added to Items for Considerat ion List.
Peri Mehling	The use of course kimberlite as a construction material. Is it being addressed? We need more explanation on consequences on metal leaching.	Added to Items for Considerat ion List.
Marc Lange	You were comparing the kimberlite you were encountering with Diavik and we want a comparison with BHP as well.	Added to Items for Considerat ion List.
Sevn Bohnet	Any geotechnical investigations into the ground underneath the north pile. Ground ice conditions. You were looking for a variable and had muskeggy areas and broken boulders and fractures. Geotechnical investigation into north pile foundation.	Added to Items for Considerat ion List.
Ken De Vos	I talked somewhat about water quality we see on site now and Mark will talk about environmental assessment. The first approach we are taking to identifying water quality issues is to identify and characterize water quality from each source of the system water management area and north pile, mine anything with respect to site relating to water system. Snap Lake is a large consideration. The next thing we do once we understand the different sources on site and characterize the different sources is link them together We think of what the links were and facilitate the process and that feeds into Mark's modelling in the lakes and downstream and based on those results feeding back into the system we identify the key aspects and change the model to reflect changes in strategies and minimize impact to water quality. The reason I went into detail is the three main sources affecting water quality is the three rock types being kimberlite, granite and metovolcanic. In terms of characterizing sources and monitoring data we have ongoing water sampling and the site monitoring data as part of Class B licence.	
Anne Wilson	**Q:** Where does the camp sewage fit in?	
Ken De Vos	**A:** Tom will talk about sewage and other camp waste shortly but it will feed into the model as well. We went through this process of looking at potential sources and there were three main issues being the (1) suspended sediment load from the mine and site, (2) nitrates and ammonia coming from explosives and the metals. We will address this area through the geochemical testing to date. We are in the process of preliminary water quality modelling to identify key issues. We will also be doing sequential leach	

NAME	COMMENT	ACTION
	testing. Repetitive leach on a specific sample using representative conditions to get a range of dip conditions. Then you will get a fresh water sample and run it through the sample over and over. Some additional detailed mineralogy will be useful in identifying the key associations with metal that could be released into a solution or not be released.	
Anne Wilson	**Q:** Could you tell us the parameters of concern?	
Ken De Vos	**A:** It is a bit early for that. I would be hesitant to go through some of the metals right now. I don't want to highlight the boogy man if I'm not sure that it is one. We will also investigate potential types of explosives used in the mine and the chemistry of the different types of explosives.	
Julie Dahl	**Q:** Is some additional hydrogeology work being done, particularly elevated phosphorus levels in ground water?	
Ken De Vos	**A:** The phosphorus didn't jump out as an issue. We need some additional data on ground water itself. We don't have any data from granite in terms of ground water – we hope to get in late summer'01.	
Rick Schryer	We are aware that is a potential issue. We are going to have to address that one.	
Peri Mehling	Changing ground water quality with depth is also an issue.	
Ken De Vos	With respect to the leachate seen in kinetic testing, I will compare Snap and Diavik again. Snap 7.3, Diavik 3 for pH. Sulphate maximum is Snap 900 opposed to 4,000 with Diavik	
Rens Verberg	Diavik is 40,000.	
Ken De Vos	Nickel Snap .2 and Diavik 163-nickel concentration. The water quality we are seeing from two different kimberlites is substantially different. I am going to show you some graphs with trends we are seeing. They typically fall between 8.5 and 7.5. Sulphate concentrations have a maximum of 900 and decrease rapidly to less than 50 mg/litre.	
Mark Digel	Is sulphide exhausting?	
Ken De Vos	There is very little sulphide there. It is exposed to oxygen when transferred to the lab and any sulphides that had been there, I doubt are reacting. You have processed water that you are flushing out. With respect to nickel concentration decrease rapidly to a low level of 50 to less than 25. We have looked at kimberlite leaching chemistry. With respect to granite. Pure granites have a low potential for acid and are non-acid generating. Granites with metavolcanics will be treated as potential acid generating. Metavolcanics will not be used for construction. The granite rock concentrations are alkaline pH 7.5 range. The sulphates are less than 50 mg / litre and consistent. Nickel is all below five micro grams and consistent throughout the duration of	

NAME	COMMENT	ACTION
	testing. Metavolcanic rock low in neutralization and relatively low in acidification level. There is a wide range of conditions observed. A significant proportion is possibly or potentially acid generating. Under neutral pH conditions, leachate concentration is typically below CCME guidelines. Moderately acidic conditions have developed in the high sulphur sample with high metal concentration in the leachate. The concentrations from kinetic test work on leachate concentrations. Some of the concentrations of metals one particular sample were elevated or high. We are talking high concentrations not at a baseline mine. Metavolcanic values pH between 7 & 8 and pH around six to neutral.	
Ken De Vos	The sample is still running. We will have consistency and be able to relate monitoring data. Sulphate 500 milligrams per litre and dropping down quickly. The remainder of samples are neutral pH's and sulphur concentrations. We had one very high and the rest ranged to about 1%. If we look at nickel concentrations they were below 25 micrograms per litre. In summary, kimberlite is non-acid generating with significant excess NP. Processed kimberlite with 20% metavolcanic dilation is non-acid. Metavolcanic significant proportions are potential acid generating all metavolcanic treated as potentially acid generating. Leachate concentration typically below CCME guideline, except under high sulphur/low pH conditions. There is not a large quantity of metavolcanic rock.	
Peri Mehling	**Q:** Can you describe kinetic tests conducted?	
Ken De Vos	**A:** Two kinds. We conducted column type tests similar to Diavik and conducted one kilogram humidity sample and weekly cycling and weekly introducing water to the system. It is typical and I have the guidelines.	
Peri Mehling	**Q:** I am not used to seeing graphs with kilograms per litre in kinetic tests. I'm used to milligrams per kilogram per week. Perhaps you can present in that manner. You don't have to go back to methodology to compare.	
Ken De Vos	**A:** We have those numbers.	
Peri Mehling	**Q:** Comparison of leachate concentration to CCME are valid only as a relative comparison.	
Ken De Vos	That is right. If anything, we feel these numbers are conservative. We will have a large amount of water flowing to mine works. If we get these ratios with these tests and temperatures seen on site, I think these numbers are conservative. We can get into more detail later.	
Peri Mehling	**Q:** That might be true for mine water but not coarse material during concentration. The high density rejects bagged on site, are	

NAME	COMMENT	ACTION
	the samples artificially low on sulphur because that dense media has been separated?	
Ken De Vos	**A:** We are looking at 20 tonnes out of 20,000 tonnes. We are going to look at that in more detail.	
Peri Mehling	Two issues: dense media material and kimberlite samples tested representative or have you scalped the pyrite by going to the dense media?	
Robin Johnstone	There are two issues: Representative sample of kimberlite for purpose of sulphide concentration and secondly the handling of the increase of sulphide concentration.	
Ken De Vos	We can get those answers. That material is coming out as rejects from the process and whether we put it underground will be easy.	Added to Items for Considerat ion List.
Peri Mehling	It is not mentioned as a process plant waste stream in the project.	
Ken De Vos	We are going to have to look into it.	
Rens Verberg	With our 10% sulphur sample we are currently testing in the lab, I would be surprised if it wasn't like our high-density material.	
Julie Dahl	**Q:** Can we talk about water treatment for a moment?	
Rick Schryer	**A:** Tom is going to talk about that.	
Hilary Machtans	Tom is going to talk about sewage treatment and run through modeling and say how to characterize discharge and to handle discharge.	
Peri Mehling	**Q:** Talking about the management of waste rock, development waste and excess mine rock backfill requirements going to the north pile and covered by kimberlite, what may come up as an issue for quarrying waste rock and would that material be used as backfill?	
Jeremy Wyeth	**A:** It was discussed that we could make it available.	
Peri Mehling	**Q:** The logic is to use it back underground.	
Jeremy Wyeth	**A:** All the mine rock later will be granite. After preproduction work, all development rock will be granitey. We have gone through metavolcanic.	
Ken De Vos	There will be a need for material to make starter berms in the north pile. They would have to blast new quarries to start the north pile if they don't use that material.	
Peri Mehling	The need down the road is to quarry material for backfill.	
Ken De Vos	We need material on site anyways. You are saying we may have to quarry for backfill later and why would we if we have backfill?	
Julie Dahl	Your metavolcanics will go in the middle of the pile and get covered.	
Leon Botham	We will develop a starter berm in the middle of the pile and will be constructed from the metavolcanic rock and will place the fines paste internal to this starter berm inside of the pile. Ken is	

NAME	COMMENT	ACTION
	correct. We will need to develop some berm material.	
Ken De Vos	There simply won't be enough kimberlite.	
Rick Schryer	Julie is concerned on phosphorus and ground water and Peri is concerned about phosphorus and ground water quality and depth.	Added to Items for Considerat ion List.
Peri Mehling	You should put up the trade-off in waste rock requirements versus quarry down the road. It would be worth explaining why you can't use your early rock against the need to quarry later on.	Added to Items for Considerat ion List.
SEWAGE TREATMENT		
Tom Higgs	Sewage Treatment – process is sequencing batch reactor. Cycles include aeration, biological treatment, settling and decanting, carried out in single tank. Includes sludge digestion in an aerobic digester followed by dewatering using a gravity bag filtration system. Includes filtration and UV disinfections. This particular design allows treatment and aeration. It is called an extended aeration plant. You may have seen them at the other site. The sludge is retained in a tank. In addition to the biological process, this incorporates a toxic cycle without air that will remove some of the phosphate and nitrate formed from the breakdown of ammonia. It has a sand filter, which removes residual suspended solids and performs two functions allowing the system to go to very low suspended solids and a very good quality effluent compared to a system without filtration. Light penetration requires effluent to be very, very clear. At this point, the effluent is being discharged to an outfall and in the full-scale operation there is still some consideration of discharge. I think we still need to discuss discharge at this point.	
Don McDonald	**Q:** Is this system the same as the one that will on site at full capacity?	
Tom Higgs	**A:** Yes. This plant will be available as a backup with a new system at a different location.	
Don McDonald	**Q:** So, the design would be the same but simply a larger system?	
Tom Higgs	**A:** Yes.	
Hilary Machtans	The plan is to keep the existing and doubling it and then start building the other system for the main sewage treatment camp for the main camp. One issue is sludge and the current thought is to bag it and incinerate it or land fill it. The second is effluent. It could get discharged out to Snap Lake in with the rest of the discharge into Snap Lake or the other option is discharged to wetlands as it is currently. We would like your thoughts to help us finalize that. I don't know what the sludge composition is.	
Anne Wilson	**Q:** Are there metals of concern?	

NAME	COMMENT	ACTION
Tom Higgs	**A:** It is just domestic sewage there are no metals.	
Hilary Machtans	The thinking is that landfills would make a decision based on sludge composition.	
Tom Higgs	The sludge would be a very stable material and could be composted.	
Hilary Machtans	With regard to the effluent, it would have to meet the water licence criteria. At minimum we would meet the water quality right now. But I don't know metals.	
Anne Wilson	I would be concerned about nutrients and phosphorus.	
Tom Higgs	Phosphorus could be removed right now if it was an issue. It just adds a bit of complexity. I would prefer to use ferochloride to prefilter.	
Anne Wilson	What would your chloride levels be? I would think that landfill would be preferable.	
Don McDonald	I think a lot of parameters are looking at the lake and sensitively to nutrient. Loadings over time and decisions become clearly quickly.	
Anne Wilson	What magnitude.	
Tom Higgs	Phosphate less than 6.5 milograms and could go lower with chemical addition. It does add another level of complexity to the operation.	
Hilary Machtans	We have some samples from the RBC but it won't be representative.	
Tom Higgs	I have lots of experience in chemical technology and that would be applicable to a biological system. Organisms need phosphate, you may starve microorganisms that do biological breakdown. You need a balanced there.	
Anne Wilson	Would that compromise the anoxic process later on?	
Tom Higgs	No, I don't think so.	
Hilary Machtans	We need to talk about the loading issue.	
Marc Digel	We will consider nutrients from the sewage treatment plant and all water.	
Robin Johnstone	More information on effluent quality is needed for decision-making.	
Julie Dahl	Sensitivty to the recuring water to return to residual.	
Anne Wilson	**Q:** What information is available on sediment and water quality?	
Julie Dahl	Undersized oxygen	
Mar Digel	We can talk about it. I don't have slides.	
	(Break)	
Hilary Machtans	To highlight where we are at so far, we have covered mine rock and processed kimberlite containment management and water quality management and Ken will talk about water discharge quality and then we will talk about water treatment and then mark will talk about receiving water quality. This gives you an idea of	

NAME	COMMENT	ACTION
	where you are at.	
WATER QUALITY:		
Ken De Vos	I will talk briefly about the water quality model itself. The first item is to develop appropriate source terms and then the appropriate linkages, what water is flowing where and what chemical concentrations are and how they move through the system. We developed a water balance model/water quality model. We can do sensitivity analysis with the water runs. GoldSim is essentially a mathematical model of the water quantity/quality lineages on site used to forecast the range of possible outcomes and experiment with different strategies.	
Rick Schryer	1999, we started collecting data. We have been collecting data for three years.	
Anne Wilson	It might be useful to talk to Chris Spence in our office because he has data collected from different regions. We would make suggestions on the models.	
Dave Milburn	You might want to talk to Bill Reid and use our data.	
Hilary Machtans	Chris Spence has been in touch with this office and is meeting with a geologist.	
Ken De Vos	Our approach is to map out site linkages. The approach is cause-effect linkages are mapped and converted to mathematical equations. Utilize and integrate existing modes like hydrogeology, hydrology and geochemistry. You have seen this slide before. This is one of the first levels in GoldSim. You can work down the complexity of the model. This is the upper level of the model. The main site component is the discharge from the mine. The secondary input is the north pile and Snap Lake and the site. We move down into the model. This is the mine. We have a pathway through the rock for the water to get to the mine and it is added to the sump water. This is an example of many of the sub-systems we look at. This is a sump based on geochemistry data. This is a typical pop-up menu for quantifying the rate of change. Any chemical component is accounted for. You can put in rate of change. This leads to a results model. Once all the linkages are in place, we can run the model several times. You get the results in the format you want. You get graphs of concentration versus time and can do comparisons. When we do sensitivity analysis, we are looking at a range of conditions like seepage from the north pile and what would happen if they were twice what we predicted, we can plug in a number.	
Ken De Vos	Where should we focus more effort? Some issues will have little effect on the overall outcome. Water Treatment:	
Ken De Vos	Our strategy is to minimize suspended solids at the source,	

NAME	COMMENT	ACTION
	seepage runoff collection pond, mine water clarification pond, modelling and test work current underway will identify additional treatment management is required. Anyway that is my portion. Mark will talk about EA.	
Peri Mehling	The model sounds great as a tool. The important part is the logic you are using to get your data and we need to be able to understand that. Describe how you put input into the model is way more important than the fact that you have a model. How are you coming up with mine water, phosphate, etc? How and where are we going to do that?	
Ken De Vos	That's why I went into so much detail. Some of the information is incremental mass loading and some is sequential leach testing and kinetic testing and what are we seeing on site and how will this incrementally change as the lake water moves into the system.	
Rens Verberg	It is a work in progress and I would not be comfortable discussing our modelling effort at this point.	
Ken De Vos	We will come out with a report on this model and all the different sources.	
Robin Johnstone	I think I hear what you are saying Peri. You want to know what you are getting and how the data is going in. Perhaps over lunch maybe we can have a general discussion of the realities of getting this information to you when and how and the format that we get it to you.	
Peri Mehling	It is a description of the approach rather than discuss results at this point.	
Mark Digel	Julie mentioned earlier discussion of water treatment. In terms of defining what the discharge water quality is and the effect on the ambient environment. Water quality is in the middle. Treatment may be an option if the water can't be managed other ways.	
Julie Dahl	I guess you have done some preliminary characterization in your project description. Discharge will increase concentrations of elements in Snap Lake.	
Mark Digel	Some of these sources have some metals that could be above guidelines. What are the expected concentrations? When we define that, we will be in a position to say if treatment is required and what it is required for.	
Hilary Machtans	I think I am getting the right feeling on wanting to know all the results but we don't have all the results right now. We have some information on what the water quality is in the metavolcanics but we don't have for the granites and we can't make statements on the discharge until we have those pieces.	
Ken De Vos	It might be a different parameter when we look at the granites. I don't want to identify issues now that may be issues later.	

NAME	COMMENT	ACTION
Hilary Machtans	What are the first thoughts on this approach? Do you feel that is an adequate approach to start with until we get more data on the granites? Where we are at today is a starting point. Do you think that is reasonable?	
Peri Mehling	It is chicken and egg here. The project description came up with some prediction. The logic of developing those predictions was not clear. Your mitigation measures made sense. When I reviewed it to identify issues concerning myself, it is tough to comment on mitigation when we have no concept of how it is being done. This is my point of view. It would have been interested to hear the approach you have taken to this point. Your method of getting to where you got to is of interest rather than the fact that you will do it again and again.	Note: De Beers is to make memo on models and assumptio ns for distributio n..
WATER QUALITY ASSESSMENT APPROACH:		
Mark Digel	Water Quality Environmental Assessment Approach. We have focussed most of the discussion defining what is going out to the environment and now we will talk about the approach to assess impacts to the environment. To evaluate the impact of the Snap lake Diamond Project on surface water quality. Address water quality issue identified in the EA terms of Reference and through ongoing regulatory and community consultation. Will integrate within overall EA framework and link with other EA components including incoming hydrology, hydrogeology air quality, outgoing fisheries, vegetation, wildlife and human health. Baseline Program, issue identification, pathways. There are the main components: analysis, characterization of discharges/releases prediction of changes in water quality analysis of potential impacts. Once we know the potential pathways, we undertake characterization of released and take that information to predict changes in water and based on those changes, we assess potential impacts. So, Rick went through an overview of the baseline and it is provided in the application so I don't want to really give a summary of what is in the baseline other than give a list of what was included and where.	
Anne Wilson	Did you do it seasonal or summer only?	
Marc Digel	Seasonal. We have winter samples and summer samples.	
Rick Schryer	The stream data was taken in spring during the freshets.	
	(Lunch)	
Robin Johnstone	I would like Hilary to provide an update on discussions for the need for assumptions and models.	
Hilary Machtans	I want to emphasize that if you have thoughts and put them out there. The opportunity for us to implement your thoughts in mine design is now. I want to summarize my meeting with Peri, Sevn	

NAME	COMMENT	ACTION
	and Don. The way forward is going to be for the Golder and the Amec engineering team to prepare a technical memo over the next couple weeks and describe, basically collating the slides you have seen today. We use this baseline data and assumed this when we put it in and the have a section on refinements and open it up again after you have a chance to review the framework. So, that is what we will do and present forward and have another meeting or conference call to go over that memo. We can circulate the memo to anyone who is interested and we can do this for every model used. We will present that data. It will be brief. Do you think that would address? If you had time to think about it and something to look at? That is what we will do. Have we collected the right data? Is it complete? Is it appropriate? And, is the analysis appropriate?	
WATER QUALITY EA ISSUE IDENTIFICATION:		
Marc Digel	Snap Lake Project EA Team, Regulatory and community consultation, Diavik and Ekati experiences, Snap Lake EA Terms of Reference. Water Quality EA Pathways Analysis, mine water discharge, STP Discharge, Air emissions, runoff and seepage. Effects on water quality in Snap Lake or downstream in Lockhart or some small lakes and streams. Fisheries to wildlife to vegetation to socio-economics. Some of the linkages are seepage and runoff is close to small lakes and streams. Most of the runoff and seepage is collected and combined with mined water discharge. Effects on Snap Lake, the mine water and sewage treatment plant will be discharged into Snap Lake. Air emission will possibly affect Snap Lake. Fisheries to wildlife to vegetation to socio-economic. Linkage diagram showing attention connections Jump in if you have any questions. The key pathways will be dominated by underground mine water. Settling characteristics of underground mine water will be a key pathways. We spent a lot of time talking about the characterization of the source terms. A lot of it focused on geochemistry work done. We actually have an underground development and can go in and monitor that. As part of the SNP, we have been monitoring the quantity and quality of water underground and do some toxicity testing of material to collect some underground mine water.	
Anne Wilson	**Q:** Which toxicity tests are you thinking about?	
Mark Digel	**A:** Rainbow trout as an acute test. For chronic we would probably look at fat head minnows. Pretty thorough. We would do that for underground mine water as well as process plant water. We will also collect water from these sources to do some settling experiments.	
Anne Wilson	**Q:** You have analysis on similar samples?	

NAME	COMMENT	ACTION
Marc Digel	**A:** We have done particle size analysis. You have finer material and it is not necessarily settling characteristics.	
Anne Wilson	**Q:** When the water settled out, are you planning to use any coagulants or flocculants?	
Marc Digel	**A:** Turbulence will affect settling velocity. You get a circulation pattern in the pond. We are doing some calculation and combining it with the settling test.	
Anne Wilson	**Q:** We were recently looking at Ekati's Long Lake containment area and toxicity was associated with coagulants and flocculants that they were using.	
Marc Digel	**A:** If you add flocculants, you need to understand the quality of those. We have some piles of various types of rock on site and as conditions allow runoff or seepage on those will be monitored. In terms of Modelling of discharges to Snap Lake, onsite water quality model (GoldSim) will predict quality and quantity of water discharged to Snap Lake. Air emissions have the definition of particulates and metals and potential acid input. The air quality modelling component of the project will look at a regional air quality model.	
Anne Wilson	**Q:** Which air quality model will you use?	
Marc Digel	**A:** Kelpa 3-D Version.	
Anne Wilson	**Q:** Will there be ground truthing?	
Marc Digel	**A:** I can't answer for the AQ Team.	
Rick Schryer	We have been doing dust monitoring since last year.	
Anne Wilson	**Q:** What size fraction?	
Rick Schryer	**A:** I don't know but that has been ongoing since last April one year ago, a year plus.	
Mark Digel	In terms for the potential for emissions in the project, the approach we use which is becoming the standard way to do this - what we have done is used a lake specific critical load approach were you can come up with estimates for the worst case of loading to a water body. You can calculate a critical load based on alkalinity and hydrology. A critical load is a measure of the maximum load that a lake can receive before sensitive aquatic life will be impacted. So, you would then compare your loadings to a critical load and if it is below the critical load, the impact on the water body would be low. In terms of some of tools we will be using to predict changes, we will use two models on Snap Lake. We will use a Cormix Mixing Zone model and a two-dimensional circulation and water quality model for the entire lake. Small lakes and streams based on fully mixed mass balance type of model. Lockhart River watershed based on mass balance calculation of incremental changes due to changes in Snap Lake. Outflow from Snap Lake moves down the Lockhart River	

NAME	COMMENT	ACTION
	watershed and incrementally becomes diluted. If you add the project on top of this, you have potential to change water quality. How do you explain mass balance? Essentially, a balance is just a measure of the inflows to the lake plus the change in storage minus the outflows. Natural water consists of pure water and constituents dissolved or suspended. Water balance tracks the balance of water. Mass balance tracks the balance of constituents in the water.	
Marc Digel	Cormix Mixing Zone Model accounts for a 3-dimensional plume characteristics. Used for design of discharge structure. US EPA supported model is the standard for modelling initial mixing of water discharges. Then there is the Snap Lake water quality model, which is a 2-dimensional circulation and water quality model. This shows a representation of the grid. Each square represents an element in the model and the colorization is a representation of the circulation pattern under a certain condition. It will be able to predict mixing characteristics. It assumes it is vertically average and we know from baseline work that Snap Lake doesn't stratify. The predominant circulation patterns effecting material are in this dimension not vertically.	
Anne Wilson	**Q:** Do these models work under winter conditions when you have 2-3 metres of ice?	
Marc Digel	**A:** Yes. You can define conditions and then you deal with density differences and temperature differences as well as differences in dissolved solid loading. Similarly, the model can account for open water conditions with fairly rapid mixing. The discharge will come out and be mixed fairly rapidly. In the winter, it is going to travel much more slowly. The direction is influenced by the slope of the bottom. Those things are accounted for in the model. This particular model is called RMA and is the most widely used model of its type and is supported by the US Army Corps. of Engineers. Over the open water period as well as the changes over time. You can run it for 20 years of the mine life and your concentration is being increased.	
Anne Wilson	**Q:** You can calibrate every year with actual data?	
Marc Digel	**A:** It is difficult to do with the information we have. There isn't enough to station the natural runoff from the lake. We need some actual data. We set parameters within reasonable ranges in similar models. Once we predicted changes in the environment we need to have a way of saying whether or not those changes would have an adverse impact or not. We do that by comparing those changes to thresholds and how do we apply those different thresholds and based on that how to classify impacts. There are a number of different types of threshold we are looking at acute	

NAME	COMMENT	ACTION
	thresholds which are levels of substances causing immediate acute effects and then there are chronic thresholds, which is prolonged exposure with growth effects or reproduction, and then there are some non-toxic guidelines like phosphorus that won't kill or harm but change the character of the lake.	
Don McDonald	**Q:** Can you give us some examples of what those thresholds are? What would the sources be? Where would you get that information?	
Marc Digel	**A:** The USEPA.	
Don McDonald	**Q:** Maximum concentrations?	
Marc Digel	**A:** Yes. Chronic would be the CCME guidelines. Non-toxic tends to be more problematic. There isn't a phosphorus guideline for example. You want to compare within some accepted ranges. It seems like the most reasonable approach to use. You can define acutely toxic and chronically toxic. Drinking water guidelines would be the Canadian Drinking Water Guideline, which includes aesthetic parameters, health based ones like fecal coliforms. You would assess these at different points. Acute would generally be assessed in the pipe so you could evaluate before receiving. You would want to know the whole effluent toxicity would pass acute toxicity tests before it was discharged. Chronic would be assessed in the mixing zone boundary. Aesthetic guidelines could be at an appropriate mixing zone boundary and health based in a pipe or mixing zone boundary. To get a little discussion about mixing zones and some rules of thumb for mixing zones would be a lake situation with a radius around that discharge. You don't want any acute toxicity in a mixing zone. You want this to be small enough to prevent chronic effects. You don't want mixing zones to overlap with water intakes and you don't want them to effect sensitive aquatic habitat. So, for Snap Lake we would consider that the mixing characteristics of discharges and spatial pattern of deposition rates for air emission. For small lakes and streams, we would consider overall mass balance. At the Lockhart River watershed we looked at mass balance assessment of the incremental effect of the project at selected locations downstream of Snap Lake. If you look at this boundary of Snap Lake and this is the project area and if you were to discharge here, based on a 60-meter radius around that, this would be the scale of the mixing zone. At the boundary of that initial mixing zone. If we were looking at thresholds, further out there is potential for higher impact and then you go back to your rules of thumb to find your level of impact.	
Julie Dahl	**Q:** When you described rule of thumb regarding the mixing zone, would it be fish only you would use to determine that criteria or	

NAME	COMMENT	ACTION
	why would you use fish?	
Marc Digel	**A:** You could use something less mobile but if you have a 60-metre radius and you affect less mobile fish in that zone your effect is limited to the mixing zone. If the mixing zone falls over sensitive habitat or key habitat, it may not be an acceptable effect.	
Robin Johnstone	**Q:** Julie you are questioning basically lower species that are immobile?	
Julie Dahl	The statement you made was fish and not other species?	
Marc Digel	That is correct. You are also including it from affecting less mobile species outside of the zone.	
Julie Dahl	That is different now?	
Marc Digel	The purpose of the impact assessment is to ensure there are no chronic effects overall to the lake. Any localized effects that could have some chronic effects would be limited to small enough zone.	
Julie Dahl	If you subtract that from the whole lake, it is insignificant.	
Marc Digel	Correct.	
Marc Digel	The first thing to do would be to compare concentrations to the Chronic Guidelines. The first assessment point you would consider the effects to be anything but negligible.	
Marc Digel	Different jurisdictions do it quite differently. You need to take the lowest observable concentration and take 1/10 of that and that is your guideline. The US guideline is quite different. The idea is to protect the most sensitive forms of aquatic life. You evaluate that at a boundary of a small enough area and realize that there is potential in that area to have some effects but effect the overall lake. You would be defining a threshold low enough that it couldn't have any effects whatsoever.	
Marc Lange	**Q:** What was the rational to have 60-metre dilution zone used in your AEP discharge?	
Marc Digel	**A:** 60 metres seems to be an average of a typical type of mixing zone. It is a limited area and it is a …	
Marc Lange	**Q:** Not driven by impacted biota?	
Marc Digel	**A:** No, you would come up with a much larger mixing zone that might not affect the overall lake.	
Marc Lange	**Q:** The discussion about the impacted organism is not really relative? Regardless of whether it is fish or what have you?	
Marc Digel	**A:** Right.	
Julie Dahl	**Q:** I propose a question to Water Resources. Does the NWT have a standard for mixing zones? Do we have our own standards? Is a mixing zone appropriate?	
Don McDonald	**A:** Generally, people around the table accepted a concept of a mixing zone. People accepted the 60-metre radius. That was all the participants on the Diavik Project and the Water Board	

NAME	COMMENT	ACTION
	accepted that.	
Julie Dahl	**Q:** I wonder if we should make sure 60 metres is the number we want to go with. People weren't really sure. I don't think we have anything in any guidelines that says the concept of a mixing zone is acceptable. We are forging ahead with 60 because it was used before but we don't know if it is adequate.	
Hilary Machtans	The NWT Water Board say 100 or 150 or up to one-third. I did ask them and know that the new Board said they are not using those guidelines. They are going to do their own someday. DIAND developed those and accepted that.	
Julie Dahl	Those guidelines were used on Kodiak Lake and it failed miserably.	
Rick Schryer	Don't think you will ever see a standard number because the conditions of your discharge will change.	
Julie Dahl	I just want a formula that is acceptable, not a standard number.	
Sevn Bohnet	Diavik ended up being changed any way.	
Marc Digel	We are using these concepts to describe what we believe will be the environmental effects of the project. So, we are using this to evaluate environmental effects. We are using an accepted standard we believe is a reasonable concept.	
Jeremy Wyeth	Is there any work being made to some type of formula or guideline being used? You put it on the table but is someone doing something about it?	
Julie Dahl	I haven't heard anything formal with going further for a guideline.	
Jeremy Wyeth	What would the recommendation be for us to proceed then, as we are?	
Julie Dahl	I just want you to be aware that we won't all buy into 60 metres being acceptable or not. We could go extreme one way or extreme the other way.	
Jeremy Wyeth	Then were do we get a guideline to proceed?	
Don McDonald	To interpret what Julie said is, what you are doing is acceptable and when we go further it may be reviewed.	
Julie Dahl	My comment was directed to the Regulators. We need to be more cautious in accepting some things.	
Marc Digel	Julie commented on does this zone increase – the mixing zone doesn't change from where we assess it. If you take the discharge mixing in and the lake water changes over time, we calculate for that so that when you mix it you end up with different concentrations. We do account for the overall lake changing.	
Julie Dahl	**Q:** Are you saying that the boundary of your mixing zone is big enough?	
Marc Digel	**A:** We set the mixing zone on what we think is a reasonable level. We will do an assessment at that level. If we have to go to a larger area then we would look at the impacts of that on some of	

NAME	COMMENT	ACTION
	the other rules of thumb.	
Sevn Bohnet	**Q:** Is this based on the assumption that you don't need a treatment process plant?	
Marc Digel	**A:** It is independent of treatment.	
Ken De Vos	The process is independent of treatment.	
Marc Digel	You might have to go back and look at your source water components. One option may be treatment. Any other questions before I go on? So, this is a map that Leslie showed earlier where here is Snap Lake and this is the whole Lockhart River watershed. As water travels through the Lockhart River watershed the water from site is going to have a smaller and smaller impact. We are also going to look at the potential for impacts combined with air emissions. To look at part of the water shed, here is the Snap Lake watershed here. We are evaluating this mixing zone right here and then we would look at different points downstream and determine what the incremental change increase in concentrations that changes in Snap Lake could have as we go down the watershed to the point where you can't see any changes. We have at least 20 times as much water here as you would have coming out of Snap Lake. We are obviously going to meet those guidelines or thresholds within Snap Lake.	
Don McDonald	**Q:** Relative to retention times in the various lakes, do we have a sense of what that is now?	
Rick Schryer	**A:** In Snap Lake it is 1.7 years.	
Marc Digel	We haven't done calculations at different points down stream but we can do it.	
Marc Lange	I got the impression from the screening that the outer impact zone from water quality is just Snap Lake. I have the impression now that it is bigger. It is the Lockhart River watershed.	
Marc Digel	We are looking at what changes there could be.	
Marc Lange	The De Beers mine will not have an impact on aquatic resources outside of the Lockhart River watershed.	
Sevn Bohnet	Less than that.	
Marc Digel	How will it change the character of water down stream?	
Marc Lange	That is the maximum you are using is the watershed for EA?	
Marc Digel	We will go with a reasonable study area affected by the air shed.	
Rick Schryer	The air shed has been calculated.	
Robin Johnstone	Which is 31km^2.	
Leslie Green	It brings us out to Mackay Lake. Here we have Snap Lake. Our regional radius is 31 kilometres and we capture Mackay Lake in the north and over to here.	
	Does it encompass the whole ice road as well?	
Leslie Green	Our entire winter access road and good portion of the Lupin winter road.	

NAME	COMMENT	ACTION
Marc Digel	If we did this just on a scientific basis, it would be much smaller. We are looking at a larger area just so we can quantify that.	
Peri Mehling	Potential impacts downstream, potential impact on increased concentration. Are you also considering doing comparable loads?	
Marc Digel	Yeah. That is the whole basis of mass balance. We can provide that.	
Peri Mehling	That puts the impact to perspective. A comment that came up outside my area and it came up at Diavik is turbidity. I don't see it as a major issue but you may want to look at it and address it because it came up. Visual turbidity. If you can demonstrate effluent looks like clear water. The pit lakes look a little bit different. There is something happening there. You might want to keep that in mind.	
Marc Digel	Impacts classified based on comparison of predicted concentrations to thresholds at the appropriate assessment point in the environment. Impact classification based on magnitude – above or below the threshold, spatial extent – the extent of the water body affected, duration – how long effects lasts and frequency one time, infrequent, continuous. These are the factors coming into the classification of the overall impact. As we go through the process, we will develop specific criteria for each component.	
Leslie Green	DIAND's response to the BHP decision has made a difference to the way the MVEIRB is going to approach information. Is it significant or insignificant? As Reviewers, you may want to determine whether this is significant or insignificant. Is it worth having a discussion on that?	
Marc Digel	Is there some other factor that may effect your definition of significance?	
Anne Wilson	After mitigation and what further mitigation or contingencies are there.	
Marc Digel	Good point. There may be additional mitigation for contingencies that could be recommended or put in place. The Snap Lake Diamond Project is the only proposed to water discharge into the Lockhart River watershed. There are not any other projects to consider in terms of discharge. For air emissions, will include Snap Lake, Ekati and Diavik.	
Robin Johnstone	Kennady Lake, results from last year will determine future development.	
Julie Dahl	Is there a skeleton crew there?	
Robin Johnstone	There is an exploration camp.	
Anne Wilson	Cumulative effects, what are the boundaries?	
Rick Schryer	Very depending on the discipline. It is outside of the boundary but for discharge it is within the watershed.	

NAME	COMMENT	ACTION
Marc Digel	Discharge is the watershed.	
Rick Schryer	The only overlap there is with the Lupin road.	
Don McDonald	This is the only proposed discharge to Lockhart relative to water. Cumulative effects assessment.	
Marc Digel	There is no additional project effect.	
Don McDonald	Have you thought about climate change, long-range transport and atmospheric effects?	
Marc Digel	Our baseline information includes historical long-range transport. I don't think that we intend to try to evaluate changes in long-range transport.	
Don McDonald	No, that is not what I am suggesting. Let us assume that we are talking about stressors. Then there are the effects of this project. There are potentials for interactive effects for contaminants for various sources. What is the potential for interactive effects?	
Rick Schryer	You would have to assess the impact of long-range transport.	
Don McDonald	Exactly. That is what is missing from baseline. That is part of what cumulative effects is. You do need to evaluate that.	
Robin Johnstone	I'm trying to work through that. Some of the baseline data that we have gives us an indication and a starter basis for what have historically been the results to some extent.	
Don McDonald	Many cumulative effects are about that. Some consideration of other potential stressors needs to be part of cumulative effects.	
Robin Johnstone	Let's put that on items to consider.	
Don McDonald	Two came to mind. Long range transport and climate change.	
Rick Schryer	We will address climate change.	
Don McDonald	You won't be addressing the effects with water. Like changing the duration of ice cover or how it might affect mixing or recycling.	
Robin Johnstone	Consider other stressors that should be considered as part of cumulative effects e.g. long rate deposition pop climate change.	
Don McDonald	There needs to be some consideration of this.	
Sevn Bohnet	From our perspective of cumulative effects there is a commercial lodge on Mackay Lake.	
Robin Johnstone	Mackay Lake Lodge is presently being considered and we are looking at human health as well.	
Sevn Bonhet	**Q:** The sewage treatment plant and the mine water discharge – what is the interaction?	
Marc Digel	**A:** Both of those, if they were discharges, would both be incorporated into the Snap Lake model predicting overall mixing.	
Sevn Bohnet	When you present your assessment, you can present the actual effects with the mitigation and supporting rational. Proper presentation of reports and mitigation. Identify some of those original impacts and what they were.	
Joe Acorn	We ask them to identify all impacts and mitigation measures. We	

NAME	COMMENT	ACTION
	want them all identified.	
	(Break)	
Rick Schryer	We were going to have linkage diagrams and potential environmental effects will be identified.	
Don McDonald	If you can include the date and transport and pathways. Where does phosphorus go if it was released?	
Robin Johnstone	Emphasized that this session is beginning dialogue and not one and only. This is the beginning and we will continue on. I appreciate your sentiment of following through.	
Hilary Machtans	Are you wanting to see a full set of diagrams ahead of time to have input in the EA process or just in the EA?	
Don McDonald	I would like to see them ahead of time so that we can give you feedback on them and we could let you know about the things we really care about.	
Hilary Machtans	One thing you had raised on GNWT comments was issues on lake stability and perma frost.	
Leslie Green	Under the Mine Act, WCB is part of that as well.	
	Where does the WCB and department of labour come in?	
Leslie Green	WCB is part of the review. We work with them. What we have now is past. It is approved by WCB.	
Lionel Marcinkoski	I would be interested if that information is available.	
Leslie Green	I don't know. I could probably find out for you.	
Lionel Marcinkoski	Obviously the majority of the mine is under the lake?	
Leslie Green	That is all covered in the Mine Safety Act.	
Jeremy Wyeth	A tester ran models for us on our regional support underground but it is based on metavolcanics and we don't think that is now representing our ore body. We have increased the size of our pillars based on work done. This will be remodelled early in July. Mid-August, we will get the next set of information and data collected. Part of the paste fill design and concrete filler design is in different ranges of sedimentation and stuff like that.	
Hilary Machtans	GNWT letter, they had put a question forward about why we hadn't developed a discharge limit. I don't think we are responsible for doing that. I think it is up to the Water Board. In terms of setting our licence limits that we will be bound by, that is up to the Board.	
Leslie Green	We explained what we would be comparing our discharge to. It is the Land & Water Board's ultimate responsibility to set that number.	
	3:50pm - End	

Snap Lake, June 4- 5, 2001

Water Quantity and Water Quality Technical Discussion Session

De Beers Canada Mining Inc.

Snap Lake Diamond Project

Snap Lake and Yellowknife

DE BEERS

Agenda for Technical Session

- Geology/Mine Engineering
- Mine Rock and Processed Kimberlite Management
- Water Management
  - Water Quantity
  - Water Quality
  - Environmental Assessment Approach

2. DRAFT: PRELIMINARY DATA ONLY

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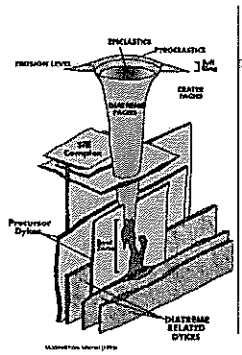
GEOLOGY/MINE ENGINEERING

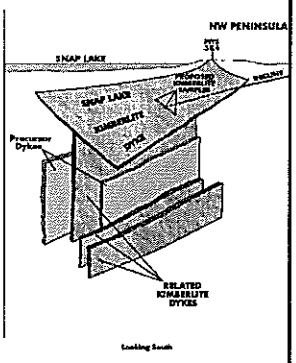
3. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

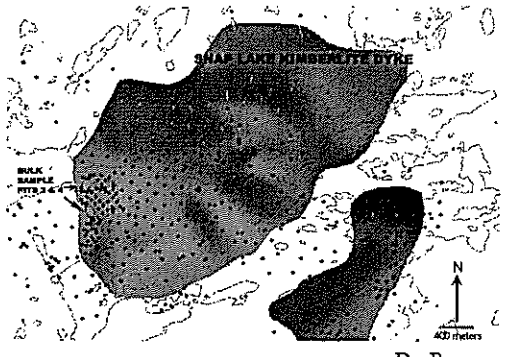
INTRUSIVE MODEL



INTRUSIVE MODEL



Exploration of Dyke



5. DRAFT: PRELIMINARY DATA ONLY

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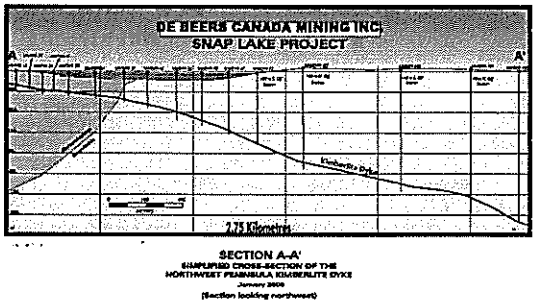
Schematic Cross Section of the Snap Lake Dyke

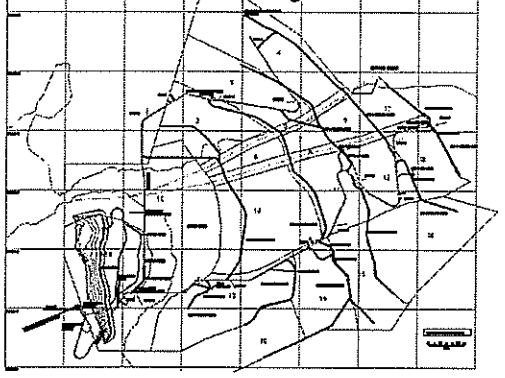


SECTION A-A'
SIMPLIFIED CROSS-SECTION OF THE NORTHWEST PEninsula KIMBERLITE DYKE

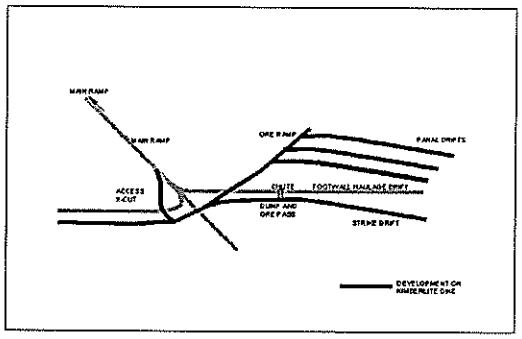
6. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

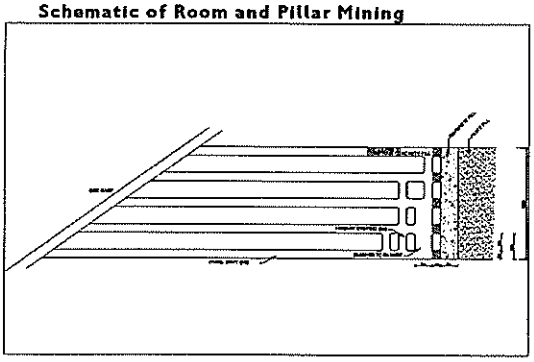
Schematic of Underground



Schematic of Kimberlite Dyke Development



Schematic of Room and Pillar Mining



Mine Rock and Processed Kimberlite Management

10. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

Rock Management

- Definitions
- General Approach
- Chemical and Physical Characteristics of Wastes
- Options for Storage Of Mine Rock and PK

11. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

Definitions of Rock Generated from Mine Activity

(1) MINE ROCK: Rock that surrounds the orebody

(2) PROCESSED KIMBERLITE (PK): Rock from the orebody that has been processed for extraction of diamonds

12. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

Approach to Management of Mine Rock and Processed Kimberlite

- Mine Rock and Processed Kimberlite will be disposed of on surface or placed back underground.
- Underground disposal reduces mine footprint
- An environmental concern with rock is potential for acid generation and metal leaching
- Rock that is potentially acid generating will be contained on surface or underground

13. DRAFT: PRELIMINARY DATA ONLY

De Beers

Definitions of Acid Rock Drainage / Acid Mine Drainage

- Results from exposure of sulphide bearing minerals to oxygen
- Typical controlling factors
  - Availability of oxygen
  - Amount and reactivity of sulphide minerals
- Acid may be mitigated by neutralizing minerals (e.g., carbonates)
- Where acid potential (AP) is greater than neutralization potential (NP), excess acidity may be produced which typically enhances metal leaching

14. DRAFT: PRELIMINARY DATA ONLY

De Beers

Quantity of Rock

- Total rock (including kimberlite) removed from mine = 24 million tonnes (Mt)
- Processed Kimberlite (23 Mt over 22 years)
  - Kimberlite (up to 80%)
  - Dilution (20 to 30 % Metavolcanic or Granite)
  - ½ used for Mine Backfill
  - ½ used for surface disposal on North Pile

Mine Rock (1 Mt)

- About 2/3 Granite, 1/3 Metavolcanic
- About 0.35 Mt produced in pre-development
- Granite used for construction and capping

15. DRAFT: PRELIMINARY DATA ONLY

De Beers

Snap Lake Geochemistry Program

- Program overview
  - Screening level static testing (1999)
  - Kinetic testing (1999)
  - Follow-up kinetic testing (2000)
  - Class B static test-work on pile and PK
  - Pile / seepage runoff monitoring
  - Site runoff / seepage monitoring

16. DRAFT: PRELIMINARY DATA ONLY

De Beers

TESTING MINE ROCK AND PK (Geochemistry)

- Sampling to determine chemical characteristics
- Testing
  - Acid base accounting (ABA)
  - Metal assay and trace metal composition
  - Mineralogy
  - Short term leach testing (modified SWEP)
  - Kinetic testing (humidity cells / columns)
- Interpretation (influencing factors)
- Full details in geochemistry baseline report

17. DRAFT: PRELIMINARY DATA ONLY

De Beers

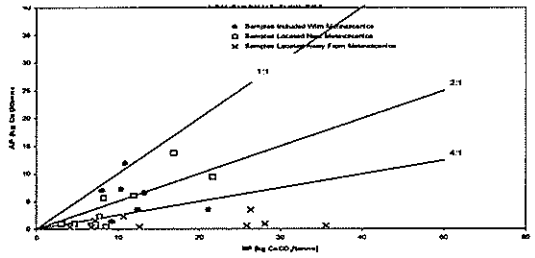
MINE ROCK – GRANITE (Chemical Characteristics)

- ABA characteristics (45 samples)
  - Granite associated with MTVC rock or fault zones treated as PAG
  - "Pure" granite is non-acid generating and is suitable for use as construction material
- Kinetic test work
  - Confirmation of static test results
  - Neutral to alkaline solutions generated
  - Low trace metal concentrations in leachate

18. DRAFT: PRELIMINARY DATA ONLY

De Beers

Summary of ABA Results for Granite



19. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

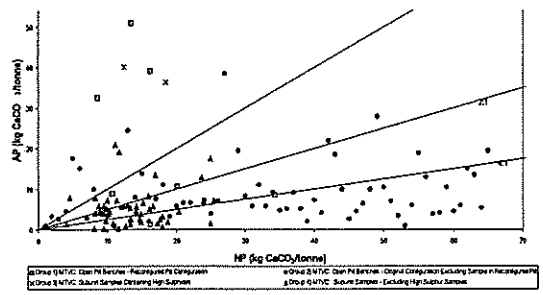
MINE ROCK - METAVOLCANIC (Chemical Characteristics)

- ABA characteristics (168 samples)
  - Significant portion potentially acid generating (PAG)
  - All metavolcanic rock is being considered as PAG and will be stored in the the North Pile, covered by a substantial thickness of PK
- Kinetic test work
  - Confirmation of static test results
  - pH ranges from neutral to acidic
  - Trace metal concentrations range from low to moderate

20. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

Summary of ABA Results for Metavolcanic



21. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

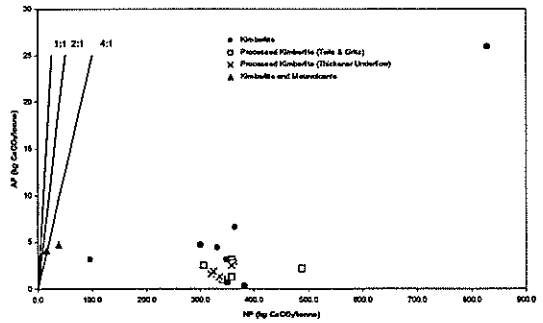
KIMBERLITE (Chemical Characteristics)

- ABA and kinetic testing indicate that PK materials are non-acid generating
- ABA Characteristics (29 samples)
  - Non - acid generating containing significant excess carbonate NP as calcite
  - 20 % of metavolcanic (at 95th percentile S content) mixed with 80 % PK (at 5th percentile carbonate content) yields a net neutralizing blend
- Kinetic Test Work
  - Confirmation of static test results
  - Alkaline solutions generated
  - Low trace metal concentrations in leachate

22. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

Summary of ABA Results for Kimberlite



23. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

Comparison between Snap Lake and Diavik Kimberlite

- Snap Lake
  - No mudstones/siltstones
  - <0.3 wt% sulphide sulphur
- Diavik
  - Contains mudstones/siltstones
    - Greater proportion of fines
  - Up to 3 wt% sulphide sulphur
- Conclusions
  - Minimal ARD potential
  - Better settling characteristics

24. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

PROCESSED KIMBERLITE (Physical characteristics)

- THREE SIZES OF PROCESSED KIMBERLITE
  - Coarse
    - 2 to 5 mm diameter
    - ½ of total
  - Grits
    - Sand Sized
    - ¼ of total
  - Fines
    - Silt Sized
    - ¼ of total
- - please examine samples on display

25. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

PROCESSED KIMBERLITE (Physical Characteristics)

- Testing indicates that PK is ideal for construction purposes (e.g. capping of mine rock piles, use underground for backfill)
- Strength
  - direct shear tests - friction angle = 32 deg.
- Compaction Tests
  - Coarse - 1.6 t/m^3, w= 4%
  - Coarse + Grits - 1.9 t/m^3, w=12%
  - Coarse + Grits + fines - 2.1 t/m^3, w = 12%
- Specific Gravity - 2.7 t/m^3

26. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

DISPOSAL PLAN

Mine Rock Disposal
- Base of North Pile (under PK)
- Mine Backfill
- Potential use of granite as construction material

Processed Kimberlite Disposal
- North Pile
- Mine Backfill

27. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

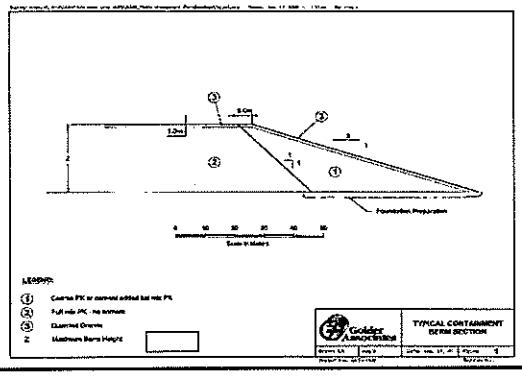
Surface Disposal (North Pile Design)

- Perimeter berms of Coarse and Grit sized PK
- Berm by conventional construction - trucks, dozers, compactors
- PK is pumped as paste to the North Pile
- 12 Mt for surface disposal

28. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

North Pile Cross-Section



North Pile Layout (12 Mt Capacity)

30. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

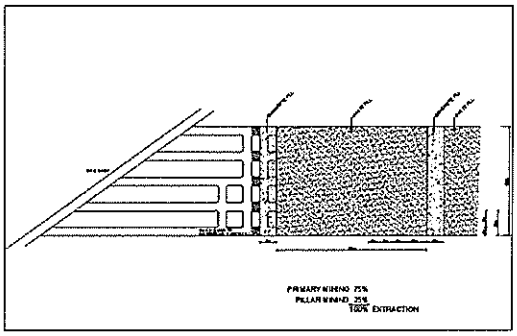
Underground Disposal

- Concrete pillars (10%)
  - Cemented mine rock
- Paste fill (90%)
  - Cemented PK

31. DRAFT: PRELIMINARY DATA ONLY

De Beers

Paste Fill



WATER MANAGEMENT

33. DRAFT: PRELIMINARY DATA ONLY

De Beers

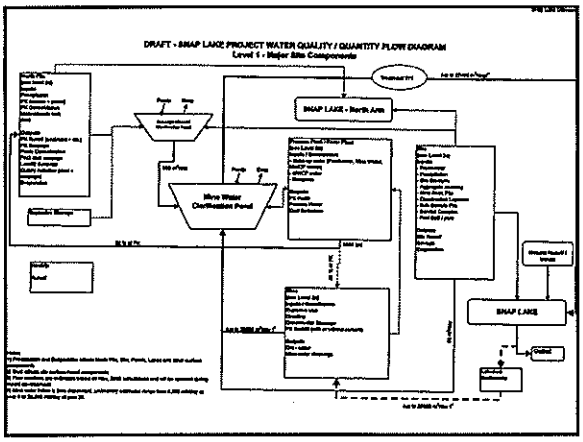
Water Management

- Overview/Approach

1. Water Quantity
   - Inflows
   - Outflow
   - Water Balance
2. Water Quality
   - Water quality data collection
   - Environmental Assessment Approach

34. DRAFT: PRELIMINARY DATA ONLY

De Beers



Water Quantity: MWCP Water Balance

- Inflows to Mine Water Clarification Pond
  - Underground Mine Water
  - Plant Site Runoff
  - North Pile Runoff
  - Direct Precipitation
  - Consolidation Water from deposited PK
  - MWCP catchment runoff
  - Process water during upset conditions in Paste Plant
- Losses from the Mine Water Clarification Pond
  - Recycle from Process Plant
  - Seepage
  - Evaporation
  - Discharge to Snap Lake

36. DRAFT: PRELIMINARY DATA ONLY

De Beers

Underground Mine Water Inflows

- Main inflow is ground water
- Inflow predominately enter by Hanging Wall
- Current best estimates is up to about 9,800 m^3/day in Year Five increasing to 26,000 m^3/day after Year 20
- Estimates currently undergoing refinement as part of Advanced Exploration Program (AEP)
- Series of hydrogeological holes currently being drilled and monitored.

37. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

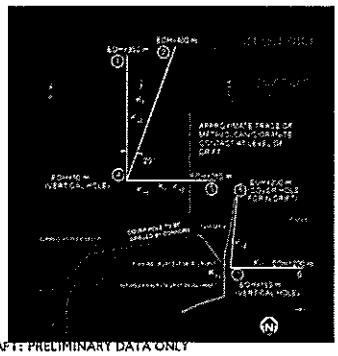
Hydraulic Conductivity Testing

- Hydraulic Conductivity is used to estimate the flow of water into the mine
- Boreholes are used to measure hydraulic conductivity of granite in three directions.
- Other boreholes are used to measure hydraulic conductivity of the Faults and the metavolcanic rock.

38. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

Location of Hydrogeologic Boreholes



39. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

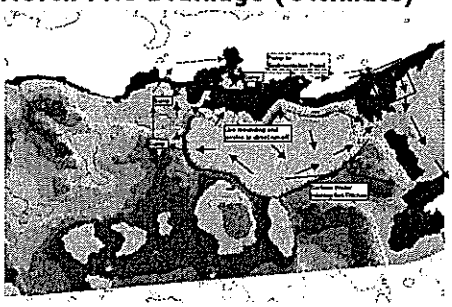
Modelling to Estimate Underground Inflow Volumes

- Mine water inflow model currently being developed
- Modelling will simulate mine inflows through life of mine, closure and post-closure
- Model results will feed into overall site water quantity / quality model

40. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

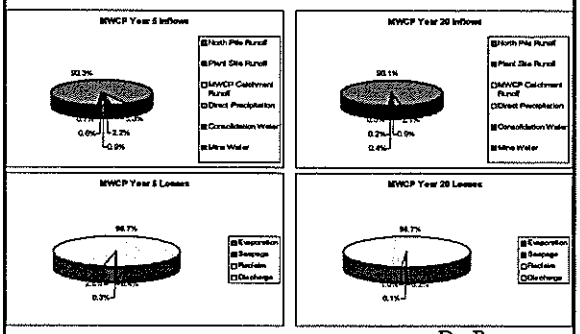
Surface Water Flows: North Pile Drainage (Ultimate)



41. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

Water Management - Mine Water Clarification Pond



42. DRAFT: PRELIMINARY DATA ONLY

DE BEERS

WATER MANAGEMENT:

WATER QUALITY

De Beers

Approach to Water Management – Water Quality

- Characterize water quality at each source
  - water management system
  - Snap Lake
  - regional area
- Use models to predict water quality over time
- Based on model results identify key impacts and refine management strategies

De Beers

Water Quality– Characterization of Water Quality from Sources

- Source Terms
  - Kimberlite
  - Granite
  - Metavolcanic
  - Other (cement, explosives, etc.)
- Mine Water
  - Ongoing mine water sampling
- North Pile / Site
  - Geochemistry Baseline Program
  - Site monitoring data

De Beers

Water Management – MINE WATER CHARACTERISATION

- Potential Issues
  - Suspended Sediment Load
  - Explosive Use
  - Metals
- Addressing Areas of Concern through:
  - Geochemistry program
  - Sediment Settling Tests
  - Development of Water Quality Model
  - Sequential Leach Test Program on Mine Rock
  - Detailed mineralogy and assay to identify release mechanisms for key parameters
  - Investigation of explosives use: types, practices, chemistry

De Beers

Summary of Kimberlite / PK Chemistry

- Kimberlite and PK is non-acid generating with excess carbonate
- Long term leachate concentrations from kinetic tests below CCME guidelines

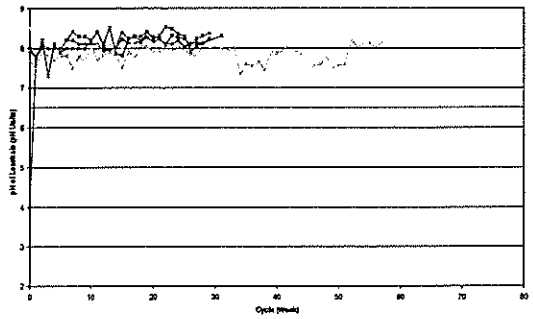
De Beers

Comparison between Snap Lake and Diavik Kimberlite

- Snap Lake
  - Minimum pH = 7.3
  - Maximum sulphate = 900 mg/L
  - Maximum Ni = 0.2 mg/L
- Diavik
  - Minimum pH = 3
  - Maximum sulphate = 4,000 mg/L
  - Maximum Ni = 163 mg/L

De Beers

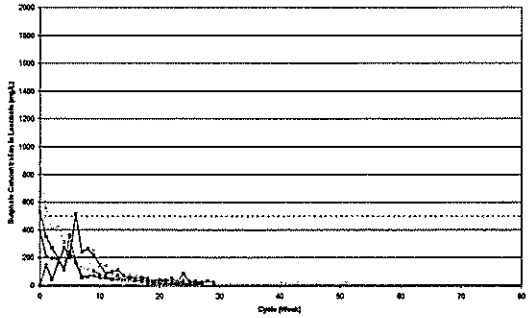
Processed Kimberlite Kinetic Test Results - pH



49, DRAFT: PRELIMINARY DATA ONLY

De Beers

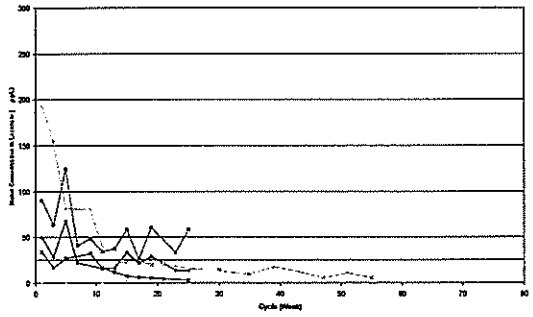
Processed Kimberlite Kinetic Test Results - Sulphate



50, DRAFT: PRELIMINARY DATA ONLY

De Beers

Processed Kimberlite Kinetic Test Results - Nickel



51, DRAFT: PRELIMINARY DATA ONLY

De Beers

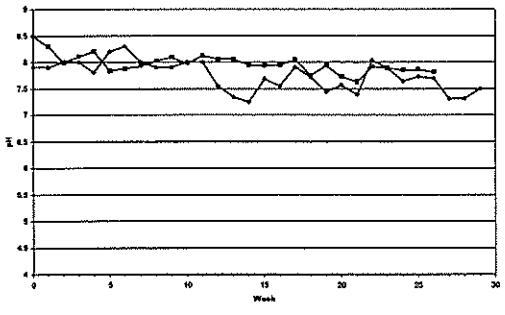
Summary of GRANITE Chemistry

- "Pure" granites have low NP, low AP, and are non-acid generating
- Granites mixed with metavolcanics or near faulting will be treated as potentially acid generating
- Leachate from kinetic test work generally has concentrations below CCME guidelines
- Construction rock will consist of pure granites from quarry or mine workings

52, DRAFT: PRELIMINARY DATA ONLY

De Beers

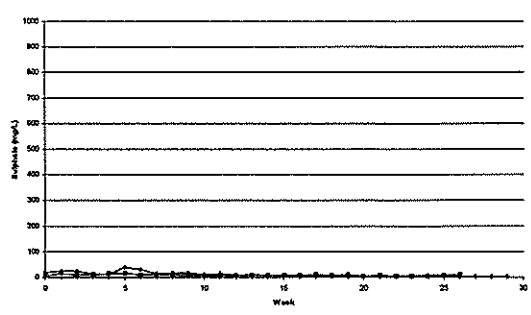
Granite Kinetic Test Results - pH Values



53, DRAFT: PRELIMINARY DATA ONLY

De Beers

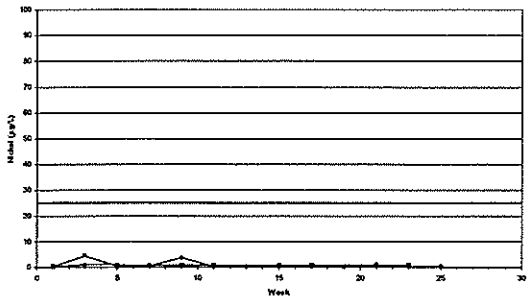
Granite Kinetic Test Results - Sulphate



54, DRAFT: PRELIMINARY DATA ONLY

De Beers

Granite Kinetic Test Results - Nickel



55. DRAFT: PRELIMINARY DATA ONLY

De Beers

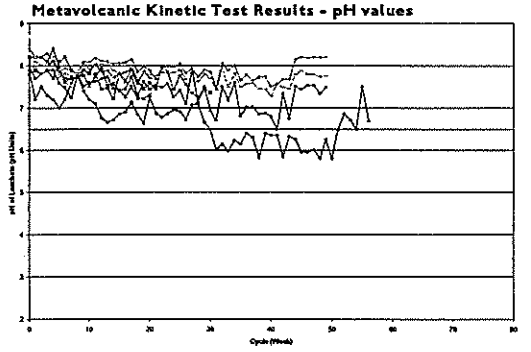
Summary of Metavolcanic Chemistry

- Low NP, relatively low AP
- Wide range of conditions observed
- A significant proportion is possibly or potentially acid generating
- Under neutral pH conditions leachate concentrations typically below CCME guidelines
- Moderately acidic conditions have developed in the high sulphur sample with high metal concentrations in the leachate

56. DRAFT: PRELIMINARY DATA ONLY

De Beers

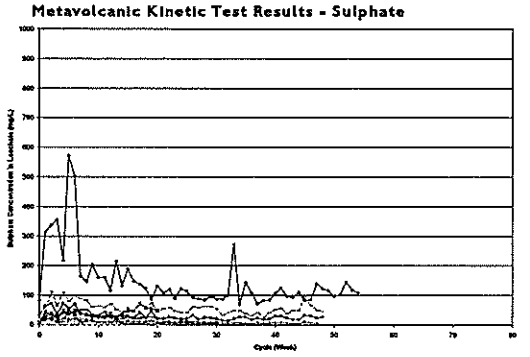
Metavolcanic Kinetic Test Results - pH values



57. DRAFT: PRELIMINARY DATA ONLY

De Beers

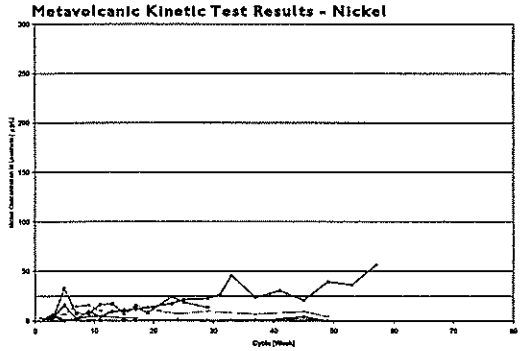
Metavolcanic Kinetic Test Results - Sulphate



58. DRAFT: PRELIMINARY DATA ONLY

De Beers

Metavolcanic Kinetic Test Results - Nickel



59. DRAFT: PRELIMINARY DATA ONLY

De Beers

Summary of Rock Characterization

- Kimberlite
  - non-acid generating with significant excess NP
  - PK with 20% metavolcanic dilution is non-acid generating
  - Long term leachate concentrations from kinetic tests below CCME guidelines
- Granite
  - Low NP, low AP
  - "Pure" granites non-acid generating
  - Leachate from kinetic test work generally has concentrations below CCME guidelines

60. DRAFT: PRELIMINARY DATA ONLY

De Beers

Summary (continued)

- Metavolcanic
  - Significant proportion is potentially acid generating
  - All metavolcanic treated as potentially acid generating
  - Leachate concentrations typically below CCME guidelines, except under high sulphur / low pH conditions

61. DRAFT: PRELIMINARY DATA ONLY

De Beers

Sewage Treatment

- Process is Sequencing Batch Reactor (SBR)
- Cycles include:
  - Aeration
  - Biological treatment
  - Settling and decanting
  - Carried out in single tank
- Includes sludge digestion in an aerobic digester followed by dewatering using a gravity bag filtration system.
- Includes filtration and UV disinfection

62. DRAFT: PRELIMINARY DATA ONLY

De Beers

Discharge Water Quality Assessment

- Approach to Definition of Discharge Water Quality
  - Develop appropriate source terms
  - Develop appropriate system linkages / transport components
  - Identify key factors that influence water quality
    - Sensitivity analyses
- Development of Water Balance / Water Quality Model (GoldSim)

63. DRAFT: PRELIMINARY DATA ONLY

De Beers

GoldSim Overview

- GoldSim – mathematical model of the water quantity / quality linkages on site
  - Forecast the range of possible outcomes
  - Experiment with different strategies (perform "what if"scenario analyses)
- Approach
  - Cause-effect linkages are mapped and converted to mathematical equations
  - Utilize and integrate existing models (e.g. hydrogeology, hydrology, geochemistry)
- Tool for decision-making
- Gives graphical output

64. DRAFT: PRELIMINARY DATA ONLY

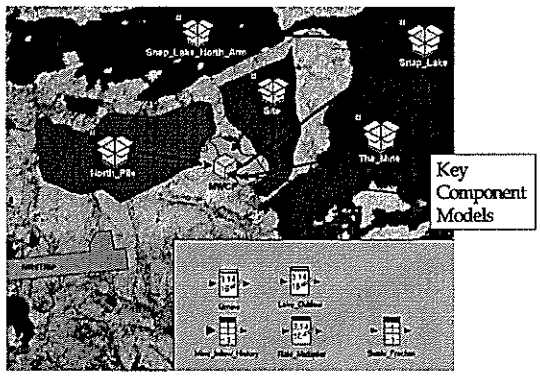
De Beers

Snap Lake Project Model(NOTES)

- Model used to evaluate multiple reservoirs and water interactions for the system.
- Main reservoirs / System Components:
  - Mine Sumps
  - MWCP
  - Snap Lake
- Secondary Components:
  - Process Plant
  - North Pile
  - Site Runoff
  - Airstrip
  - etc ...

65. DRAFT: PRELIMINARY DATA ONLY

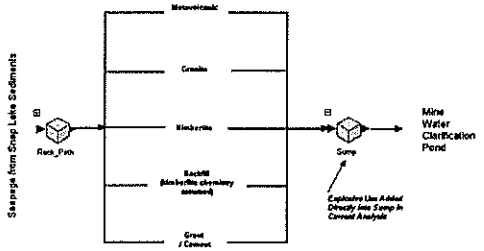
De Beers



66. DRAFT: PRELIMINARY DATA ONLY

De Beers

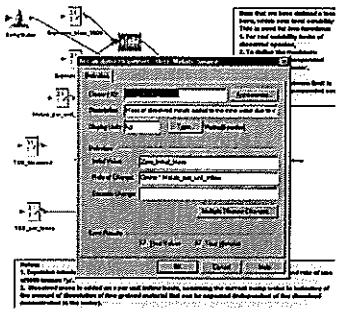
The Mine



67. DRAFT: PRELIMINARY DATA ONLY

De Beers

The Sump

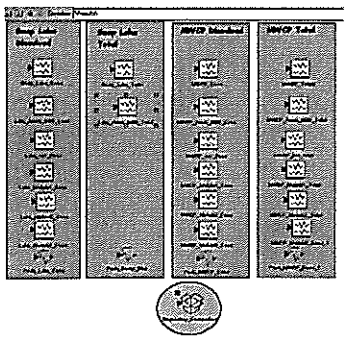


- Incremental dissolved load calculated per unit inflow.

68. DRAFT: PRELIMINARY DATA ONLY

De Beers

Results Module



- Results are summarized, and formatted after each model run in the Results Module

69. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Treatment

- Minimize suspended solids at source
- Seepage/Runoff Collection Pond
- Mine Water Clarification Pond
- Modelling and testwork currently underway will identify if additional treatment/management is required

70. DRAFT: PRELIMINARY DATA ONLY

De Beers

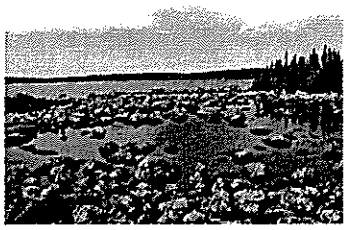
Receiving Water Quality Assessment and EA Approach

See File: H20techsessionPt2

71. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality - Environmental Assessment (EA) Approach



1. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA - Objectives

- To evaluate the impact of the Snap Lake Diamond Project on Surface Water Quality
- Address water quality issues identified in the EA Terms of Reference and through ongoing regulatory and community consultation
- Will integrate within overall EA Framework and link with other EA components, including:
  - Incoming - hydrology, hydrogeology, air quality
  - Outgoing - fisheries, vegetation, wildlife and human health

2. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA – Approach

- Baseline Program
- Issue Identification
- Pathway Analysis
- Characterization of Discharges/Releases
- Prediction of Changes in Water Quality
- Analysis of Potential Impacts

3. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA – Baseline

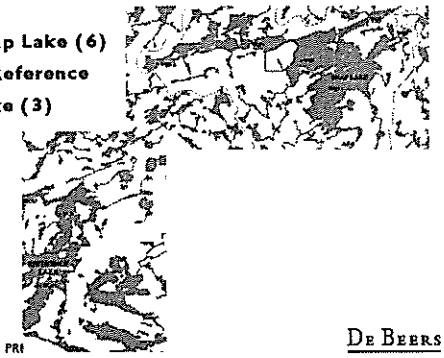
- Parameters
  - Water Quality
  - Sediment Quality
  - Phytoplankton and Zooplankton
  - Benthic Invertebrates
- Water Bodies
  - Snap Lake
  - Small Lakes
  - Tributaries to Snap Lake
  - Reference Lake

4. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA – Baseline

Snap Lake (6) & Reference Lake (3)

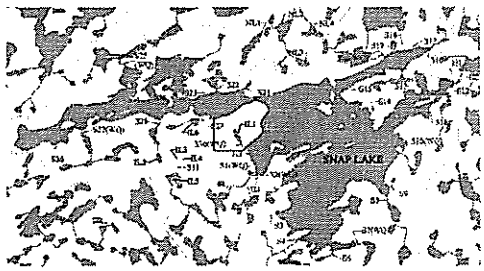


5. DRAFT: PRI

De Beers

Water Quality EA – Baseline

Small Lakes (10) & Streams (8)



6. DRAFT: PRELIMINARY DATA ONLY

De Beers

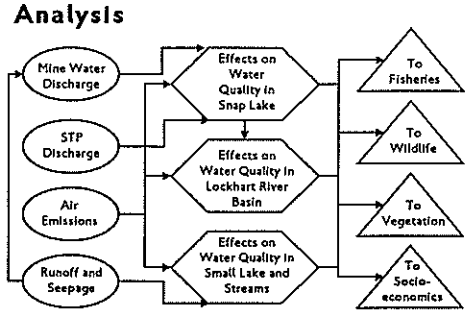
Water Quality EA – Issue Identification

- Snap Lake Project EA Team
- Regulatory and Community Consultation
- Diavik and Ekati Experiences
- Snap Lake EA Terms of Reference

7. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA – Pathway Analysis



8. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA – Key Pathways

- Water releases will be dominated by underground mine water
- Settling characteristics of underground mine water

9. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA – Characterization of Water Releases

- Monitoring of Quality, Quantity and Toxicity of main mine water sources
  - Underground mine water
  - Diamond Process Plant water
- Settling tests
- Monitoring of other source water components
  - Runoff and seepage from rock piles
  - Site runoff

10. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA - Modelling of Discharges to Snap Lake

- On-Site Water Quality Model (GoldSim) will predict quality and quantity of water discharged to Snap Lake
- Air modelling will provide deposition rates for air emissions:
  - particulates
  - metals
  - potential acid input (NOx/SOx)

11. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA - PAI and Critical Loads

- Potential Acid Input is a measure of the wet and dry acid deposition resulting from air emissions
- Critical Load is a measure of the maximum PAI load that a lake can receive before sensitive aquatic life will be impacted.
  - major ion characteristics (alkalinity)
  - hydrology

12. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA - Lake and Stream Water Quality Modelling

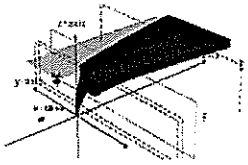
- Modelling in Snap Lake
  - Initial mixing of discharges using Cormix Mixing Zone Model
  - Two-dimensional circulation and water quality model for entire lake
- Small lakes and streams based on fully mixed mass balance model
- Lockhart River watershed based on mass balance calculation of incremental changes due to changes in Snap Lake

13, DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA - Cormix Mixing Zone Model

- Accounts for 3-dimensional plume characteristics
- Used for design of discharge structure.
- US EPA supported model is the standard for modelling initial mixing of water discharges

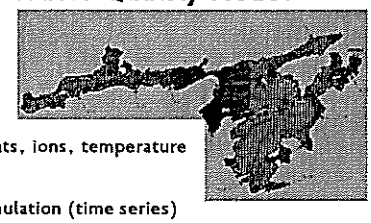


14, DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA - Snap Lake Water Quality Model

- 2-dimensional circulation and water quality model



- Metals, nutrients, ions, temperature and sediment
- Continuous simulation (time series)
- Accounts for time variable winds and inflows/outflows
- Widely used and supported by US Army Corps of Eng.

15, DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA - Analysis of Impacts of Predicted Changes

- Thresholds
- How to apply different thresholds
- Impact classification

16, DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA - Thresholds

- Aquatic Life Water Quality Guidelines
  - Acutely Toxic (e.g., metals)
  - Chronically Toxic (e.g., metals)
  - Non Toxic (e.g., phosphorus)
- Aquatic Life Sediment Quality Guidelines
  - Acutely Toxic (e.g., metals)
  - Chronically Toxic (e.g., metals)
- Drinking Water Guidelines
  - Aesthetic (e.g., manganese)
  - Health Based (e.g., coliforms)

17, DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA - Assessment Points for Water Quality Thresholds

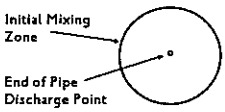
- Aquatic Life (Water and Sediment)
  - Acute - End of Pipe
  - Chronic - Mixing Zone Boundary
  - Non Toxic - Lake or sub Lake scale
- Drinking Water
  - Aesthetic - Mixing Zone Boundary or Lake Wide
  - Health Based - End of Pipe or Mixing Zone Boundary

18, DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA - Mixing Zone Rules of Thumb

- No acute toxicity
- Small enough to prevent chronic effects
- Does not overlap with water intakes
- Does not affect sensitive aquatic habitat



19. DRAFT: PRELIMINARY DATA ONLY

De Beers

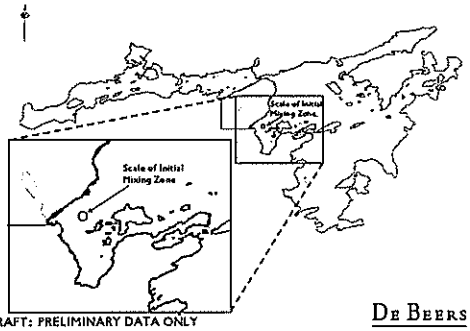
Water Quality EA - Assessment Points for Snap Lake Diamond Project

- Snap Lake - Consider mixing characteristics of discharges and spatial pattern of deposition rates for air emissions
- Small lakes and streams - consider overall mass balance (i.e. completely mixed)
- Lockhart River watershed - mass balance assessment of the incremental effect of the Project at selected locations downstream of Snap Lake

20. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA - Snap Lake Assessment Points

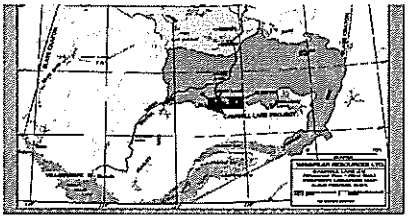


21. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA - Impact of Project on Lockhart River Watershed

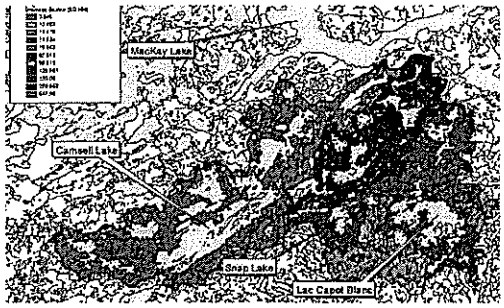
- Effects of Project on downstream water quality
  - Changes in Snap Lake
  - Direct effects of air emissions



22. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA - Assessment Points in the Lockhart River



23. DRAFT: PRELIMINARY DATA ONLY

De Beers

Water Quality EA - Impact Classification

- Impacts classified based on comparison of predicted concentrations to thresholds at the appropriate assessment point in the environment
- Impact classification based on
  - Magnitude - above or below thresholds
  - Spatial Extent - extent of waterbody affected
  - Duration - how long effect lasts
  - Frequency - one time, infrequent, continuous

24. DRAFT: PRELIMINARY DATA ONLY

De Beers

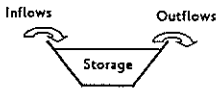
Water Quality EA - Cumulative Effects Assessment (CEA)

- The Snap Lake Diamond Project is the only proposed to water discharge into the Lockhart River watershed
- Air emissions will include:
  - Snap Lake Diamond Project
  - Ekati Diamond Mine
  - Diavik Diamond Mine

25. DRAFT: PRELIMINARY DATA ONLY

De Beers

Mass Balance



Balance = Inflows +ΔStorage - Outflows

- Natural water = Pure water + constituents (dissolved or suspended)
- Water balance tracks the volume of water
- Mass balance tracks the mass of constituents in the water

26. DRAFT: PRELIMINARY DATA ONLY

De Beers