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RESPONSE MEMO

DATE: April 5, 2005
TO: Jonathan Browne
John Keyuk
FROM: Jeff White
FILE: P05-1802
RE: Iqaluit Comments on Earthtech's Activated Sludge & NWC's EVC* Wastewater Treatment Plant Proposals for Iqaluit

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General Comments

It is regrettable that Northern Watertek Corporation (NWC) did not make better use of Iqaluit's visit to Westport to answer the number of questions Iqaluit has detailed herein. For that, NWC accepts the responsibility and the following is an attempt to address that failure as professionally and thoroughly as possible.

1a) Price and Summary Breakdown

- Turnkey fixed price – guaranteed – 6.635 MM$ plus taxes.
- Developed on basis of total cost, all goods, services and contingencies with no esclation in costs based on proposal details (plus taxes, as applicable).

1b) Existing Lagoon

- What is the capacity, in cubic meters? Area? Depth?
- Statement made states current lagoon is inadequate. On what basis? Cleanouts are based on grit accumulation. Grit accumulation is minimal – clean out every 20 – 30 years.
- Grit calculations: 0.3% of voume with 90% volatile solids as no industry is present at Iqaluit.

1c) Grit Calculation – Annually (based on assumptions)

Annual loading at Iqaluit presently:
Solids = 6,000 x 0.3 x 365 x 0.003 = 1,971 m^3
Grit = 1,971 (1 – 0.9) = 197.1 m^3/year worst case – average generation 150 m^3/year

Generally speaking, for any rational biodegradation of solids to take place on a seasonal basis, total solids accumulation should not exceed 15% to 20% of total retention capacity. This will allow for volatile solids conversion and release as gases developed in the anaerobic lower lagoon levels.

In 20 years, this volume of non-biodegradable grit would be 4,000 m^3 (maximum) and more likely less than 3,000 m^3 using 0.2% solids for non-industrial municipal waste.

Clean outs are usually 20 – 30 years apart, provided the volume retained plus annual solids accumulation does not exceed 15% - 20% of retention.

1d) Ekati

The information as presented is factually incorrect. It is regrettable that questions with respect to the Ekati project were not asked rather than incorrect statements made.

The (Ekati) Misery EVC* plant is a unique concept plant, designed and built with extreme Arctic conditions in mind.

First: The plant was prefabricated in Ottawa at Davtair Industries, to NWC's design. The prefabrication eliminated most of the expensive on-site assembly costs normally associated with this type of complex facility.

Second: The plant was designed to address the meteorological extremes of both winter and summer, both land (tundra) application concepts – partial (70%) evaporation in summer, and snowmaking in winter (250,000 m^3 in summer, 150,000 m^3 in winter).

Third: The MacKenzie Valley Land and Water Board licence is currently only for the summer operation and NOT the winter extremes. Therefore, this plant has not operated during the winter, as yet.

Fourth: The system works very well to specifications as it is essentially the same capacity as Westport, Ontario which plant effectively disposes of ammonia and nitrates to virtual non-detectability. The current licence is not so much to determine the viability of ammonia and nitrate reduction/removal as it is the effect of nitrate concentrations applied to the tundra for a projected period of time in the range of 10 years, the life of the mine pit – projected. Concentrated nitrate applicatin is designed to accelerate the projected time of full operation.

Ammonia stripping is old hat to industry and concentrations of NH_3 are well below detectable limits (35 mg/m^3 EPA standard). Stripping by the HP method utilized by NWC in its plant is very effective compared to LP stripping as described by EPA design manuals for ammonia stripping. NH3 is not the concern as stripping is 100% removal.

Nitrate removal is designed at (Ekati) Misery in two stages. BHP-Billiton's microbiologists have confirmed that the phytoremedial uptake of the nitrates held in the top 2 or 3 centimeters of the active layer will be rapidly absorbed by tundra plants, based on review of several studies and experiments on nutrient application to the tundra to date.

Further, the final stage of waterflow to the new watershed represented by Cujo Lake is through a significantly sized wetlands of some 30 hectares. Any nitrates incidentally not phytoremedially uptaken, uptake will pass, via waterflows, through this wetland.

Nitrates in this environment will be anaerobically converted to N_2 (nitrogen) gas and volatilized to the atmosphere (dentrification).

Fifth: Ekati (Misery) is not a sewage treatment plant but is designed to remove ammonium nitrate contamination as required by CCME (Canadian Council of Ministers of the Environment) new standards. It is, however, very similar to the Westport operation.

Sixth: This EVC* plant, as noted above, has several innovative design considerations to operate effectively, particularly during the critical winter months. Simplication of instrumentation functions and elimination of flow meters et. al., together with valves installed in horizontal configurations to assure complete drainage when shut down, are incorporated into this design.

Seventh: NWC design team has designed, in whole or in part, more than 300 systems to make snow all over the world in the last 40+ years. Temperatures as low as –52ºC have been experienced with no difficulty, whatsoever, on an ongoing basis.

Iqaluit weather extremes have been limited to –46ºC as far as the Environment Canada record is concerned.

Iqaluit's comments with respect to confidence or lack thereof in NWC's understanding of the Arctic challenges is misplaced as this plant, unlike all NWC's other plants worldwide, has not yet been licenced to operate in winter and the two minor problems incurred during commissioning had nothing, whatsoever, to do with such understanding and experience.

NWC should like to see the pictures you have received from BHP-Billiton. Further, NWC should like to receive the identification of the source of these pictures, particularly as they are obviously misleading.

BHP-Billiton has accepted the plant as complete, functional and authorized payment of holdbacks, etc.

Problems at Ekati (Misery EVC* Plant)

- The plant was ordered from NWC in January 2003.
- The plant was delivered on site, prefabricated, in March 2003, less than 90 days!
- Final set up and commissioning was scheduled for May/June 2003. This was cancelled due to unavailable space on site for personnel.
- NWC requested several times to visit the site to examine final set up. This was denied. No space!

The plant was connected to discharge pipeline (surface). However, BHP-Billiton cancelled the testing program due to lack of space on site and failure of BHP-Billiton to obtain the licence to operate the system in a timely manner (summer 2003).

BHP-Billiton also failed to complete the King Pond water supply system (influent) or to hook up power to the EVC* plant in 2003. This was not done until August 2004.

The BHP-Billiton plan was to "mothball" the EVC* plant with no heat, power or maintenance during the winter of 2003-2004. NWC strongly recommended against such a plan. Manufacturers of incorporated equipment recommended the same, threatening to void warranties under such a circumstance. The warnings were ignored.

The only failures, however, were the two Davtair designed aluminum towers which, totally without maintenance all winter, vibrated so severely that the aluminum towers failed immediately above the base gussets.

NWC has never had a tower failure because we have always used steel towers, I repeat, NO failures in 25 years of tower design, since EVC* was conceived in the late 1970s.

NWC replaced these 2 test towers with guyed lattice-work towers BEFORE the plant was commissioned. They can be assembled and disassembled in 2 hours.

The Davtair design was scrapped for 2 reasons:

a) They failed due to vibration in high winds – aluminum - fatigue.
b) The BHP-Billiton failure to obtain the winter operating licence predicated the use of towers that could be disassembled during the non-operating winter.

Suffice it to say the lattice-work towers have worked well to date. Confirmation with respect to above, contact Derrick Chatman, Contracts Dept., BHP-Billiton (867) 880-2169.

Note: It must be clearly understood that the Ekati EVC* plant has not operated in the winter as yet BUT it has survived 2 winter seasons without heat or power with no problems other than the initial tower failures, which would not have happened if the plant had been operated and maintained.

The second minor problem was that NWC's contract documents and drawings called for permafrost "solid" anchors for the pipeline "by others". This was clearly discussed at NWC's offices in Ottawa on January 26, 2003 with BHP-Billiton engineering and environmental personnel.

BHP-Billiton or its designate had to install 2 permafrost anchors, one for the suction line and one for the discharge line. Someone, yet to be identified, failed to ensure the pipeline was anchored properly – repeat – this was a clear contract item, exclusive of NWC's responsibilities.

From this anchor to the discharge centreline, expansion and contraction was properly allowed for. NWC was to inspect the pipeline during its installation by the on-site contractors, but BHP-Billiton did not let us on site due to lack of accommodation during the summer of 2003.

Someone decided to use NWC's hoop design which allows the pipeline to slide through the hoops. This was a mistake. They then covered the mistake with insulation, so it was not readily obvious.

During commissioning, the NWC technicians inspected the pipeline, as much as they could see. They then pressurized the system, during a hydraulic-dynamic test.

The whole pipeline moved less than 30 cms, bending and distorting the HP expansion joint. It did not fail, but it was bent out of shape.

In 2 hours, a spool piece was made, the pipeline properly anchored and the plant was fully commissioned and inspected for acceptance by the various technical specialist committees of BHP-Billiton's Engineering Department.

The plant was run for several days to accommodate the installation of software and to ensure all controls and equipment were performing to specification. When this was completed, NWC was hired to "winterize" the system. Towers were disassembled and everything was drained.

The statement that the plant ran for 2 days before the piping to the snow nozzles broke is FACTUALLY INCORRECT. The pipeline never broke. The line shifted when initially pressurized, bending the discharge expansion joint, a minor problem rapidly solved.

Following this initial minor problem, there were no major problems and no pipeline failure. NWC regrets this false impression and we are sure Iqaluit is pleased to have this issue clarified.

Again, this was not a snowmaking operation as yet. Further, the commissioning problems as described above, were so minor in scope, readily solved, that the commissioning went so well as to be an attestation of NWC's "Arctic" skills.

2. Design Criteria

The codes governing the EVC* system proposed would be ASME, CEMA and AGA codes and the building codes where applicable. NWC does not anticipate the requirement for additional building space at this time, only to use, judiciously, what exists.

3. Time of Receipt of Order to Startup

The time estimates for approval are grossly excessive. A go-ahead now (April 2005) would result in an operational system this year. Machinery deliveries and delivery to site are the critical issues. This is not to minimize, however, the approvals process.

As Iqaluit is apparently without effective treatment at this time, the delay of an approval would be absolutely unimaginable. We do not anticipate the requirement for additional lagoons or pumping systems. We anticipate utlization of existing lagoon and pumping facilities. This, NWC is sure, will set Iqaluit at ease. A site inspection by NWC would verify the NWC design position. So far, any assumptions made are based on NWC's review of the Earth Tech Study and site visit report and photographs obtained from IMG.

4. Iqaluit's comments here are puzzling indeed, considering the concern expressed in Item 7 about pollution, local health, etc.

For far less money, >$3,000,000 in savings with present value savings considered, a far higher standard of performance would be available. This would be advantageous for all in Iqaluit, as well as establishing a new practical and sustainable standard in the North.

The comment that the high standards of performance of the EVC* system ARE NOT CURRENTLY A CONCERN FOR THE NWB OR THE CITY is incomprehensible and NWC rejects this position professionally and totally.

Is it appropriate that NWC would assume that means Iqaluit would pay more for less peformance as a preference? NWC thinks not, and considers this comment as confusing or contradictory to Iqaluit's best interests, health-wise and financially.

5a) Standby Capacity

The prime movers considered critical to the system (i.e.) pumps and compressors, are additionally more critical due to the inaccessibility of the site location at a reasonable cost. Therefore, NWC proposed 100% unit standby and has so included the same in the proposed price. Systems do fail, but with the standby capacity proposed as part of the package, the EVC* plant proposed should not shut down.

Of course, NWC agrees with Iqaluit that all systems fail at some time or other. NWC has simply taken such possible failure into account according to proper engineering design standards by providing 100% unit standby. No raw sewage discharge would occur as the retention facility would accommodate influent flows during such an emergency.

5b) Expandability

The EVC* system simply needs only to run more hours, as noted in our preliminary proposal P05-1802, initial page 2 of 3, Note (1)…"the size proposed can handle treatment as proposed for 12,000 persons based on present levels of sewage generation".

No additional capital investment would be required, simply extended O&M costs due to operating more hours.

This is a major advantage of the EVC* systm notwithstanding the superior environmental performance.

6a) Discharge

The Earth Tech documents clearly indicate the discharge specification as:

45 BOD with a "hopeful" result of 20 mg/l
45 TSS with a "hopeful" result of 20 mg/l
10 NH_3 with a "hopeful" result of 10 mg/l

Further, this standard is not acceptable anywhere else in Canada. Why, therefore, is it acceptable in Iqaluit?

Considering less cost of the EVC* high standard discharge for less money, this position as noted previously, is incomprehensible.

Earth Tech's letter of March 29th, 2004 (attached) further states that 10 mg/l ammonia is considered lethal.

From review of several documents hereto attached, authorities have been struggling with the attempts to improve standards of performance of wastewater treatment plants. Simply stated, biological treatment plants do not function well in the far north, no matter how they may be modified.

As a result, authorities have be willing, reluctantly, to accept lower standards of performance in lieu of no treatment whatsoever. The use of the sea as a "septic tank" has not worked elsewhere and continued practice as such will provide seriously diminishing returns to Iqaluit.

The NWC EVC* technology represents the sought-after performance. In fact, the EVC* technology proposed represents far better than tertiary standard performance, and will most assuredly set a new standard for the North for less cost – a win-win situation.

6b) EVC* is a **ZERO DIRECT DISCHARGE SYSTEM** utilizing the ground surface effect as well as subsurface effects of flow in the active layer each summer as the snow melts.

NWC rejects the statement that the long term effects have never been adequately studied. NWC respectfully requests what references have been accessed by Iqaluit that gives rise to such a conclusion. Controls and conditions of each EVC* operation to date belie that statement. The speculation that a nutrient plume may potentially develop and migrate into sensitive areas is again rejected.

These reasonable concerns are certainly warranted initially, with any land application system, however, monitoring controls and conditions of operation of a system, let alone its approval, establishes design criteria based on site specifics to prevent just those possibilities.

In all testing, monitoring and operations to date, totalling over 50 years of operations, have shown that NWC's site engineering has more than adequately prevented such nutrient plumes from forming and migrating into sensitive areas, even in high permeable soils of "P" ratings of 10^{-5} cms/sec or greater.

Over 100 years of monitoring land applications, it is well established that constituent nutrients are generally held in most soils strata in the top 2-3 cms. Plumes do not form and migrate as speculated. Source EPA, MOE Ontario.

6c) The suggestion that snow would be blown anywhere gives rise to an unfortunately false impression.

Much work by NWC over many years, and working with NRC's Cold Temperature Laboratory in Ottawa on droplet and ice particle diameters, has shown that the discharge is completely controllable to a point of 100% evaporation and/or sublimation.

90% of the volume of any pneumatic spray is represented by 10% of the droplets. Furthermore, 90% of the droplets represent only 10% - 15% of the spray volume (Golitzine 1951 NRC Ottawa).

Trajectories, distances of fallout, evaporation, sublimation and evapotranspiration are well understood by NWC and are designed to full advantage into NWC's EVC* systems.

In other words, spray of water and snow crystals go where they are designed to, and do not end up in drinking water supply, lakes, rivers, streams, playgrounds and school grounds. This concern is warranted, however, to speculate that the ultimate destination of such processing in such sensitive locations is unfairly prejudicial and grossly inaccurate.

Every system implemented to date is so designed in great detail to avoid such consequences.

NWC is prepared to detail such engineering criteria to Iqaluit to alleviate such concerns (see attached design photo).

6.1 a) The Iqaluit assessment that the EVC* system is dependent for its performance on lagoon biodegradation is factually incorrect.

b) As well, the statement "snowmaking does not reduce BOD_5 or TSS" is also factually incorrect.

c) Data from Westport DOES NOT DEMONSTRATE THIS IN ANY WAY.

NWC again accepts the responsibility for not ensuring that visiting Iqaluit officials were not briefed on these items (a), (b) and (c).

d) The use of retention facilities – lagoons – is to accommodate weather anomalies (i.e.) days or hours when temperature or wind conditions are not amenable to proper EVC* operation (i.e.) high ambient temperature – zero or low wind velocity and high wind velocities (a wind window is designed into operational limits put upon the system).

Secondly, only a few hours are needed to accommodate the settlement of primary solids, which will eventually biodegrade, leaving only a very small amount of non-biodegradable grit.

According to Earth Tech, this grit totals some 0.624 m3 for every 4,800 m^3 (Page 16 of 61, ET Project 75360, May 2004).

Based on Earth Tech's estimate, which NWC considers somewhat low. This grit, is relatively minimal, requiring removal, perhaps every 30 years. This depends, of course, on the volume and bottom surface of the retention facility-lagoon and thus the accumulately depth of grit.

e) NWC has run tens of thousands of tests on various aqueous wastewater streams to BOD of 15,000 mg/l and COD's of 30,000 mg/l (potato wastes, animal wastes, agrifood wastes, industrial wastes, leachate/landfill, radioactive wastes).

In every case, with varying strengths of waste in these aqueous streams, the net result was the same > 99% BOD removal, > 99% COD removal.

The lagoon activity makes a difference only as described above.

In fact, the BOD_5 is reduced by the effect of constituent nutrient precipitation to virtually zero BOD_5.

TSS (Total Suspended Solids), therefore, increase initially. Increased pH due to freezing and evaporation causes NH_4 to convert to NH_3, which is gradually volatilized to the atmosphere is non-detectable gas. It ultimately breaks down in sunlight to nitrogen and hydrogen in the upper atmosphere – non-pollutants.

The freezing also "virtually kills" the bacteria in the wastewater streams with the toxic residue normally accompanying disinfection such as chlorination.

In fact, freezing is much more effective than chlorination to log scale 8 (or greater). That is 99.9999999% bacterial reduction.

NWC recommended previously and does so again, that Mr. Doug Huber be contacted (retired) Senior Water Quality Officer, Ministry of Environment, at (519) 633-5889. He has carried out recent independent assessments on the Westport EVC* system and was co-auhtor for MOE on the 1980-85 MOE study on the AFC* Atomizing Freeze Crystallization EVC* system. He is the most knowledgeable regulator in this process (30 years with MOE).

As the snowpack ages, interstitial spacing increases via the formation of larger crystals, allowing all trapped or converted gases (NH_3) to release at undetectable levels, H_2S, NH_3, CO_2, etc. The process is virtually odourless.

Further, the snowpack melts primarily due to radiant energy of the sun when ambient

temperatures creep over the 0ºC level.

Meltwater saturates and flows vertically through the snowpack to the ground matrix, the snow acting as a filter.

Suspended solids collect on the snowpack surfaces allowing the much cleaner meltwater "escape" through the soils strata or over the surface of the terrain.

Rates of melting are adequately slow enough to prevent rapid melting and subsequent erosion of the ground matrix surface. **Therefore, to infer that snowmaking plays no role other than the "storage" of frozen sewage, is factually incorrect**.

This process has been researched and tested to a far greater degree than apparently presented. Again, this is most regrettable.

Note (1): No CH_4 is produced in the AFC portion of the process as no sewage or wastewater becomes septic. At these temperatures in the snowpack, biodegradation is virtually zero. During summer, bio forces do affect the lagoon contents. During winter, due to ice formation, concentrations increase.

Note (2): CO_2 reduction in "stripping" during the making of snow causes the pH to rise, a key part to cause NH_4 to NH_3 by creating H_2O in a reversible disassocation process. Thus, the increase in pH by definition, a lowering of available H^+ ions.

6.2a) Snow Dilution "Concentrations"

Again, this assumption by Iqaluit is factually incorrect. Confirmation is available from Doug Huber, above noted.

During tests by MOE, snowmaking in tanks was covered immediately after snowmaking to prevent dilution. This CLEARLY verified the effectiveness of the process. Huber will confirm this.

Because of the concentration effect of the snowpack, dilution by natural snow resulted in no appreciable effect on process results.

This information is available in the 1985 five-year study on this proces by MOE Ontario – Huber and Palmateer 1985.

b) Ammonia

As surmised by NWC in the foregoing, regulations have obviously allowed lethal levels of NH_3 discharge because no nitrification or denitrification process in this winter climate is

effective enough to reduce such NH_3 concentrations to acceptable levels.

However, NWC fails to understand the correlation of "city exemption from NH_3 criteria" as sewage volumes are inadequate to trigger such NH_3 reduction requirements.

This makes no sense whatsoever, particularly taking into account the "lethal level of 10 mg/l of NH_3 tolerated" (see attached Earth Tech letter dated March 29th, 2004. The volume of sewage is from ½ MM m3 to 2 MM m3, depending upon the loading criteria used. This is significant.

7.0 Operation

The statement that a lagoon system is "far easier" to operate than a mechanical plant is incorrect. We draw Iqaluit's attention again to Westport wastewater treatment plant.

Notwithstanding the superior performance of the Westport EVC* system over its previous "lagoon system", which polluted the Upper Rideau Lake thoroughly after 20+ years of operation by MOE Ontario:
- costs have been reduced by 50%;
- full time labour has been discontinued;
- in 2004-2005 (this year) on site presence during operations (normally at night) totalled less than 4 hours out of nearly 900 hours of operation, some 0.4% of the time;
- no chemicals, floccing agents or disinfectants were used;
- the process is fully automated with full remote control, even from Iqaluit.

We would suggest the opposite statement is more accurate, "the EVC* system is easier to operate than a lagoon system". It is certainly less expensive, all the while being a far better performer.

7.1 Operating Time

"Lagoon and pumping system to move sewage would be operating 24 hours per day". NWC agrees. That is the "nature of the service". However, the Earth Tech system proposed, without standby equipment, if experiencing difficulties, is not as forgiveable as the proposed NWC EVC* system, which will not bypass or discharge raw sewage.

7.2 Chemical Floccing

EVC* requires no chemicals, no disinfection.

7.3 UV Disinfection

UV disinfection is not required.

7.4 Odours

a) Pumping stations do not "generate" odours as residual wastewater in a pumping station does not reside in the station long enough to become septic and thus generate odours. Some odours can be detected in a properly managed pumping station, but they should be managed by proper level control, exchange and venting.

b) The EVC* system significantly contributes to odour generation reduction by emptying lagoons below ice formation over lagoons. Ice coverage makes a lagoon a completely anaerobic cell generating excessive odours due to NH_3 and H_2S, CH_4, etc. By pumping down volume of wastewater below the "ice coverage" during the winter, these odour generating conditions are alleviated.

7.5 "Honey Wagons"

It is proposed by NWC that the "honey wagon" loadings be discharged directly to the existing lagoon as is done at Wetsport. This is approved by MOE Ontario to a maximum dilution by volume of 2% septage. NWC has no problem with this Iqaluit comment.

7.6 Monitoring

The EVC* system does not require an operator. It is a fully automated plant. It can be run remotely where internet facilities can be accessed by NWC exclusive software.

Full database readings are accumulated 24 hours per day, 365 days per year. Such a database is accessible at any time.

8.0 Operating Costs

EVC* costs $350,000 per year, maximum, all costs included.

8.1 Labour Costs

As noted above, incremental as maintenance costs only.

8.2 Power Costs

A total of $285,000 to $300,000 per year, based on maximum operation at $0.27/kW-hr.

8.3 Heating Costs

Heat release from system drivers averages some 350,000 Btus/hour, 30% heat losses due to motor operations of average 350 kW-hrs/hr.

This heat release reduces heat requirements for the machinery room, generating significant savings.

8.4 Filters

Filters are not required except at the lift station to remove **readily identifiable objects** in wastewater and septage.

8.5 Sludge Removal

As chemical floccing is not required by the EVC* system, "sludge generation" is greatly reduced. NWC references its response to 1(c), page 1 of these responses and comments.

With this type of community (ies), minimum industry solids generation is an average of 0.2% to a minimum of 0.15%. Again, this type of community contributes up to 90% of volatile solids loss, leaving 10% of 0.2% of solids.

To NWC, "cautious" design allows some 1,100 to 1,200 m^3 solids generation per year. With 90% volatile solids, biodegradation of 90% of solids reduces solids to non-biodegradable grit, 10% of solids to 15% maximum. 135 m^3 to 165 m^3 per yer out of current generation of 547,500 m^3 wastewater total volume.

Earth Tech projects half this volume, a calculation that is somewhat aggressive but is in the "ballpark". We have no concern as NWC number is conservatively double Earth Tech's for grit production.

Based on NWC estimated for grit production, IF the Iqaluit lagoon is 2.5 hectares or 6.2* acres, grit build up over 20 years would be 120 mm (12 cms or 4 ¾ inches), representing 5% of the lagoon volume on an assumed bottom area of 2.5 ha or 6.2 acres.

* Subject to verification of existing lagoon volumes.

9.0 Use of Pre-Existing Facilities

NWC does not concur at this time that new lagoons and pumping systems are needed. Earth Tech's report does not quantify the existing lagoon volume.

NWC has not indicated the required volume, which NWC anticipates is less than Iqaluit's assumptions based on Iqaluit's error in assuming a biological role for lagoons on wastewater treatment (see response to 6.1).

Respectfully submitted,

NORTHERN WATERTEK CORPORATION

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JAW/lp

D. Huber