Response to Comments

The following comments were received from Jennifer G. Feder on behalf of Zenon Corporation:

Ms. Feder submitted the following general comment in response to EPA's Public Notice 98-21:

> "The equivalency test program was grossly incomplete and is deficient in many areas. As such, it did not provide enough substance for complete evaluation of equivalency"

EPA's Response:

Prior to this study, NYCDEP attempted to show equivalency with studies performed at Brewster NY in 1994, Delhi NY in 1995, and Stamford NY in 1996. Both EPA and the NYSDOH were actively involved in the review and critique of these efforts. In fact, the protocol developed for this study is based on the "lessons learned" from this previous work. Also, in response to NRDC's suggestion, the EPA agreed and conducted a peer review of this study including its decision on equivalency. The peer review panel consisted of national experts from EPA's Office of Research and Development in the areas of microbiology, engineering (filtration design), statistics, and quality assurance/control. The reviewers had no prior involvement with this study and in no way benefit from its outcome. This review was set up consistent with EPA's Peer Review Handbook (1998) and was run concurrently with the Public Notice process. The peer review concluded the following:

- "The protocol used in this study has addressed the deficiencies in the studies previously conducted by the NYCDEP, and the statistical analysis of the results from both treatment units (CBUDSF and microfilter) appears to be appropriate. The data comparing the performance of the two treatment systems are reasonable and, in our opinion, have yielded meaningful results."

- "Based on the information presented, we believe there is adequate justification for EPA Region II to announce its intent to approve CBUDSF as equivalent to microfiltration. The test results support the application of this technology in the New York City Watershed for minimizing the discharge of Cryptosporidium via treated wastewater. We believe (based on the data presented) the CBUDSF system is equivalent to microfiltration for the purposed wastewater application."

Other comments submitted by Ms. Feder on the technical aspects of the study included:

1. CBUDSF is dependent on the addition of coagulants in order to maintain optimum performance whereas microfiltration is not.
2. Long-term performance of CBUDSF technology was not demonstrated.
3. Temperature effects on CBUDSF performance were not demonstrated.

EPA's Response:

Please see EPA's response to comments by NRDC, US Filter, O'Brien and Gere Engineers, Inc. and Dr. James P. Malley, below, where all of these comments have been addressed in detail.

The following Comments were received from the Natural Resources Defense Council (NRDC):

Comment 1:

The two systems were not stressed enough to produce a difference.

Response:

Approximately 320,000 cysts/100 L for 100 minutes were measured entering the two filtration systems under steady state conditions. This loading is far greater (approximately 2 to 3 orders of magnitude greater) than the background loadings cited in literature for residential effluent from wastewater treatment plants. Under these highly stressed conditions, no statistically significant difference in effluent concentrations from the two treatment systems were observed.

Comment 2:

The hypothesis has not been demonstrated conclusively because it was biased towards acceptance by the lack of (oo)cyst detection in the effluent.

Response:

Every effort was made to enhance the detection of (oo)cysts in the effluent samples. The average level of detection was < 0.3 (oo)cysts /100 L. This detection limit is much lower than the < 1.0 (oo)cyst/100 L detection level typically found under EPA's approved ICR method. To achieve the equivalency study's low detection limit, the ICR method was made more sensitive with the use of absolute pore size (Nuclepore #641505) collection filters instead of the nominal pore size collection filters specified by the ICR method. The Nuclepore filter had an absolute pore size of 1 micron whereas the nominal pore size collection filters include a range of pore sizes, some as high as 5 microns. In addition 100% of the pellet was examined instead of the 5%-10% typically examined under the ICR method. Examination of the entire pellet eliminated the error associated with extrapolating from a portion of the pellet.

Comment 3a:

Coagulant addition is included in the CBUDSF system.

Response:

Both the CBUDSF and the Microfiltration systems were operated under strict compliance with the manufacturer's recommended standard operating procedures. Coagulant addition is an integral part of the CBUDSF sand filtration operation.

Comment 3b:

Optimization may not be possible at WWTPs with different water quality.

Response:

Optimization is possible using standard engineering procedures for floc removal (e.g., jar tests). In addition, Delaware Engineering has established an optimization procedure that uses real-time effluent particle count data. This procedure will be reported in a separate document which addresses the performance of the systems with respect to other water quality parameters, as well as the operation, maintenance and cost of the two systems at the Stamford WWTP.

Comment 4a:

Recovery of (oo)cysts was not reported. It may be from 5 to 70 percent. Therefore the units did not provide 7-log removal.

Response:

The best estimate of the recoveries of (oo)cysts was approximately 53% for *Giardia* and 65% for *Cryptosporidium*. This is based on the Lab's recovery performance determined through the ongoing ICR lab approval program plus the additional recovery of approximately 10% as a result of the improved capture of (oo)cysts with the use of absolute pore size filters. The recovery improvement with absolute pore size filters was demonstrated by a previous study.

Overall, these recovery estimates are conservative since they do not include the additional recovery improvement expected with evaluating 100% of the pellet. As previously mentioned, examination of the entire pellet eliminated any error associated with extrapolating from a portion of the pellet.

The impact of the recovery loss is minimal on the log removal reported (7.0 log) for the two systems. The efficiency of recovery is similar for both the influent and effluent sample analyses and is applied to both systems when calculating the log removal. In addition, there is evidence to support the hypothesis that there was virtually no difference in the efficiency of recovery of (oo)cysts between the systems (as discussed in the next response).

Comment 4b:

The recovery efficiency of the CBUDSF system could be reduced due to the addition of coagulant and, therefore, may be different from the recovery efficiency for the Microfiltration system.

Response:

If the use of coagulant in a treatment process affected the analytical test for (oo)cysts, this would be a significant concern to EPA's Information Collection Rule (ICR) program since many water treatment plants use coagulants in their processes. Based on a discussion with Dr. Frank Schaefer from EPA's Office of Research and Development (Cincinnati, Ohio), the use of coagulants has not been an issue of concern within the ICR program. It is believed that the coagulant is removed in the reject stream. Dr. Schaefer stated that coagulant in the effluent would likely result in larger pellet sizes and noticeable differences during microscopic examination. Pellets generated during this study were consistently the same size (approximately 0.5 ml) without any noticeable microscopic differences, regardless of the treatment system with which they were associated.

The coagulant used in this study was the inorganic polymer (PASS). Unlike other coagulants (e.g. Alum or PAC), PASS is neither temperature or pH dependent and during cold weather operation is used at a significantly lower concentration, typically half of the traditional coagulant process. Furthermore, the biological oxygen demand (BOD) levels in the effluent from the CBUDSF system were consistently low (0.2 mg/l). The presence of PASS in the effluent, would have produced high BOD levels. In fact, there was slightly less BOD found in the CBUDSF system effluent than the Microfiltration system effluent which exhibited a BOD level of (0.4 mg/l).

Comment 5:

The results provide no information on the long term performance of either system.

Response:

The operational period ran from May 1, 1997 through October 27, 1997, approximately 6 months. This testing period was long enough to capture the extremes of wastewater temperature (10°c to 22°c), including warm sewage during late summer and cold sewage during early winter. Stamford is located at a relatively high altitude and experiences very cold temperatures by late October. Six months was the time period necessary to perform the multiple test runs required for a rigorous statistical data analysis, as determined by EPA's statistician. In addition, as noted in EPA's cover letter on equivalency, NYCDEP has agreed to perform long-term, pathogen monitoring at a

number of to-be-selected wastewater treatment facilities.

Comment 6:

The Microfiltration unit appeared to have a high rate of defects.

Response:

The manufacturer's technicians for the Microfiltration unit believed that the O-rings for one module was defective during the first three tests. Defects on the integrity of the Microfilter membranes is determined through the use of a pressure hold test which is part of the standard operating procedures. Based on the pressure hold tests conducted during the first three challenge tests, the membrane was intact, however, the technicians believed noise and air bubbles observed in the manifold indicated a leaky O-ring. The "16% defective rate" noted in the comments was only present during the first three tests (25% of the study period). Using the same calculations, the defective rate was only 4% for the whole study period. Due to the leaking O-ring, the data generated by the microfilter over the first three tests were not included in the statistical test for equivalency. Interestingly, the inclusion of the first three test results would have added even more statistical confidence to the equivalency determination.

Comment 7:

Average Microfiltration effluent levels for (oo)cysts were 0.009/100L and were 2.2 times higher for Giardia and 3.7 times higher for Cryptosporidium when using the CBUDSF system. This was shown to be insignificant due to the variability of the test.

Response:

Although the CBUDSF effluent mean concentration was 2.2 times greater for *Giardia* cysts and 3.7 times greater for *Cryptosporidium* oocysts, the actual differences in concentration between the two systems were very small (a difference of 0.011 *Giardia* cysts per 100 liters and 0.025 *Cryptosporidium* oocysts per 100 liters). This equates to a difference in means of 1.1 to 2.5 (oo)cysts per 10,000 liters. Indeed, the statistical tests showed these small differences to be statistically insignificant, given the variability of the effluent concentration measurements. More importantly, the variability of the effluent concentration measurements was small enough that the power requirement for the test was achieved, as explained in Section 5.6 of RTI's report.

Comment 8:

Figure 3.10 on pg. 19 of the Protocol document shows a 1,000 fold difference in the recovery of the two methods used in the study. This implies that the log reduction could be as low as 2.

Response:

As stated in the caption for the figure, the difference in recovery was between the filter concentration method used on influent samples from a previous study and the direct count method from the influent of this study. Since the influent was highly concentrated, (oo)cyst recovery was more efficient when analyzing the samples without the introduction of the known losses associated with the ICR analytical method. Conversely, since the effluent samples were highly dilute, similar to finished water, the filter concentration method was the preferred method. One of the most important findings in the development of the protocol is that the recovery efficiency of a method can be dependent on the (oo)cyst concentration of the sample. The figure in question provides evidence that the filter concentration method used in previous studies has poor recovery with samples that are already highly concentrated with (oo)cysts.

Comment 9:

Where is the breakthrough curve for microfiltration? Microfiltration had a storage tank and may have had different hydraulics.

Response:

A breakthrough curve for microfiltration was not developed because, based on dye tracer tests, it was expected that the retention of (oo)cysts would be under two minutes. Retention of (oo)cysts within the tank was minimal since the injection of (oo)cysts was within 5 cm of the outlet of the breaktank. One of the protocol's sampling objectives was to sample the effluent of both systems under steady-state spike challenge conditions. Therefore, the focus of breakthrough timing was on the CBUDSF system, since it had a retention time much greater than that of microfiltration.

Comment 10:

The breakthrough curve shown in Figure 3.12 shows a level of breakthrough equivalent to 4 log removal. This conflicts with the 7-log removal reported.

Response:

For the specific purpose of generating a breakthrough curve, the CBUDSF system was subjected to an extremely concentrated dose of one hundred million (oo)cysts within two minutes. It is possible that the log removal efficiency of both units is lowered when subjected to such a (oo)cyst load. For the purpose of the equivalency study, however, the two systems were subject to thirty three million (oo)cysts over 80 minutes. In the study, the two systems were subject to similar test conditions (including identical spike challenges) which were repeated over 12 trials. It was under these conditions that 7-log removal was calculated. Again, it is important to note that, while absolute log removal is an important consideration, the primary objective of the study was to determine the equivalency of the two systems. In addition, whether dosed with one hundred million (oo)cysts within two minutes or thirty three million (oo)cysts over 80 minutes (used in the study), these concentrations of (oo)cysts are far greater than those expected to be seen in WWTP effluent during a disease outbreak.

The following comments were received from the Riverkeeper:

Comment 1:

Equivalency should consider the needs of each system including equipment, operation, raw materials and waste disposal.

Response:

We agree that there are many factors to consider in the decision making process. These factors may vary with wastewater treatment plant based on site-specific conditions. However, it is important to emphasize that the focus of EPA's determination is one of technical equivalency. Assuming a level "playing field" (i.e., removing other factors from consideration), on technical merits alone, were the systems equivalent? Because of the public health issue regarding the potential release of cysts and (oo)cysts from wastewater treatment plants (WWTPs) into the watershed, EPA's primary objective going into this evaluation was to compare the treatment removal efficiency of the two technologies and base the equivalency determination solely on cyst/oocyst removal performance. If the treatment systems are determined to be technically equivalent, then other considerations (e.g. operation and maintenance, resources, waste disposal, and human resource needs) should be - and are expected to be - added to the evaluation. In fact, along with the equivalency study, the City performed an additional study to evaluate the factors you mentioned. Those results will aid the City

in evaluating which system should be installed at each location.

Comment 2:

The human element must play an important role in deciding which treatment system to install. Consideration must be given to operator friendliness, complexity and frequency of maintenance.

Response:

We agree. Again this is an important issue which will be assessed on a site-specific basis. Please see our response to Comment 1, above.

Comment 3:

Provide specific data on backwash quality. This information would greatly improve the reliability of the analysis and their statistics.

Response:

During the development of the testing protocol, the City, in consultation with EPA and NYSDOH, decided that since the equivalency determination will ultimately be based on the quality of the effluent of the two systems and not the backwash, a full data set was not collected for the backwash stream. EPA believes that quantitative backwash data is not necessary to make a equivalency determination. However, some backwash samples were collected to confirm **qualitatively** that large numbers of (oo)cysts were being captured by the filters. This was confirmed, but, because the data is qualitative, a quantitative analysis such as a mass balance using the backwash streams was not performed.

The following comments were received from U.S. Filter:

Comment 1:

The pathogen study appears to have been thoroughly conceived and implemented and the data analysis and report seem to be comprehensive.

Response:

No response necessary.

Comment 2:

The removal efficiencies reported for the dual sand filters were achieved with the coagulation process optimized. The loss of proper coagulation would result in the undetected discharge of *Giardia* and *Cryptosporidium*.

Response:

Refer to EPA's response to the Riverkeeper's comment 1 and NRDC's comments 3a, 4b. The coagulant used in this study was the inorganic polymer (PASS). Unlike other coagulants (e.g. Alum or PAC), PASS is neither temperature or pH dependent and during cold weather operation is used at a significantly lower concentration, typically half of the traditional coagulant process. Also, the EPA believes that reliable optimization of coagulant dosage for the CBUDSF system is possible using standard engineering procedures for floc removal (e.g. jar tests, turbidity monitoring, particle counters). The implication that the CBUDSF was operated with the benefit of optimum coagulant dosage during the challenge test only is incorrect. With the exception of one brief down period due to a lightening strike, both units were successfully operated on around-the-clock basis for approximately a six month period. The CBUDSF system was also challenged through a broad range

of temperatures (approximately 10°c to 22°c). Stamford is located at a relative high altitude and experiences colder temperatures by October.

Comment 3:

U.S. Filter by contract was given primary responsibility for operating the microfiltration system during the length of the pilot study and was required to visit the study site on a weekly basis. This amount of attention is outside the normal level of service required.

Response:

EPA agrees.

Comment 4:

The lower number of (oo)cysts in the sand filter backwash should be a point of concern. Adherence to the piping upstream may have resulted in a reduction of the loading seen by the sand filters. More importantly, adherence to the sand particles could result in accumulation and sloughing of (oo)cyst over long-term operation.

Response:

Refer to EPA's response to the Riverkeeper's comment 3. In addition, this study consisted of many (oo)cyst spike challenges over a five month period. If there was adherence of (oo)cysts to piping and sand it would be expected that an increase in (oo)cyst levels would be observed between the start and end of the testing (as (oo)cysts built up and then were released). This was not observed.

Comment 5:

U.S. Filter/Memcor's standard membrane integrity test (pressure hold test) is only used to estimate log removals of less than 4.5 to 5.0, although minor losses of membrane integrity can be detected with this test they cannot be accurately quantified. US Filter/Memcor can supply a more sensitive integrity test (diffusive air flow test) which can be used to quantify log removals of up to 7.0. As the study progressed, a diffusive air flow system was installed by the Memcor representative on the pilot test equipment but was not fully implemented by the Delaware Engineering (wastewater treatment plant operator).

Response:

During this study the microfiltration unit was operated by Delaware Engineering strictly in accordance with the Standard Operating Procedure (SOP) supplied by the manufacture. Since the SOP calls for the pressure hold test for testing membrane integrity, a decision was made to direct Delaware Engineering to use this test. Throughout the study the microfiltration unit met the membrane integrity test provided through the pressure hold test.

Comment 6:

The pressure hold test and other simple visual methods indicated that there was a minor loss of integrity on the microfiltration test unit that was never fully corrected. It was decided by NYCDEP that the equipment should not be modified as the test progressed because the pressure decay value published in the manufacture's operating manuals was not reached.

Response:

These observations were discussed among NYCDEP, EPA, NYSDOH, Memcor, and Delaware Engineering personnel. A decision was made not to modify the microfilter in the middle of the study since the unit was still meeting the membrane integrity test provided through the manufacture's SOP. Under actual (normal) operating conditions, a wastewater treatment plant (WWTP) operator would be using the manufacture's SOP for testing membrane integrity. Since the

membrane integrity test called for under the SOP passed and the microfilter was achieving greater than 6.0 log removals, the typical WWTP operator would not be expected to call for a more advanced test.

The following comments were received from O'Brien & Gere Engineers, Inc.:

Comment 1:

Equivalency of technologies is more far reaching than strict log removal. Equivalency of technology should also consider robustness of design.

Response:

Refer to EPA's response to the Riverkeeper's comment 1. Also the agencies involved in this study want to make it clear that they are not questioning the performance potential of microfiltration technology. The participants are very satisfied with microfiltration performance. This equivalency determination in no way implies endorsement for either of the technologies over the other. One technology may be more suited for a particular site due to other design or operational considerations. The choice is best left to the design engineer.

Comment 2:

Other robustness issues should be considered. In particular the inability of CBUDSF technology to handle variation in flow, seasonal temperature changes and CBUDSF dependence on chemical additives should be considered. [e.g. (a) Overdose of coagulant, (b) Underdose of coagulant, (c) Loss of coagulant feed, (d) Need for 24-hr attention.]

Response:

Many of the "robustness" issues raised in this comment were addressed in the pilot study. As noted previously (NRDC, comment 1), the two systems were subject to highly stressed conditions during multiple test runs over a 6 month period. They were also subject to a variety of wastewater temperature conditions (NRDC, comment 5). With respect to coagulant dependence, see EPA's response to NRDC's comments 3a and 4b and U.S. Filter's comment 2.

Comment 3:

Has consideration been given on how to acceptance test the CBUDSF at full scale installations without having to conduct challenge tests?

Response:

A combination of particle counters and turbidity monitors will be used.

Comment 4:

What exactly is being tested here for equivalency, CBUDSF systems in general or a particular vendor's system known as Dual Stage Dynasand?

Response:

In-series Continuous Backwash Upflow Dual Sand Filtration (CBUDSF), as a general technology, was evaluated in this equivalency study for removing *Giardia* cysts and *Cryptosporidium* oocysts from treated wastewater discharging in New York City's drinking water watersheds. The equivalency decision is limited to this wastewater application only.

Comment 5a:

It is not clear where samples were taken.

Response:

Refer to Figure 3.16 page 26 of the Protocol Document.

Comment 5b:

Is it possible that some removal at piping, valves etc. is not being subtracted out of the results?

Response:

This issue was addressed by NYCDEP and was tested on site while performing seed recovery studies by direct sampling prior to the actual start of equivalency testing. In addition EPA's peer review considered this question and concluded that "the protocol used in this study has addressed the deficiencies in the studies previously conducted by NYCDEP, and statistical analysis of the results from both treatment units (CBUDSF and microfiltration) appears to be appropriate. The data comparing the performance of the two treatment systems are reasonable and, in our opinion, have yielded meaningful results."

Comment 6a:

The NYCDEP Watershed Rules and Regulations require sand filtration upstream of microfiltration or an approved equivalent. Since CBUDSF is a coagulant based system, having a sand filter upstream could negatively impact coagulation performance.

Response:

The original intent of requiring sand filtration prior to microfiltration was to make sure total phosphorus limits contained in the revised SPDES permits were met. Since CBUDSF technology by definition meets the requirements for sand filtration, and will meet the total phosphorus limitations, sand filters prior to CBUDSF will not be required.

Comment 6b:

Without upstream sand filters could CBUDSF achieve total phosphorus and *Giardia* cyst and *Cryptosporidium* oocyst removals in due consideration of robustness issues?

Response:

Yes, the phosphorus data gathered during this study showed excellent performance out of the CBUDSF unit. In addition, NYCDEP has established a procedure that uses real-time effluent particle count data that will optimize the performance of the CBUDSF.

Comment 7:

On page 20 of the protocol development document there is a discussion of time of travel. Generally speaking, challenging the CBUDSF with massive concentrations of seed over a short period of time, resulted in Giardia and Cryptosporidium breaking through. Why?

Response:

The study was designed to cause breakthrough. The concentrations used were unrealistically high for this purpose. Time of travel tests were performed to determine the location and best timing to capture contaminants in the effluent. The equivalency tests were done with concentrations and feeds that would represent concentration of oocysts that might be expected during a major outbreak. Also refer to EPA's response to NRDC's comment 10.

Comment 8:

Based on the following three issues it is difficult to conclude that the CBUDSF system is

equivalent to membrane filtration for parasitic cyst removal: First, the definition of equivalency used by the study is problematic; second, is CBUDSF's reliance on optimal coagulant dosage in order to prevent break through; third, EPA's report stated that the mean concentration of *Giardia* cysts and *Cryptosporidium* oocysts were 0.009 per 100 liters for the microfilter, and runs 0.020 *Giardia* cysts per 100 liters and 0.034 *Cryptosporidium* oocysts per 100 liters for the CBUDSF - clearly not equivalent.

Response:

Issue 1: EPA's primary objective going into this evaluation was to compare the treatment removal efficiency of the two technologies and base the equivalency determination solely on cyst/oocyst removal performance. Assuming a level playing field (i.e. removing other factors from consideration) were the systems technically equivalent? A comparison of log removals to show equivalency is consistent with EPA's Enhanced Surface Water Treatment Rule (ESWTR) requirements for *Giardia* cyst removal. As this study's protocol was being developed, it became clear that when using massive influent loadings of cysts, a test based solely on the difference between influent and effluent concentrations would end up being a measurement of the inherent variability among the influent concentrations to each system - clearly not the objective of the study. The study was designed, therefore, to ensure that influent loadings to each system were as equal as possible. Thus the log removal differences, and ultimately EPA's technical equivalency determination, were based on differences in effluent concentrations only.

Issue 2: Please refer to EPA's response to U.S. Filter's comment 2.

Issue 3: Please refer to EPA's response to NRDC's comment 2.

The following comments were received from James P. Malley Jr., Ph.D.
Associate Professor of Environmental Engineering
on behalf of Zenon Corporation:

Comment 1:

I think the team did an excellent job addressing many of the problems associated with challenging pilot systems and I professionally commend them all.

Response:

No response necessary.

Comment 2:

I have a practical problem with the assertion that both systems provided consistent (oo)cyst removal of approximately 7 logs. In reality the best these data can show is that the systems removed about 3×10^5/100 L to 3.36×10^5/100 L. Clearly these are still excellent removals.

Response:

EPA's log removal calculations are all based on measured influent and effluent concentrations. In fact, the recovery efficiency of the (oo)cyst measurement technique is conservatively estimated to be about 55 to 65 percent. Given the fact that both systems received massive (oo)cysts influent loadings, both units exhibited outstanding results. That no statistically significant difference in effluent concentrations from the two treatment systems were observed, attests to the power of the equivalency study.

Comment 3:

It remains clear from the data set presented that comparable log removals were achieved by both systems. However, it is not clear from the data set what kind of dilution of the influent cyst concentrations occurs in the CBUDSF system as it goes through its cycle of continuous sand washing. How much of this filtered water actually entered the system during the 100 minutes of (oo)cyst spiking and did it have any effect?

Response:

Since filtered water is not used for the CBUDSF continuous backwash cycle, no dilution of the influent (oo)cyst load occurred. The continuous backwash cycle is performed using raw water only.

Comment 4:

The biggest failing of the equivalency testing is that it makes no mention of the fact that the CBUDSF performance will be totally dependent upon proper coagulation whereas microfiltration efficiency clearly is not dependent upon this. Over time, this will result in less reliable operation of the CBUDSF system compared to microfiltration.

Response:

Refer to EPA's response to the Riverkeeper's comment 1, NRDC's comments 3a, 3b, 4b and US Filter comment 2. Also, individuals involved in this study had sufficient experience, information and knowledge about filtration methods and moving bed sand filters to realize that the operational needs of each removal technology are different. Other operational factors (e.g. the human element), although not considered part of this study, must be and will be considered on a site specific basis when selecting the appropriate technology.

Comment 5:

It is fundamentally impossible for me to understand how the CBUDSF could always have lower effluent (oo)cyst counts than the microfilter. It makes me wonder if there is a systematic problem with the data such as an unaccounted for dilution effect with the CBUDSF or if the microfilter system was actually not operating in an optimal mode. This only becomes a significant problem if there was some systematic error in the CBUDSF data like dilution.

Response:

First, the CBUDSF did not "always have lower effluent (oo)cyst counts than the microfilter." In the vast majority of runs, (oo)cysts were not detected in the wastestream from either system. However, in a couple of test runs an (oo)cyst was detected in the CBUDSF while not in the microfiltration system. (The opposite was also found.) Once again, it is important to note that with the initial massive loading and the very low concentrations detected in the wastestream from both systems, these differences were determined to be statistically insignificant.

Regarding the dilution issue, as stated in EPA's response to comment 3 above, there was no dilution effect seen in the CBUDSF data. Although there were differences in the effluent data, as exhibited by different means, the study showed these differences to be statistically insignificant with a 90% certainty. This was due to the care taken in the designing and performance of this study. Also, remember that both technologies were operated in strict conformance with the manufactures' Standard Operating Procedures and both showed outstanding removals. Although the study participants are satisfied with the performance of both technologies we fully recognize that one technology may be more suited over the other for a particular site due to design, operation, and maintenance considerations. These choices are best left to the design engineers, and the City and

State which will be responsible for approving the final designs.