Report to

St. Lawrence County Board of Supervisors
and Bion Technologies

on the

Probability of Nuisance Odors from the Proposed Feeding Operations of Bion Technologies

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INTRODUCTION

Bion Technologies is proposing the construction of integrated facilities to produce ethanol and beef cattle in St. Lawrence County with a minimum of discharges and maximal use of the energy and materials used as input to the various components of the project. In particular, the wet residual fermentation mash that is the byproduct of the ethanol production will be fed to 84,000 beef cattle, the manure residuals of which will be used as fuel for the process heat required to ferment and distill the ethanol. The outline of this project is provided by the Bion Technologies Executive Summary that is provided as Appendix 1 of this report.

The 84,000 cattle are proposed to be divided into groups of 14,000 that will be housed and fed in 6 feeding operation units that will be located with an average distance of 10 miles from the ethanol plant. At this time, the actual sites of these feeding operations are unknown, thus we will need to evaluate a generic plan for each of the feeding operation sites.

The conceptual framework for each of the six feeding operations is outlined in Appendix 2, provided to us by Dr. James Morris of Bion Technologies. The general framework is a central core of 4 barns, each of which will be 2 acres in area and house 3,500 cattle. These barns will be distributed around the Bion Technologies proprietary bioreactor system. This system will treat the waste to produce dried bricks of the large solids that will be trucked back to the ethanol plant, consolidate the nutrients into the fine solids such that they can be used as fertilizer, and the water will be dispersed into a constructed wetland/agricultural zone surrounding the feeding operation facilities as shown in Figure 1 (taken from Appendix 2).

The purpose of the consulting contract to Drs. Hopke, Grimberg, and Rogers was to evaluate the probability of nuisance odors arising from a feeding operation as planned and to report to the County and Bion Technologies if the current design would likely lead to complaints of odors. Odor is not currently regulated, but would produce local dissatisfaction with the site selection and operation of the feeding operations. Thus, we have endeavored to evaluate the generic design recognizing that site specific designs might have quite different configurations as noted in the document in Appendix 2.

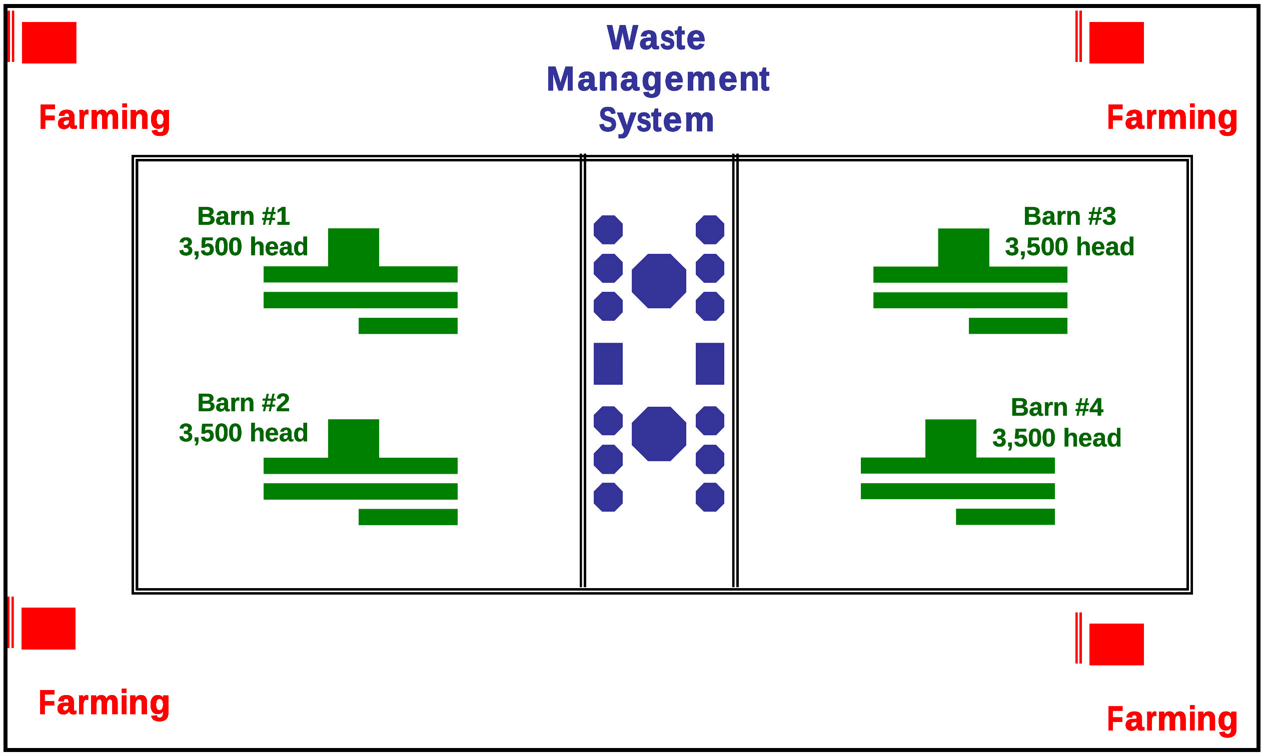

Figure 1. Schematic diagram of one of the six generic cattle feeding operations to be constructed.

APPROACH

Our approach to estimating the likelihood of nuisance odor complaints arising from one of the animal housing facilities was to utilize the OFFSET (Odor From Feedlots Setback Estimation Tool) tool developed by Larry Jacobson, David Schmidt, and Susan Wood at the University of Minnesota (Guo et al., 2005; Jacobson et al., 2005). OFFSET is a simple tool designed to help answer the most basic questions about odor impacts from livestock and poultry facilities. It is the result of four years of extensive data collection and field testing in which odor measurements were taken downwind from Minnesota farms raising different livestock animals and poultry. Odor measurements were taken during different climatic conditions relevant to Minnesota, and the detection of odiferous compounds related to the types of farms including animal and manure management practice as well as distance downwind from the farm. To use the OFFSET tool, information on the layout of a farm operation and manure management are entered into a worksheet, and then a "total odor emission factor" is calculated. This factor can be used to estimate the separation distance needed such that the air at a downwind neighbor is 91%-99% "annoyance free". Annoyance free is defined as air in which the odors associated with the farming operation are "a 2 or less on a scale of 0-5," with 0 being no smell, 2 being "weak or mild odors that are not likely to be annoying", and 5 being most offensive. Therefore, a distance associated with 98% annoyance free air means that 98% of the time the odors from the facility will be weak or mild at that distance downwind the facility. It needs to be emphasized that the system will not be odor-free 98% of the time, but the odor will be deemed to be tolerable. In addition Stowell et al. (2007) assess measures of odor with annoyance in a field study and found that prediction of annoyance depended on the extent of annoyance to be considered. They found that a level of 1 did result in reported annoyance, but not sufficient to alter activities and where there was only short-term recall of the event. A level of 2 was associated with alteration of the individual's routine or activities in order to reduce exposure, and some memory of the event will persist after the event has ended. There was a range of sensitivities for different individuals so more sensitive individuals can be affected at lower odor levels.

Nimmermark et al. (2006) recently evaluated the OFFSET tool, making a comparison between predicted and observed odor intensities at 20 neighborhood residences in the vicinity of seven various livestock farms in five different Minnesota counties. Observations by neighborhood monitors suggest that the OFFSET-predicted separation distances for annoyance-free frequencies of 99, 98, 97, and 96% are sufficient to result in minimal odor issues. The observations additionally indicate that predicted distances to obtain 94 and 91% annoyance-free frequencies may be large enough for some farms, but for other farms, greater distances may be needed. They concluded that odor emission rates used in the OFFSET model seem to describe the average emission fairly well for many odor sources, but improvement may be needed for some types of sources.

OFFSET has been compared with a number of other odor estimation tools (Chaoui and Brugger, 2007) and found to produce setback distance estimates that are in middle of the range of values produced from the 5 models tested.

OFFSET is designed to estimate average odor impacts from a variety of animal facilities and manure storage approaches. The authors indicate that using this tool in other geographic areas should be done with caution. However, we anticipate that the climate of Minnesota has a great deal of similarity to that of St. Lawrence County, and thus this approach to odor estimation should be quite applicable to the problem at hand. Thus, this approach would appear to be an ideal method to evaluate these feeding operation barns.

The approach used in OFFSET is a simple spreadsheet as outlined in Table 1. The tool provides emission factors for animal housing facilities for different animal types with average management levels. For beef cattle, the standard emission factor is given as $4 \bullet ft^{-2}$. They also provide emission factors for various manure storage practices as shown in Table 2.

To calculate the Odor Emission Factor, the area of the facility is multiplied by the odor emission number for either the animal housing facility or the manure storage system, multiplied by the odor control factor and divided by 10,000. The effects of the animal housing facilities or the manure storage facilities can be reduced by the imposition of odor controls. Thus, the fourth column is a reduction factor (≤ 1) that represents the degree of control on the emission sources. These factors are given in Table 3. It can be seen that the highest control factor provided by the University of Minnesota OFFSET tool is 0.1. This odor control factor is achieved for a barn where 100% of the exhaust air is treated by a biofilter. Once the odor emission factor is calculated using the procedure outlined in Table 1, the tool provides a graphic analysis of the setback distance from the facility to achieve "annoyance free" air at the nearest downwind observer. This figure is reproduced in Figure 2. If 99% "annoyance free" air is desired, the setback distances will be described by the top line in Figure 2. As noted previously, the lines for the 96% to 99% annoyance free were found to be reliable (Nimmermark et al., 2006), but the lower lines were found to under-predict the required setback distances in some cases.

Table 1. Schematic of the OFFSET odor emission factor calculation.

Odor Source	**Odor Emission Number** (per ft^2)	**Area** (ft^2)	**Odor Control Factor**	**Odor Emission Factor**
Barn 1				
Barn 2				
Barn 3				
Barn4				
Bion Treatment Unit				
		Total Odor Emission Factor		

Table 2. Odor emission reference rates for manure storage facilities.

		Odor Emission Number (per ft^2)
Animal and Housing Type		
Beef Cattle	Dirt/concrete lot; Free stall, scrape	4
Dairy Cattle	Free stall, deep pit; Loose housing, scrape	6
	Tie stall, scrape	2
Manure Storage Type		
Earthen Basin (single or multiple cells)		13
Steel or Concrete Tank (above or below ground)		28
Crusted Stockpile		2

Table 3. Odor control factors.

Odor Control Technology	Odor Control Factor
No odor control technology	1
Biofilter on 100% of building exhaust fans	0.1
Geotextile cover (≥ 2.4 mm)	0.5
Straw or natural crust on manure	
4 inches	0.5
8 inches	0.3
Impermeable cover	0.1
Oil sprinkling	0.8

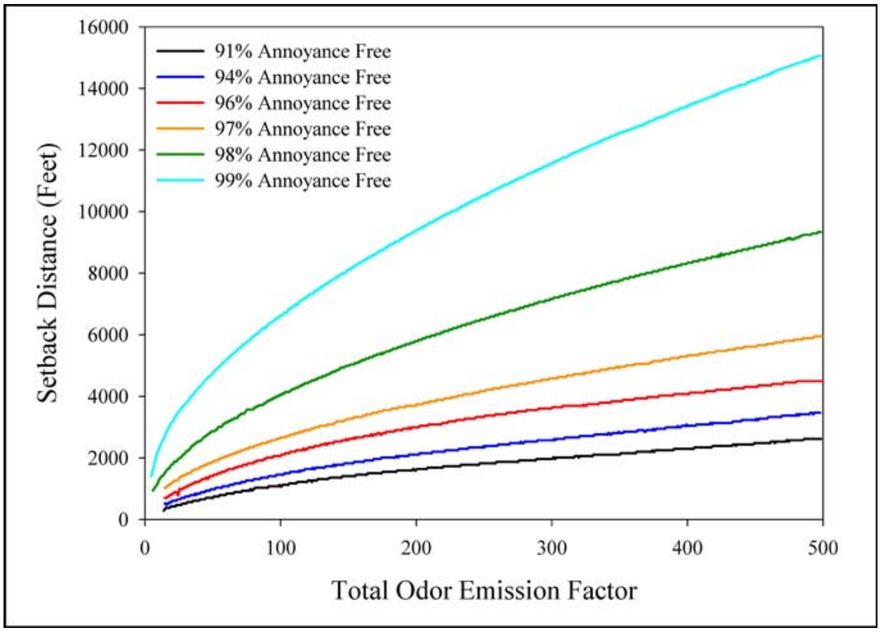

Figure 2. Estimated setback distances (in feet) needed to obtain different odor-annoyance free frequencies leeward of the prevailing wind director from the animal facility. Redrawn from the OFFSET tool booklet.

APPLICATION TO THE BION TECHNOLOGIES FACILITY

Bion Technologies proposes to regularly (at least three times per day) collect the manure from the pits under the slotted floors on which the cattle will stand. They are not planning on having manure storage, but rather the manure would be transported to a solids separator and a continuous bioreactor that would be processing the waste into the large solids, small solids and liquid residue. The emissions sources include the animal housing facilities (4 barns covering 2 acres each filled with 3,500 head of cattle) and their proprietary waste management system. Thus, we need to estimate the adjustments to emission and control factors that are applicable to the Bion facility. Since the specific sites have not yet been selected, the results presented below are for a hypothetical system. Nicolai (2004) suggests differences in the impact of the same odor emissions sources depending on the location within South Dakota. Similarly, Stowell et al. (2005) also showed that there were differences in the effects of sources depending on location within Nebraska. Thus, there is uncertainty in the specific values provided below. However, these results should provide reasonable initial guidance for expecting odor problems and providing suggested directions for their control.

Animal housing facilities: Odor emission number

At our request, Bion provided their review of the odor emissions that could be expected in the housing units. Accordingly, Bion estimated the effect of "frequent manure collection" to be equivalent to an odor control factor of 0.1 and that the slotted floor will yield an additional odor control factor of 0.1 (Appendix 3). In our estimation, there may be a significant reduction of odors caused by the frequent collection of manure through the slotted floor; however, there is insufficient data to support an estimate of greater than a 10-fold reduction in odors using this technology relative to a barn with regular manure scraping. Several farm managers have reported a significant reduction in odors using these barn configurations.

The slotted floor barn design with frequent manure collection was accounted for by adjustment (reduction) of the Emission Number within the OFFSET tool that describes the barn configuration (Table 2), rather than through the use of an odor control factor that describes technologies used for odor reduction (Table 3). Emission numbers for cattle range between 2 and 6 /ft^2 for standard animal housing facilities. Using a slotted floor design, manure is removed from the barn more rapidly compared to a free-stall barn (emission number 4/ft^2) or a tie-stall barn with regular scraping to remove the manure (emission number $2/ft^2$). Given the range of reported emission factors, we estimated the emission factor of the slotted floor barn to be $1/ft^2$. This is equivalent to the lowest odor emission factor listed for all animal types and housing configurations in the OFFSET tool, and is 50% less than the lowest listed odor emission factor listed for beef or dairy cattle.

<u>Animal housing facilities: Odor control factor</u>.

The current barn designs do not include control technology on the animal housing, but it would be possible to add controls. The animal housing facilities are enclosed spaces so it is possible to route the building effluent through control technology that would reduce the concentrations of odor components and hence the emitted odor potential. The maximum control level listed in Table 3 is 0.1 for the use of biofilters. It is possible to envision other potential control technologies that are commonly used to control VOC emissions from industrial operations. Such control methods include combustion and catalytic oxidation (Wark et al., 1998). Thus, there are options for reducing the emissions from the animal housing facilities that represent emission control factors in the range of 0.1 to 0.5 if odors are problematic. Because no odor control technologies are currently planned, we used an odor control factor of 1 (Table 3).

<u>Bion proprietary waste management system: Odor emission number</u>.

The OFFSET tool does not list odor emissions numbers associated with advanced waste management systems such as that of Bion Environmental Technology. Unfortunately, there is also a paucity of information in published literature on equivalent odor emission factors for these types of systems. We requested Bion to provide estimates of the odor emission and control that could be expected from their proprietary waste management system. Because they also lack specific information on the odor emissions from their system, they provided their best estimate, which was based on actual measurements of gaseous species emissions from their reactors. These emissions were compared to those of anaerobic lagoons treating similar waste streams published in the scientific literature for which information is readily available (Morris et al., 2007). Using this data set, they have estimated odor control factors relative to an equivalent anaerobic lagoon to be between 0.01 and 0.05 based on the assumption that odors generated would be similar to ammonia, hydrogen sulfide, and volatile organic compounds (VOCs), the three odiferous compounds present in the gas (Appendix 3).

As eluded to in Bion's response, use of data on the reduction of these specific gases to estimate reduction in odor is tenuous. Reports in scientific literature clearly show that perceived odors and measured *specific* gaseous compounds emitted by livestock facilities are poorly correlated at best. Odor issues are a complex interaction between hundreds of potential gaseous compounds, particulate matter, topography and site choices, moisture, atmospheric conditions, public perception, and more. However, it may not be unrealistic to assume that a large reduction in total measured off-gases across a variety of gaseous compounds is positively correlated to a reduction in odors that would be generated. The process clearly results in a net reduction of total problem off-gases, not just a single species.

We sought reports of real odor comparisons and odor emissions values in the scientific literature. Given the absence of data, we agree that the most practical approach to estimate the odor emission factor from the bioreactor is to (1) estimate the odor emission number for an anaerobic lagoon that would otherwise be designed to treat the equivalent volume of cattle manure, then (2) apply an odor control factor based on the reduction of specific gases emitted by the Bion Waste Management process relative to that hypothetical lagoon to arrive at an odor emission factor for their waste treatment process. Bion has provided actual measurements of the gaseous emissions from a Bion waste management system and summary data from several data sets in published scientific literature on gaseous emissions from anaerobic lagoons to facilitate an estimate of the odor control factor relative to an equivalent anaerobic lagoon.

It is important to note that there is no waste treatment lagoon planned for the facilities in question. The estimation of the size of the hypothetical "equivalent lagoon" is needed to the calculate the odor emission number, which will be used with the odor control factor estimated from published data on reduction in off-gases to arrive at an odor emissions factor for the Bion Waste Management System.

Equivalent lagoon design. To use the approach to estimate the emission of odiferous compounds from the Bion Waste Management system described above, the surface area of an anaerobic lagoon that would be used to store and treat the manure from an equivalent facility was estimated. To this end, we used the recommendations of three extension services programs: The University of Illinois at Urbana-Champaign (UIUC), Iowa State University (ISU), and Purdue University. For the lagoon design, a total of 14,000 beef cattle, 890 – 1000 lb. live weight, a single stage lagoon, and a 2.5:1 slope to the side walls were assumed. The average lagoon volume estimated from the three university extension services recommendations was used to obtain a range of surface areas that describe the equivalent lagoon by dividing by a range of lagoon depths commonly observed in practice (10-20 ft.). Design criteria of ISU and UIUC extension services allow for as much as a 25% reduction in the lagoon volume for solids removal prior to discharge to the lagoon. As such, the lagoon volume used for calculations varied between 75% and 100% of the design lagoon volume to get a range of estimates for the equivalent lagoon. The average volume of lagoon determined as described above was roughly $^1/_3$ that determined by multiplying the volume requirement for a 100 head beef cattle operation in Missouri by 140 (Univ. Missouri, http://extension.missouri.edu/explore/envqual/eq0387.htm).

In the OFFSET tool, earthen basins for manure storage of single or multiple cells are given an odor emission number of 13 / ft^2 (Table 2) Earthen basins are typically designed for manure storage without any treatment. As stated in the OFFSET manual, properly designed anaerobic lagoons may have far less odor than earthen basins. Unfortunately, odor emissions numbers for anaerobic lagoons for use in the OFFSET model do not exist in peer-reviewed published literature. The analyses of anaerobic lagoons by Koppolu et al. (2004) provide limited information.

South Dakota has modified the OFFSET model for use in estimating odors from livestock production facilities in their state. The South Dakota Odor Footprint Tool (SDOFT) uses the exact same framework as the OFFSET tool, except that they have used modified odor emissions numbers that are 4.84 ± 0.12 times larger than those reported in the OFFSET model, and have modified their relationship between the separation distance and total odor emission number accordingly. The SDOFT tool provides a separation distance estimate that is county-specific within the State of South Dakota. SDOFT lists the odor emission number for non-phototrophic anaerobic lagoons as 3 suggesting an odor emission number as low as 0.6 / ft^2 (=3/4.84) could be appropriate for use as an odor emission number in the OFFSET tool for well-designed anaerobic lagoons. Considering that anaerobic lagoons commonly encountered in livestock agriculture span a range of configurations that may or may not provide a high level of odor control, it seems reasonable to assume that the average odor emission number for anaerobic lagoons that would be encountered in scientific literature would be variable. On the low end, we estimate that the odor emission number would be 4, with odors approximately 1/3 that of earthen pit manure storage as listed in OFFSET (odor emission number of 13). On the other end of the spectrum, poorly designed or managed lagoons could produce odors equivalent to that of earthen pit manure storage. Therefore, as a conservative upper bound, we have assumed an odor emission number equivalent to 13 for the lagoon. Considering that we are using a properly sized anaerobic lagoon for comparison in this study that should result in odors on the lower end of this range (4-13), it seems appropriate to use an estimate of 6 for the lagoon odor emission number, approximately half that an earthen manure storage basin.

<u>Bion proprietary waste management system: odor control factor of the equivalent lagoon</u>.

As described in Morris et al. (2007), measured concentrations of ammonia, hydrogen sulfide and VOCs from the Bion waste management system were compared to measurements of these gases from anaerobic lagoons in published literature. Based on those measurements and reported values, a mass-weighted average odor control factor based on reduction in gaseous emissions from the Bion waste management system relative to anaerobic lagoons treating similar wastes was determined to be 0.034. Again, it should be noted that gaseous emissions and odors are not well correlated, however, this number will serve as the best estimate that we could generate with the limited data on odor emissions at hand. An odor control factor of 0.05 was used as a conservative estimate based on emissions for methane (Appendix 3). It should be noted that methane has no odor.

As indicated above, we are using a hypothetical lagoon to estimate emissions from the Bion waste treatment process. However, there is a critical difference between the lagoon and the actual treatment units that will be used. The Bion waste management system is an enclosed operation. The effluent gas stream can be subjected to end-of-the-pipe treatment similar to that described above for the animal housing facilities. Thus, if emissions from the process become problematic, there is the opportunity to treat the gaseous waste stream to reduce the emissions. It is likely that control technologies, if added, could provide additional odor control factors of the order of 0.1 – 0.5. Since these technologies are currently not planned, we did not include these additional odor controls in our base case estimates of the setback distances.

Impact of solids removal.

The above approach of assessing odor emissions from the Bion process using the OFFSET model compares the process at hand with a more traditional process assuming an effective control factor derived from actual measurements of one of the Bion facilities. At that farm, the Bion process removes approximately 50% of the total solids using a Houle Screen before entering the lagoon. Similarly, the proposed Bion process will employ a range of solid/liquid separation processes that may remove particulate matter. A reduction in total solids concentration of up to 50 % could be expected using a Fan or Houle separator (Gooch et al., 2005). Volatile solid reduction of similarly up to 60% could be expected with these processes. Adding additional unit operations such as centrifuges or hydrocylones will increase recovery of TS and VS, but will only marginally affect odor production potential. In addition, separated solids represent a potentially significant source of odor at the farm (BAE, 2007). Since solids separators will be housed in separate buildings, odor control systems can also be readily implemented.

Estimated total odor emissions.

In this analysis, the generic design provided by Bion that does not contain any additional emission control technologies will be analyzed. In a subsequent section, we will explore the effect of applying additional controls on the emissions on the level of odor problems that might be anticipated. Table 4 shows the model input parameters used to estimate OFFSET values for the conservative and optimistic cases as well as the values we feel may be more representative of the proposed system (central estimate). In this base case there are no odor controls on either the animal housing facilities or the waste management system sicne they were not included in the initial Bion design. The odor control numbers shown in Table 4 for the equivalent lagoon are to scale the odor emissions to estimate those of the Bion Waste Management system and encompass a range of values that represents the uncertainty in that estimate.

An example calculation using the values presented is presented in Table 5. In this calculation, the Bion Waste Management System is approximated by scaling the odor emissions that would occur in a hypothetical lagoon of 1,600,000 ft^2 surface area with an odor emission number of

6/ft^2 and an odor control factor of 0.034. Thus, the factors shown in Table 5 would provide a mid-range estimate of the odor emission factor expected to be realized from the facility.

Table 4. Modeling parameters for conservative, central, and optimistic OFFSET setback distance estimates for low odor problems at down-wind receptors.

Potential Odor Source	Parameter Estimate		
	Conservative	Central	Optimistic
Animal Housing Facilities			
Barn Size †, each (ft^2)	87,120	87,120	87,120
Odor Emission Number (ft^{-2})	2	1	1
Odor Control Factor	1	1	1
Bion Waste Treatment System			
(estimated relative to an equivalent hypothetical lagoon)			
Equivalent Lagoon Area (ft^2)	2,900,000	1,600,000	1,040,000
Odor Emission Number (ft^{-2})	13	6	4
Odor Control Factor	0.05	0.034	0.01

† Four barns at each facility are planned.

Table 5. Illustration of the use of the OFFSET tool to estimate the total odor emission factor.

Odor Source	**Odor Emission Number**	**Area (sq. ft.)***	**Odor Control Factor**	**Odor Emission Factor**
Barn 1	1	87,120	1	9
Barn 2	1	87,120	1	9
Barn 3	1	87,120	1	9
Barn 4	1	87,120	1	9
WM System	6	1,600,000	0.034	33
			TOEF	67

Estimated Setback Distances

The OFFSET tool is designed to estimate the setback distances necessary to reduce the probability of nuisance odor to given values. The plot in Figure 2 shows the probabilities of avoiding odor problems. It is important to note that we are not predicting that there will be no odor. It is highly likely that there will be a perceptible odor at the site boundary of the facility. The issue is whether the odor is strong enough to be defined as a nuisance odor and how frequently such odors will be present. Thus, a policy decision that will need to be made is the acceptable probability of nuisance odor occurrences. As indicated above, it is our opinion that values lower than 97% are likely to be unacceptable to the public.

Table 6 shows the estimated setback distances that would be required to avoid nuisance odors 96 – 99% of the time. The range of setback distances estimated reflects the level of uncertainty about the operation given its current state of planning. Figure 3 shows the proposed distances in this initial generic site plan proposed by Bion Environmental Technologies. As can be seen, the effective setback distance in this design is 1,150 feet. Based on our analyses shown in Table 6, it is likely that nuisance odors would extend across site boundaries at a rate greater than would be deemed acceptable by neighbors unless additional control technologies or greater setback distances were implemented. Increased setback distance can be achieved either by acquiring more land or through agreements with adjacent land owners.

Table 6. Estimated setback distances required to achieve various frequencies of nuisance odor avoidance.

	Estimated TOEF	**Minimum Separation Distance (ft)**			
		99%	**98%**	**97%**	**96%**
Conservative	258	10,800	6,600	4,200	3,300
Central Estimate	67	5,400	3,200	2,000	1,500
Optimistic	39	4,300	2,500	1,700	1,200

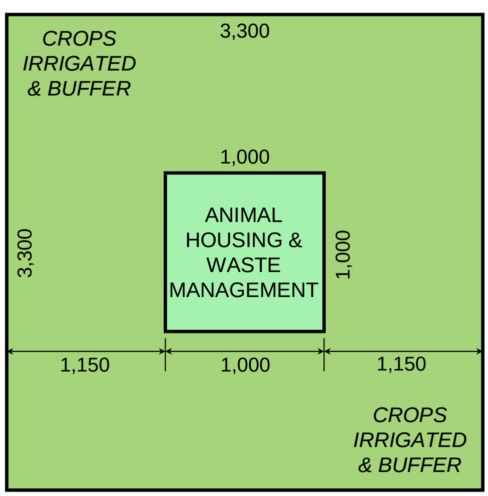

Figure 3. Proposed setback distances and configuration of the animal housing and waste management area relative to a hypothetical layout provided by Bion.

Other potential odor sources and controls

We have chosen to model the proposed facility based on processes for which we have data to estimate odor production. As eluded to in the prior sections, other potential odor sources may exist that were not considered due to lack of specific data. These potential odor sources may include transportation of cattle to and from the facilities, storage of manure and separated manure solids on site, the solids separation process, production, on-site storage, and transport of solids residuals for co-firing to provide energy input to the ethanol production facility or for fertilizers, potential odors from the constructed wetlands and irrigation fields (assumed small in comparison to those of this study), disposition of animal carcasses from animal deaths in the facility, and more. It is likely that these and other related sources will collectively contribute additional odors to the airshed that were not accounted for in the model as formulated here. As a result, the setback distances or levels of additional controls necessary to achieve low probabilities of nuisance odors may need to be raised to account for additional odors not considered in this model.

Similarly, careful consideration in site selection for the facilities and appropriate choices regarding external odor controls can reduce odor transport from the facility. Constructed windbreaks within the facility and tree lines can reduce odor transport from these operations. If these are not sufficient, the fact that these facilities are all within structures provides additional opportunities to control odors using biofilters, catalytic converters, or other end-of-the-pipe control technologies. As suggested before, these end-of-the-pipe technologies may offer odor control factors of 0.1 – 0.5 relative to the no odor control design considered in the prior section Table 7 provides the estimates based on the OFFSET control factor values obtained with readily available control technologies. . For example, if the barns and/or waste management units are equipped with the best control technology included in the OFFSET tool (biofilters on 100% of the barn air or on the waste treatment facility or both), the risk of odors can be reduced substantially (Table 8).

Table 7. Modeling parameters for conservative, central, and optimistic OFFSET setback distance estimates for low odor problems at down-wind receptors if odor control technologies are implemented.

Potential Odor Source	Parameter Estimate		
	Conservative	Central	Optimistic
<u>Animal Housing Facilities</u>			
Barn Size †, each (ft^2)	87,120	87,120	87,120
Odor Emission Number (ft^{-2})	2	1	1
Odor Control Factor with Emission Control Technology, such as:			
Catalytic emission control	0.5	0.5	0.5
Biofilter	0.1	0.1	0.1
<u>Bion Waste Treatment System</u>			
(estimated relative to an equivalent hypothetical lagoon)			
Equivalent Lagoon Area (ft^2)	2,900,000	1,600,000	1,040,000
Odor Emission Number (ft^{-2})	13	6	4
Odor Control Factor	0.05	0.034	0.01
Additional Odor Control Factor with Emission Control Technology, such as:			
Catalytic emission control	0.5	0.5	0.5
Biofilter	0.1	0.1	0.1

† Four barns at each facility are planned.

* Assuming catalytic emission control for each barn

Table 8. Estimated setback distances required to achieve various frequencies of nuisance odor avoidance if odor control technologies are implemented.

Odor control technology:	**Minimum Separation Distance (ft)**					
	Conservative		**Central**		**Optimistic**	
	99%	**97%**	**99%**	**97%**	**99%**	**97%**
Catalytic emission control or equivalent on:						
Barns only	9,900	3,900	4,700	1,800	3,300	1,250
Waste treatment house only	8,600	3,300	4,700	1,800	4,000	1,500
Barns and waste treatment house	7,500	3,000	3,900	1,400	3,200	1,200
Biofilters or equivalent on:						
Barns only	9,300	3,700	4,000	1,500	3,300	1,250
Waste treatment house only	6,500	2,500	4,200	1,550	4,300	1,600
Barns and waste treatment house	3,500	1,300	1,500	<1,000	1,200	<1,000

CONCLUSIONS

Given the range of behavior of the odor estimation tools that are available, we believe that the values presented here from OFFSET represent a realistic estimate of the odor potential. We again emphasize that the results presented here in terms of controls and setback distances will not achieve an odor-free condition. There is even significant uncertainty as to how low the odor level has to be in order to not cause annoyance. Thus, we are making best estimates with the data and tools that are available based on a generic layout and other assumptions that have been detailed in this report.

The acceptable frequency of nuisance odors at downwind locations is a policy issue that needs to be addressed by the appropriate authority such as the St. Lawrence County Board of Legislators in consultation with the public and other stakeholders. Based on our estimates of odor emissions, it appears that a facility can be constructed with a less than 3% probability of nuisance odors, but only with the addition of a combination of odor control technologies and/or greater setback distances than are currently in the generic plan for the facility. There is considerable uncertainty in the specific values of the setback distances as we do not have a specific site to evaluate or more details on odors emissions from the Bion Waste Management System process. It appears that application of odor control technology to the ventilation air from the animal feeding barns and/or the waste processing system will reduce potential odor problems substantially. Depending on the level of odor avoidance desired, choices of levels of control along with some additional land to provide adequate setback distances and good site selection can make the facilities feasible in regards to nuisance odor emissions.

REFERENCES

BAE, 2007; Biosystems and Agricultural Engineering , University of Minnesota Extension Program. http://www.bbe.edu/extens/faq/sol_liqfaq.html; accessed 10/4/07

Chaoui, H., Brugger, M., 2007 Comparison and Sensitivity Analysis of Setback Distance Models, International Symposium on Air Quality and Waste Management for Agriculture. ASABE Publication Number 701P0907cd, American Society of Agricultural and Biological Engineering, St. Joseph, MI.

Funk, T., G. Bartzis, and J. Treagust "Designing and Managing Livestock Waste Lagoons in ILlinois" Cooperative Extension Service, University of Illinois at Urbana-Champaign, Circular 1326. (http://www.ag.uiuc.edu/~vista/html_pubs?LAGOON/lagoon.html).

Gooch C.A., Inglis, S.F., and K.J. Czymmek (2005) "Mechanical Solid-Liquid Manure Separation: Performance Evaluation on Four New York State Dairy Farms – A Preliminary Report" Paper Number 05-4104, 2005 ASAE Annual International Meeting, Tampa, FL, 17-20 July 2005.

Guo, H., Jacobson, L.D., Schmidt, D.R., Nicolai, R.E., Zhu, J., Janni, K.A., 2005. Development of The Offset Model for Determination of Odor- Annoyance-Free Setback Distances from Animal Production Sites: Part II. Model development and Evaluations, Transactions of the American Society of Agricultural Engineers 48(6): 2269−2276.

Jacobson, L.D., Guo, H., Schmidt, D.R., Nicolai, R.E., Zhu, J., Janni, K.A., 2005. Development of the Offset Model for Determination of Odor- Annoyance-Free Setback Distances from Animal Production Sites: Part I. Review and Experiment, Transactions of the American Society of Agricultural Engineers 48(6): 2259−2268

Jones, D., and A.L. Sutton "Design and Operation of Livestock Waste Lagoons" Cooperative Extension Service, Purdue University, ID-120. (http://www.ces.purdue.edu/extmedia/ID/ID-120.html).

Morris, J.J., J. Northrup, G.W. Bloom, and S.J. Pagano 2007. Dairy Farm Atmospheric Emissions Control Using a Microaerobic Biological Nutrient Removal (BNR) Process. International Symposium on Air Quality and Waste Management for Agriculture, ASABE publication number 701P0907cd,

Nicolai, D. (2007) SDOFT: South Dakota Odor Footprint Tool. Available online at abe.sdstate.edu/wastemgmt/airquality_files/SDOFT.doc. 16pp.

Nimmermark SA, Jacobson LD, Schmidt DR, Gay SW., 2006. Predictions by the Odor From Feedlots, Setback Estimation Tool (OFFSET) compared with observations by neighborhood monitors, *Journal of the Air & Waste Management Association* 55 (9):1306-1314.

Stowell, R.R., Koppolu, L., Schulte, D.D., Koelsch, R.K., 2005. Applications of Using the Odor Footprint Tool, Livestock Environment VII, Proceedings of the Seventh International Symposium, 18-20 May 2005 (Beijing, China), ASAE Publication Number 701P0205. Ed. T. Brown-Brandl, American Society of Agricultural Engineers, St. Joseph, MI.

Stowell, R.R., Henry, C.G., Koelsch, R.K., Schulte, D.D., 2007. Association of Odor Measures with Annoyance: An Odor-Monitoring Field Study, International Symposium on Air Quality and Waste Management for Agriculture. ASABE Publication Number 701P0907cd, American Society of Agricultural and Biological Engineering, St. Joseph, MI.

Wark, K., Warner, C.F, Davis, W.T., 1998. *Air Pollution: Its Origin and Control*, Addison-Wesley, Menlo Park, CA.

Zhang, R., J. Lorimor, and S.W. Melvin (1995) "Design and Management of Anaerobic Lagoons in Iowa for Animal Storage and Treatment." Cooperative Extension Service, Iowa State University, Pm-1590, 10pp. (http://www.extension.iastate.edu/Publications/PM1590.pdf).

APPENDIX 1

Executive Summary
(June 6, 2006)

bion™

environmental technologies, inc.

Executive Summary
(June 6, 2006)
Introduction

Bion's patented technology provides a comprehensive environmental solution to the single largest segment of US agriculture, Confined Animal Feeding Operations (CAFO's)--dairy cows, beef cattle, swine and poultry. The technology is 'comprehensive' in that it surpasses current (as well as likely future) environmental regulations for polluting emissions to air and nutrient releases to water from livestock waste streams. Additionally, Bion's technology integrates ethanol and renewable energy production and utilization with CAFO's while reducing CAPEX and operating costs for the entire integrated complex.

The traditional business model for CAFO's, regardless of livestock type, has relied on a combination of: 1) a passive environmental regulatory regime, and 2) access to a relatively unlimited supply of cheap land and water to serve as the basis for '*environmental*'' treatment of animal waste. Such land and water resources have now become significantly more expensive while ongoing consolidation of the CAFO industry has produced a substantially increased and more concentrated waste stream. At the same time, regulatory scrutiny of, and public concern about, the environmental impact from CAFO's has intensified greatly.

Agricultural runoff is the #1 water pollution problem in the US. Over-application of animal waste to cropland has resulted in manure nutrients polluting surface and ground water systems, adversely impacting water quality throughout the country. Clean-up initiatives for the Chesapeake Bay and Great Lakes are spending billions of dollars to reduce excess nutrient pollution. In both cases, agriculture in general and CAFO's in particular have been identified among the main contributors of pollution. CAFO's are also significant emitters of pollutants to air, with dairies having been identified as the largest contributor to airborne ammonia and other polluting gases in the critically impaired region of the San Joaquin Valley.

Bion's technology enables increased herd concentration (a minimum of 3 to 5 times irrespective of species) that is economically and environmentally sustainable because the technology is a process control system which removes nutrients from the waste streams generated by animal operations while dramatically reducing atmospheric emissions. The resulting herd concentration is the catalyst that drives the entire Bion economic opportunity and results in a "core" Bion technology platform that integrates environmental treatment, renewable energy production and utilization with ethanol production.

Bion's technology platform and the resulting herd concentration, in turn, provide the opportunity to integrate a number of revenue generating operations while maximizing the realized value of the renewable energy production and co-generation potential for on-site utilization. The Bion model accesses diversified revenue streams through a fully balanced integration of technologies that provide a hedge to the commodity risk associated with any of the separate enterprises. The Bion integrated model will generate revenues and profits from:

- Ethanol production;
- Generation and onsite utilization of renewable energy with values maximized by eliminating transformation inefficiency, distribution cost and profit to the local utility;
- Waste processing fees;
- High-value organic fertilizer and/or high protein feed products;
- Permanently integrated utilization of the distiller grains by-product of ethanol production.

It is important to note that Bion's technology platform and its Projects (defined below) involve little or no 'technology risk'. Bion has proven the efficacy of its waste handling technology. The other integrated components---ethanol plant, methane digester, combustion and drying equipment, etc.---are all 'off-the-shelf', relatively 'low tech' technologies which do not pose any experimental challenges once properly sized, selected and installed. It is Bion's ability to integrate the component parts in a balanced proportion with large CAFO herds in an environmentally sustainable manner that creates this unique economic opportunity. Bion has a patent pending relating to the Bion integration model described herein.

This integration includes:

- An ethanol plant whose size is balanced to the feed requirements of the CAFO herd. Beyond the production of ethanol, the ethanol facility functions as:

    - A feed mill for the CAFO herd which utilizes the spent grain from ethanol production in its feed ration, materially reducing the operating expenses (energy and transportation), CAPEX requirements (dryers) and energy efficiency of ethanol production;
    - An end user of renewable energy in the forms generated on-site---methane and steam---without the inefficiencies and energy loss from conversion to electricity and sale to the local utility;
- A source of waste heat (which, if not utilized, increases ethanol production costs for required disposal) that is used to pre-heat the CAFO waste stream prior to anaerobic digestion and to maintain temperatures throughout the Bion system. In colder climates, additional uses of this waste heat can include heating the CAFO facilities; An ethanol plant whose size is balanced to the feed requirements of the CAFO herd. Beyond the production of ethanol, the ethanol facility functions as:
- Large scale generation of, and value capture from, renewable energy through:
    - Production of methane from livestock manure by anaerobic digestion which is utilized to dry: i) the cellulosic portion of the manure waste

stream in preparation for combustion, and ii) the fine solids portion of the waste stream, and in other manners;

- Combustion of the dried, highly cellulosic solids portion of the processed manure stream to generate energy which, together with the methane, supports the ethanol production process;
- Combustion that transforms the condensed 'solubles' by-product (and even portions of the spent grain) from ethanol production into energy. (Inclusion of distiller grains in dairy rations may be doubled when 'solubles' with high fat content are excluded, thereby further improving the balance between ethanol plant and herd size.);

- The processing of the fine solids portion of the manure stream into a value-added, marketable, organic fertilizer and/or high protein feed product.

To illustrate the probable magnitude and value of the integrated renewable energy & co-generation when utilized on-site as a replacement for purchased energy, Bion calculates that, in aggregate, renewable energy (not including the produced ethanol) generated at a co-located 40,000 cow dairy integrated with a 40+ M GPY ethanol facility will offset the need to purchase in excess of 2.4 M MBTU per year of natural gas, which would otherwise cost more than $20,000,000 per year at $8.00 per MBTU. This does not include additional savings of approximately $4,000,000 per year (approximately .5M MBTU) resulting from on-site use of wet distillers grain without drying.

To express the Bion integration opportunity slightly differently, each dairy Integrated Project will include:

1-Ethanol production with a competitive advantage in unit production cost due to: a) lower CAPEX and operating costs (no dryers, grain drying or grain shipping), and b) an agreement for the consumption of the spent grain by the integrated CAFO herd;
2-Bion environmental waste processing that: a) receives fees from the CAFO operators, and b) revenue from sale of its unique end product---fine solids marketable as fertilizer and/or high-value feed;
3-A more efficient dairy CAFO herd (located at a single location or modules in a small geographic area) due to scale, environmental and economic sustainability and proximity to end-user (cheese or bottling plant) which herd may be housed in barns (and related facilities) under long-term lease arrangements;
4-End-users (bottling or cheese plant) with competitive advantages due to 'single sourcing' and proximity to CAFO herd; plus
5- Net energy benefits of net on-site production and utilization of renewable energy (excluding ethanol product itself) and avoided energy use that totals in excess of approximately $24,000,000/yr (approximately 3M MBTU).

As a result, Bion's technology creates a far more energy efficient, and substantially more profitable, integrated business enterprise while meeting rigorous environmental standards and, importantly, without environmental liability.

Bion projects that its unique integrated model (with patent pending and made possible only by Bion's patented waste treatment technology) will yield long-term annual EBIT/DA (earnings before interest, taxes, depreciation and amortization) of 35% - 45% on the approximately $70,000,000-$120,000,000 CAPEX for each such Integrated Project (sized to include Bion waste treatment system for 20,000-40,000+ dairy cows, anaerobic digester, 20M-40+ M/GPY ethanol plant, solids processing & renewable energy and co-generation production facilities) ('Project' or 'Integrated Project'). [Note that this projected EBIT/DA is conservative --- based on long-term ethanol prices ($1.70/gallon ten-year average) far lower than current prices (approximately $2.40+/gallon). If ethanol prices remain at or near current levels, profit will be far higher.] This profitability is projected for Bion's Integrated Project core module supported by its technology platform and does NOT include the additional economic benefits related to integrated CAFO producers, lease of CAFO facilities, or on-site end-product user facilities (e.g. a cheese or bottling plant).

Bion is currently working with local, state and federal officials and with potential industry participants to evaluate sites in multiple states (New York, California, Indiana and Nebraska have progressed furthest at this date) and anticipates selecting a site for its initial Integrated Project during mid-2006. Bion is presently establishing its implementation management team with the intention of commencing development and construction of the initial Project during early 2007. In addition, Bion intends to site additional Projects from later in 2006 through 2008 to create a pipeline of Projects that will insure significant market share and profitability within 3-5 years (both regionally and nationally). Management has a 5-year development target of approximately 12-20 Projects. Each Project is projected to include: a) Bion waste treatment system, b) processing the CAFO waste stream from the equivalent of approximately 20-40,000+ dairy cows, c) while producing renewable energy (methane, steam, etc.) for on-site use, d) solids to be marketed as feed and/or fertilizer, e) which is integrated with a 20-40+M Gallon/Yr ethanol plant (though some smaller Projects may be undertaken in appropriate situations). At the end of the 5-year period, Bion projects that 5-10 of these Integrated Projects will be in full operation in 3-6 states, and the balance of the Projects would be in various stages ranging from partial operation to early construction stage.

For further information, See 1)'Development/Technology/Business Model', below, 2) our website: www.biontech.com, and 3) (a) 'Supplemental Information', and (b) 'October 24, 2005 Executive Summary', below.

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Development / Technology / Business Model

The growth of the CAFO industry has been achieved due to its ability to ignore existing environmental regulations while delaying implementation of more rigorous environmental regulation. This 'success' has re-enforced an entrenched defensive strategy that has diminished the industry's willingness to invest in 'what could be' as opposed to clinging to 'what has been'. The resulting dearth of new strategic options has resulted in huge investment in economically and environmentally unsound and unsustainable projects. The CAFO industry today has billions of dollars of assets in place that do not meet present (let alone future) regulatory requirements. These facilities represent a significant liability for the industry going forward unless they can be cost effectively retrofitted to meet environmental regulations or adapted as sites for large-scale, environmentally sustainable projects. In many cases, these CAFO operations, as presently positioned, are neither environmentally sustainable in the face of stricter regulatory enforcement nor will they enjoy a competitive advantage on a unit of production cost basis. In essence, the CAFO industry has become captive to its own political power.

In December 2004, Bion published independently peer-reviewed data from its 1,250-cow DeVries project in Texas, demonstrating a reduction in nutrients of 75% and air emissions of 95%. More specifically, those published results indicated that on a whole farm basis, the Bion System produced a 74% reduction of nitrogen and a 79% reduction of phosphorus. The air results show that the Bion system limited emissions as follows: (in pounds per 1,400 pound dairy cow per year):

▪ Ammonia	0.20
▪ Hydrogen Sulfide	0.56
▪ Volatile Organic Compounds	0.08
▪ Nitrogen Oxides	0.17

These emissions represent a reduction from published baselines of 95%-99%.

See the full report at www.biontech.com.

The demonstration project at the DeVries Dairy in Texas has also provided Bion with the opportunity to explore mechanisms to best separate the processed manure into streams of coarse and fine solids, with the coarse solids supporting generation of renewable energy and the fine solids becoming a value-added, organic fertilizer and/or high protein animal feed ingredient.

Bion's technology platform and the integrated enterprise it makes possible will generate large quantities of useable renewable energy (in addition to the ethanol produced). Bion anticipates the annual net generation of renewable energy utilizable on-site at a single-site Project including a 40,000-cow dairy (or equivalent) herd integrated with a 40+ million gallon per year ethanol production facility will be approximately as follows (in addition to the ethanol production):

- Methane produced from anaerobic digestion of the manure stream:
  - 16.8 MBTU / cow
  - 725,000 MBTU/ herd
- Steam from combustion of pre-dried coarse, cellulosic solids:
  - 24.5 MBTU / cow
  - 1,060,000 MBTU / herd
- Steam from combustion of condensed 'solubles' by-product of ethanol production: 850,000 MBTU
- Capture and reuse of more than one-quarter of the 1,250,000 MBTU's per year of waste heat resulting from the production of ethanol: not less than 312,500 MBTU.

In aggregate, renewable energy produced at such a 40,000 cow dairy integrated with a 40+ M gpy ethanol facility will offset the need to purchase more than 2.4 M MBTU per year of natural gas, which would otherwise cost in excess of $20,000,000 per year at $8.00 per MBTU. This does not include additional savings of approximately $4,000,000 per year (approximately .5M MBTU) resulting from on-site use of wet distillers grain without drying.

Use of the renewable energy generated on-site, without conversion for sale off-site, results in enhancement to the operating rate of return from dual impacts related to both energy volume and energy unit value as follows:

1) In typical current applications, methane is converted into electricity with a resulting net energy loss of 20% - 30% (assuming that the waste heat generated in the conversion process is fully utilized); without consideration for waste heat, conversion to electricity retains only 30% - 40% of the original methane energy value depending upon the efficiency of the equipment used. Bion's onsite utilization of renewable energy, on the other hand, will typically experience an approximate 80% energy efficiency in conversion of methane to steam; and

2) The value of renewable energy in its conversion to electricity is further diminished when transferred to the power grid for sale to the electric utility since the purchase agreement will be at wholesale production rates (avoided costs for commercial power generation), not at retail rates that incorporate the full cost of the distribution network. In contrast, Bion's integrated platform utilizes most of the renewable energy generated onsite at Bion's "avoided cost" for natural gas at local retail rates.

This unique renewable energy generation/utilization strategy enables Bion to capture the entire utility value proposition. This model allows Bion to capture not just the "wellhead" or 'as produced' value of the renewable energy BTU's produced but the full "burner tip" or 'as utilized' value which is the utility's delivered price to the end user. Historically the delivered costs of energy ("burner tip") have increased even when the raw energy costs ("wellhead") have remained stable or declined.

Integrated CAFO livestock will consume the distiller grains by-product (the spent grain from ethanol production with corn as its feedstock) without the need for drying (or driers) while the methane generated from anaerobic digestion of the manure waste stream generates sufficient heat to dry the coarse, high cellulosic, low nutrient solids for the purpose of combustion to offset natural gas use in the ethanol production and other areas of the integrated complex. Evaporators utilizing the waste heat from the coarse solids dryers in turn enable drying the high-protein fine solids (40% - 45% crude protein) into a marketable, value-added feed supplement and/or organic fertilizer. Thus, Bion's renewable energy capability enables it to economically produce a series of energy surrogates—i.e., renewable ethanol, renewable nitrogen and renewable protein. None of these integration advantages are realizable without the animal numbers and concentrations with strict pollution control provided by the Bion technology alone. Bion has a patent pending relating to the Bion integration model described herein.

Bion projects that the total integrated CAFO development, as described above, will generate an annual EBIT/DA of 35% - 45% on invested CAPEX. Bion projects that each such integrated facility (including waste treatment system, anaerobic digester, ethanol plant, solids processing & renewable energy and co-generation production facilities) will require a CAPEX ranging from $70M (smaller Projects) to $120M, depending on the project size, location and mix of animals (not including CAPEX related to either the CAFO herd and its facilities or the end-product producer).

Meanwhile, this projected financial performance of the Bion integrated model does not fully reflect the sizable competitive advantage for each of the integrated economic activities as compared to stand-alone, greenfield dairy operations or ethanol production facilities. In each case, the total CAPEX required by the Bion integrated approach is significantly reduced from that traditionally required for these activities as greenfield operations while operating costs are also significantly lowered.

The strength of Bion's implementation platform comes from the unique opportunities provided by a combination of scale and technology integration created by the core Bion waste treatment technology. The key elements of the integration model that provide these unique advantages include:

- Unprecedented herd concentration supported by
- A comprehensive, environmental technology that meets present and future requirements for
- Standards based operating permits, which in turn allows for
- Capital markets to leverage the scaled technology platform involving
- The large scale generation and on-site utilization of renewable energy.

For the past two years, Bion has focused on completing its technology platform/business model, electing not to pursue near term revenue opportunities (from CAFO retrofit business) that would have diverted resources and negatively impacted its ability to complete development of an integrated technology platform in support of large-scale sustainable facilities. Significant retrofit opportunities exist that will provide additional future revenue streams from Bion's technology. However, Bion's management team remains focused on implementation of its integrated technology platform as the basis for development of its large scale Integrated Projects---the long-term strategic goal.

Based upon discussions with various industry stakeholders including producers, industry senior lenders and various state and federal agencies, Bion believes that its business model can be successfully implemented to develop Projects with the long-term profitability outlined above.

In its business model, Bion will be the developer and manager of, and direct participant in/owner of, the Integrated Projects. As such, Bion will:

- Locate, secure and develop appropriate sites;
- Negotiate agreements with both input providers and in certain instances end-product users;
- Secure required permits based upon standards that clearly establish acceptable environmental operating parameters for each component of the integrated facility;
- Manage construction and operation of the Projects; and
- Provide its waste treatment services to CAFO operators for a fee.

In turn, the CAFO operator will use the wet distiller grains from the ethanol plant as a feed component for the herd at a long-term competitive price. The CAFO facilities, with their standards-based operating permits, can be owned either by the CAFO operator or by an independent third party finance source and subsequently leased to the CAFO operator. The CAFO operator will be responsible to provide its herd and operate the

CAFO. In some instances, Bion will own a direct interest in the CAFO herd, end-product user and/or related facilities.

Bion's near term technical objective is to build a cold weather "validation facility" (which will be expanded into a full Project) to be used to further demonstrate aspects of its dairy and cattle (as well as other CAFO species) integrated model. Specifically, the "validation facility" will be used

- To finalize determination of equipment sizing and technology utilization on a per 1,000 cow basis depending upon a number of variables including scale, animal type, animal husbandry procedures, energy values and environmental requirements;
- To optimize the engineering basis for integration of the renewable energy and co-generation technologies and system components in the Projects;
- To better understand the implications of project scale to support increased flexibility for future Project roll-out; and
- To provide a source of fine-solids samples in support of product development and marketing. Bion anticipates that a value-added solids product will generate revenue either as a high-protein feed supplement based upon crude protein levels of 40% - 45% and/or as a high-end organic fertilizer based on nitrogen content in excess of 5%.

Bion anticipates that its validation facility will be constructed during the summer of 2006 and complete testing by late 2006 that will enable Bion to commence development and permitting of its initial large-scale, Integrated Project early in 2007 with construction underway during the first half of 2007.

Bion is presently working on developing sites for large-scale Integrated Projects in multiple locations with assistance from a number of local, state and federal agencies.

Bion is continuing to file additional patent applications to add to its 9 US patents (additional US patents are pending and additional foreign patents are held and pending) and is now beginning to develop a strategic plan that will communicate and brand its producers' outputs as environmentally sustainable to the consumer marketplace. Bion believes that its capacity to evolve the integration applications of its technology platform has been and continues to be its single biggest asset. Its management team is focused on the objective of creating and implementing Projects based on its economically and environmentally sustainable technology platform. Bion's business model will provide value to all stakeholders, investors and project partners, through a strategic blending of scale, efficiency, on-site generation and utilization of renewable energy and environmentally sustainable agricultural and production operations.

Bion believes that the combination of embedded strategic advantages described above will create stable, long-term cash flow from Projects that can generate exceptionally profitable economics while avoiding the volatility normally associated with single commodity based businesses. The integration of strategic advantages from both renewable energy and basic commodity activities will ensure consistent earnings growth over the long term while allowing rapid deployment to gain market share in the short term. In short, Bion's model provides not only a competitive advantage today but also a sustainable advantage going forward.

This material includes forward-looking statements based on management's current reasonable business expectations. In this document, the word 'intends', 'projects', 'anticipates', 'believes' and similar expressions identify certain forward-looking statements. These statements are made in reliance on the Private Securities Litigation Reform Act, Section 27A of the Securities act of 1933, as amended. There are numerous risks and uncertainties that could result in actual results differing materially from expected outcomes.

Forward Looking Statements

Statements made in this ‘**Executive Summary**’ (and any documents delivered with it) that are not historical or current facts are "forward-looking statements" within the meaning of Section 27A of the Securities Act of 1933, as amended (the "Securities Act") and section 21E of the Securities Exchange Act of 1934, as amended. These statements often can be identified by the use of terms such as "may," "will," "expect," "believe," “anticipate," "estimate," or "continue" or the negative thereof, or other words which clearly indicate that future possibilities rather than currently existing facts are being discussed. Bion Environmental Technologies, Inc. and its subsidiaries (collectively ‘Bion’) intend that such forward-looking statements be subject to the safe harbors for such statements. We wish to caution readers not to place undue reliance on any such forward-looking statements, which speak only as of the date made. Any forward-looking statements represent management's best judgment as to what may occur in the future. However, forward-looking statements are subject to risks, uncertainties and important factors beyond our control that could cause actual results and events to differ materially from either or both of historical results of operations and events and those presently anticipated or projected. These factors include adverse economic conditions, entry of new and stronger competitors, inadequate capital, unexpected costs, failure to gain product approval and/or market acceptance in particular states or provinces in the United States or foreign countries, failure to capitalize upon access to new markets and/or adverse litigation results. Additional risks and uncertainties that may affect forward-looking statements about Bion's business and prospects include the possibility that Bion’s technology may not perform as anticipated, that a competitor will develop a more comprehensive or less expensive environmental solution, delays in market awareness of Bion and our systems and soil, possible delays in Bion's marketing strategies, or inability to obtain financing on a timely basis and/or on reasonable terms, each of which could have an immediate and material adverse effect by placing us behind our competitors. Bion disclaims any obligation subsequently to revise any forward-looking statements to reflect events or circumstances after the date of such statements or to reflect the occurrence of anticipated or unanticipated events.

The following Executive Summary should be read in conjunction with our financial statements and accompanying notes and other publicly available information concerning Bion including the materials on (or referenced on) our website.

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Mission Statement

We will provide the highest value to our shareholders only by serving the highest interests of our entire stakeholder community:

- Farmers/Producers - empowering those in animal husbandry to become more sustainable, comply with environmental regulations and maximize profitability.

- Employees, Vendors and Technology Partners – providing challenging and rewarding work on the cutting edge of the most important odyssey in agricultural environmental technology.

- Livestock – improving livestock's environment which we believe will also improve livestock health and well-being.

- The Environment – protecting the planet by making continuous improvement in mitigating polluting livestock production releases to air, land and water while preserving threatened ecologies, recycling valuable nutrients and organics, and conserving energy.

bion™

environmental technologies, inc.

EXECUTIVE SUMMARY (October 24, 2005)

Agricultural runoff is the number one cause of water pollution according to the US EPA and livestock are its major source. Livestock operations are also a major source of air pollution. According to California's San Joaquin Valley Air District (SJVAPCD), emissions of Volatile Organic Compounds (VOCs) from cows in the Valley exceed those from cars and refineries combined. The polluting releases to water and emissions to air from Confined Animal Feeding Operation (CAFOs) are in the process of being regulated more stringently around the country.

This environmental problem is the result of increased herd concentration per acre of farmland. The increase in herd concentration has become an economic necessity because the lack of contiguous land at affordable prices makes increased density the only means of expansion which can maintain profitability while achieving the national objective of affordable food prices.

The CAFO industry employs a waste disposal methodology of land application. As herd sizes increase without an increase in farmland available for waste disposal, the resulting environmental problems are excess nutrient application and concentrated air emissions. Excess nutrient application results when the nutrients applied to an acre of farmland exceed the agronomic rate (roughly the nutrient needs of the crops that are grown on that acre). Excess nutrient application results in surface and ground water pollution. More than 90% of the dairies in the US have insufficient farmland to properly land-apply the nutrients that their existing herds produce.

Air emission pollution is largely a function of emissions per animal and the greater the concentration of animals in an air district the greater the emissions.

Essentially the costs of increased herd concentration to date has been borne by the environment and the public. That cost is now being shifted back to the agricultural producers.

Bion has developed patented, proprietary technology, versions of which are in operation on over 20 CAFOs. Peer-reviewed performance data has demonstrated that Bion's technology mitigates most of the pollution to air, water and soil from CAFOs. Bion's process, which is economically affordable, can be utilized to retrofit existing dairies, hog farms, cattle feedlots and poultry operations to comply with existing and pending regulations, and it will also allow them to gain permits to expand, thereby enhancing their profitability.

Bion's core technology enables a significant increase in herd concentration by solving the nutrient and air pollution issues that CAFOs face. The economics of Bion's solution are driven by scale and, as a result, increased herd concentration and environmental benefit are no longer mutually exclusive but can actually complement each other. Bion's core technology applications for large scale herds creates: a) an integrated technology platform for production of renewable energy utilizing the CAFO waste stream as its feedstock; b) waste solids converted into various soil amendments and fertilizers that can be both applied locally, packaged and transported for sale to markets in need of organic nutrients, as well as single cell protein products that can be used as an animal feed; and c) environmental reduction credits (ERCs) for air and nutrient pollution. As herd size in a small geographic area increases, Bion's integration platform expands to incorporate ethanol production. Lastly, Bion's core technology can support a fully integrated and balanced facility where the dairy cows, a 'milk user' (such as a cheese plant), and Bion's technology platform (including an ethanol plant) can all be located within one site to collectively utilize Bion's biological technology to extract value/revenue from their respective waste streams that had been a cost burden to each separate enterprise.

Bion refers to its integrated facilities as Central Processing Facilities (CPFs) when the installation serves an off-site dairy herd (10,000 or more dairy animals) in a small geographic area and as Dairy Parks (DPs) when a dairy herd (25,000 or more dairy animals) is directly integrated into the Bion site. Both CPFs and DPs allow integration of ethanol production. Dairy Parks additionally directly integrate end-product producers with the dairy herd's milk production on the same site.

INTRODUCTION:

At the heart of the U.S. livestock industry lies an environmental problem resulting from increasing herd concentrations, which has resulted in livestock densities that create better economics to producers while significantly increasing the environmental damage/threats to both water and air quality. Confined Animal Feeding Operations (CAFOs) are rapidly increasing in number as well as herd size. Economic pressures continually force increased consolidation in order to maintain profitability. Concurrently, permitting for these large, high-density CAFOs is becoming more rigorous as environmental organizations and regulatory authorities bring increased scrutiny and regulation to bear on the need for environmental compliance. In many areas, including California, permitting activity has effectively come to a halt. According to the US EPA, agricultural runoff from CAFOs is the greatest remaining untreated cause of water pollution in the U.S. Awareness of the air pollution from CAFOs has increased many-fold in the past several years. The status quo is a losing strategy for today's large livestock producers, as they are increasingly unable to maintain their profitability. Without expansion and/or increased herd concentrations, the constant pressure on margins will continue to erode profitability.. Political awareness, new regulations and litigation prevent such expansion in ever larger portions of the country. The status quo is also a losing strategy for the public and the environment as the negative impacts of conventional CAFO expansion have become increasingly evident.

Bion believes that it has developed a comprehensive, affordable environmental solution to CAFO air and water emissions----a solution that will both enable and drive the continued consolidation and vertical integration of the livestock industry while eliminating the negative environmental impacts on air, soil and water. Bion's technology creates the possibility of a comprehensive solution that will enable the industry to increase herd density (and profitability) without the need for additional contiguous land (which is often not available) while mitigating existing polluting releases and emissions. Bion's technology platform provides a long-term economically and environmentally sustainable solution to the environmental air and nutrient issues facing the CAFO industry.

Bion's initial CAFO focus is the dairy industry due to the industry's fragmentation at both the producer and finished product levels. Bion's ability to solve the environmental constraints will allow the dairy industry to realize the significant economic benefits that can be derived from the vertical integration of the dairy industry with synergistic business opportunities based upon renewable energy production such as ethanol. Increased herd density will create both the opportunity and economic need to integrate these large herds with business line extensions (both vertical and horizontal). Such integration cannot be achieved without Bion's technology.

The result will be a transformed industry with diversified, new and improved cash flows and with a smaller, more benign environmental impact. This transformation results from the combining of existing industry segments into integrated new facilities capable of reducing operating costs and generating economic benefit from their respective waste streams. Further, many of the risk factors of these individual entities will be significantly reduced or eliminated while new risk factors associated with integrated processes can be managed in a coherent manner. Overall the risk/reward ratio will improve dramatically since the risks associated with such integrated complexes can be better defined and managed and, as a result, insured. Lastly, since the significant, but usually unquantified, environmental risks will have been addressed by Bion's technology and converted to a defined, conventional regulated industry risk, it will become possible to finance these projects through the institutional capital markets in the same manner as any other large integrated industrial complex.

Bion has developed its integration model so that it is scalable and capable of delivering benefits at various levels of implementation. Depending upon whether the technology is being deployed to address the environmental issues of existing dairies or new dairies would determine whether they would be classified as 'retrofit' installations or new installations. This classification has no relevance to Bion's core technology or its technology platform, but is relevant to the CAFO industry as it relates to its environmental regulation and compliance.

The economics of scale are a function of many factors. As a rule of thumb, a basic Bion installation for 5000 dairy animals will provide sustainable economics as it relates to Bion's core technology and some additive revenue including ERCs and anaerobic digestion producing renewable energy in the form of methane gas. On smaller dairies (from 1000-5000 dairy animals) the economic benefits from renewable energy production will be more limited. Such dairies will, however, be able to achieve the benefits related to environmental compliance and herd expansion.

In the context of a Bion CPF, sufficient methane gas energy will be produced to support economic utilization to: a) make on-site process heat, b) be converted into electricity for internal use and/or resale, c) cleaned and piped locally to heat homes and/or businesses, d) run LNG powered cars, and/or e) potentially converted into hydrogen. In almost all such cases Bion would enter into a long term facility operating agreement including operation and maintenance (O & M) (these services would be either provided directly by Bion employees or would be subcontracted by Bion to local agricultural, environmental engineering firms) for which Bion would receive annual operating and/or 'tipping' fees.

Commercial solids processing, including packaged fertilizers and single cell protein animal feeds (depending upon climate), which will usually require a scale of 10,000 (or more) dairy animals to achieve sustainable economics, will be part of Bion's activities in CPFs and DPs.

ERCs related to regulated air emissions as well as greenhouse gas emissions and nutrient emissions are potential sources of income for each Bion CPF.

Herd concentrations in a specific geographic area in excess of 25,000 dairy animals will be able to support integration of an ethanol production facility into the Bion technology platform in either a CPF or DP.

The harvested solids can be made into a high Nitrogen, high Phosphorus premium organic fertilizer, cellulose rich bedding for the dairies and, subject to feeding trials, a high-grade animal feed depending upon climate, geographic access to markets, herd size and the equipment utilized as part of the Bion technology platform. Due to the energy embodied in fertilizer (most commercial fertilizer production utilizes natural gas as a primary feedstock), Bion anticipates that ERC's will also develop over time in relation to Bion's solids/fertilizer production.

Scale can be achieved in a number of ways: a) a single large dairy, b) a dairy complex that utilizes the capabilities of Bion's technology to expand the facility to allow siting the necessary herd density (DP), or c) a group of dairies in a small geographic area that deliver their waste into on large scale economically efficient Bion treatment system (CPF).

A fully site integrated Bion facility which incorporates a dairy herd of a minimum of 25,000 milking cows on site and includes end-product production (such as cheese, yogurt, ice cream or fluid milk), together with ethanol production and a Bion system (including anaerobic digestion and solids processing) is referred to as a Dairy Park (DP).

At each level of herd concentration, the efficiencies that can be achieved as a result of process integration with particular emphasis on waste recovery and utilization become more pronounced. As a result, the larger the herd, the greater the degree of integration that will be possible. The greater the integration that takes place, the larger the energy recovery and utilization efficiencies will be. This results in greater savings in capital expense and operating costs and higher returns on invested capital as the scale increases and integration benefits are more fully realized.

The more advanced the integration model, the more energy independent and more immune the dairy operations will be from future potential energy inflation which limits the profit from the protein products produced from the entire integrated facility (such as cheese, fertilizer and single cell fish food). In fact, the integration of large-scale ethanol and methane production enables the enterprise to benefit from energy prices.

Bion technology provides the key to this industry transformation. *In nature there is no waste*. Bion's core principle is enhanced profitability with reduced environmental risk through the use of its patented and proprietary technology to enable process integration. The Bion solution results in agriculture enterprise that is both environmentally and economically sustainable.

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THE REVENUE PLAN

Bion's revenue stream from a CPF facility would consist of:

- a one-time license and engineering fee for its waste treatment technology which would constitute part of the capital cost of the facility; plus
- annual user/tipping fees in the range of $200-250 per milking cow (related to the technology fees, O&M costs, and debt service) for the waste treatment services.

Additionally, Bion would have an ownership interest in:

- Processed solids (to be sold as soil amendments, fertilizer and/or a single cell protein feed source, etc.);
- ERCs;
- The renewable methane/energy output from the anaerobic digester system.

In the case of a fully integrated DP or a large CPF, in addition to the items set forth above, Bion would also participate in:

- revenues from ethanol production (including ethanol sales, sales of the spent corn/ distillers grain to the dairies, and energy production from recycling the ethanol plant's 'solubles' stream through the digester).
- management fees for operating the entire integrated complex on a long-term basis.
- Enhanced revenue streams resulting from the greater integration of the ethanol plant, waste treatment system, end-product user and the dairy cows;

In addition, DPs will generate 'lease/rental' income from provision of the barns and related facilities to the dairy producers.

And, in some DPs (but probably not the initial DP), Bion may also have an ownership interest/participation in:

- The dairy operations (including direct participation in the milk revenue stream);
- The cheese plant or other end-product facility.

In its CPF and DP revenue models, Bion projects that the aggregate realizable value of solids, environmental credits and renewable energy production from anaerobic digesters will range between $200-$800 per dairy cow per year depending upon the size, location and climate of the installation.

Bion's 40,000 milking cow DP model projects an aggregate capital cost of approximately $440M (prior to any grants and subsidies) and an annual EBIT/DA for all components of the DP to range between $110-$120M annually. Bion will retain direct ownership of the Bion waste system and associated platform components including anaerobic digestion facilities, environmental credits and all aspects of solids processing including drying, composting and packaging. Bion would also own the ethanol production facilities with purchase agreements with the participating dairies for its spent corn/distillers grain by-product. The capital cost of the Bion system platform (for environmental waste handling and soil production) and a 40M gallon ethanol plant at a DP are estimated at $100 million (prior to any grants and subsidies) and an annual EBIT/DA for these components is estimated at between $35-$40 million annually. In some cases, but probably not the initial DP, Bion may have a direct ownership interest/participation in the revenue from the dairy animals and/or end-user. In such cases, there will be additional capital costs.

THE NEAR TERM IMPLEMENTATION PLAN:

Bion is pursuing an implementation plan for 2006 that consists of installing two large facilities: a warm weather and a cold weather CPF type facility. The completion of these large-scale commercial projects will not only provide substantial revenue streams to Bion, but will also provide further validation of the economic and environmental performance to facilitate future partnering, financing, and regulatory and local approvals required to fully develop the DP business opportunity. In addition, these initial projects will serve as drivers for regulatory standards to be adopted for new and expanded facilities that will comprise the vast majority of Bion's retrofit opportunity as the dairy industry elects to leverage Bion's environmental compliance technology into operating permits.

- **Initial Large Scale Projects:** Bion is working towards both a warm (California) and a cold weather (Indiana) large scale (at least 5-10,000 cows each for initial stage) project that will: a) generate operating income, and b) also provide the 'proof of concept' required to commence full scale Dairy Park projects.

- **California Dairy Project:** Bion is working towards securing a project for construction in early 2006, which it expects to result in air and nutrient emission standards being adopted in California (and later elsewhere) for existing large dairies and new installations. Bion believes it will not only qualify under the Best Available Control Technology (BACT) initiative presently under way in CA, but will drive the regulatory standards to a higher level of rigor (and environmental protection) than previously contemplated by either the industry or the regulatory community. There are currently in excess of 200,000 dairy animal permit applications pending in Kern County, CA alone that are required to use BACT to meet these new standards. At present, in the ongoing political process, the dairy industry and the environmentalists in California are each seeking a BACT outcome that virtually guarantees that, whatever the outcome, the "loser" will commence litigation which will continue to defer the issuance of permits. Bion has proposed a solution of 'voluntary interim standards' which would only apply to new permits. These interim environmental standards would be far more stringent than anything presently proposed but would be on a voluntary basis. By committing to meet such standards, dairies that wanted to secure permits could proceed immediately (in 2006). Existing dairies would not be required to achieve these emission levels until the BACT process was completed. Bion has recently submitted an application to the SJVAPCD for a review for an air permit for an initial CPF and has been promised an expedited review. Bion projects that it will be able to secure a permit for an initial CPF module during the first quarter of 2006. This commercial installation will provide additional peer-reviewed data commencing 4-6 months after the system begins operation. CA is presently the leader in air emission standards. The standards and BACT adopted in California will significantly influence the regulatory agencies nationwide as well as existing and future litigation between the industry and the environmental and regulatory agencies. Once rigorous CAFO standards for emissions to air and releases to water are promulgated anywhere, regulators (and environmentalists) elsewhere will be far less likely to implement (or allow) less rigorous standards.

- **Indiana Dairy Project:** Bion has executed an initial agreement to install a 10,500 milk cow Bion system for the proposed expansion of Fair Oaks Dairy Farm (FODF). Bion has completed its engineering and feasibility analysis. The proposed project would be a joint venture (JV) with FODF and Bion being 50/50 partners in the installation in Phase I. In addition, the JV under discussion now contemplates construction and operation of a 40M gallon ethanol plant that would subsequently be constructed on the site. Bion is presently in negotiations with FODF concerning final JV scope and terms with a projected commencement of construction scheduled for the spring of 2006 and projected completion of Phase I by the late fall of 2006.

Taken together, the CA and FODF installations will provide Bion with both warm and cold weather full-scale, commercial projects that can additionally be utilized to demonstrate the technology and its results for use in securing local and state approvals as part of its Dairy Park (DP) initiatives. It will also support the refinement of DP integration process engineering and provide an economic model for subsequent DP project development.

- Bion is currently working to develop a DP project in Nebraska. Bion has just completed an economic assessment of the value of the grant and subsidy programs available from state, federal and local government units for such a project. Review of potential sites has commenced. Bion anticipates making a decision on proceeding with the NE DP project by the end of calendar 2005.
- Bion is in the early stages of evaluating another cold weather DP installation in New York State.

THE LONG TERM IMPLEMENTATION PLAN:

Once the large scale warm and cold weather installation agreements have been completed and construction has commenced, Bion proposes to site, secure permitting, financing and economic assistance (grants/loans/subsidies) for an additional 5-10 large scale integrated DP facilities in the continental US. Additionally, Bion would seek approval for expansion of the first central processing facility (CPF) in California and begin permitting for 4-8 additional CPFs in California.

Bion is also in the preliminary stages of investigating Canadian and European opportunities. Europe and Canada, which have 20 million and 1 million cows respectively, are signatories of the Kyoto Treaty which requires that they take specific steps to reduce their output of Greenhouse Warming Gases. They are not meeting their current targets and this has pushed the value of Carbon Credits in Europe to approximately $28 per ton. The Kyoto Treaty calls for granting of credits for reductions of greenhouse gases against established baselines. Defined ‘greenhouse gases’ include methane and NOx, both of which are produced by livestock. Bion’s process would mitigate approximately 9.3 tonnes of Greenhouse Gases per cow per year. While the total cost (including debt service and operating costs) of a Bion CPF is projected to be in the range of $150-$250 per cow per year, the value of the Carbon Credits that could be generated by a CPF at current prices is approximately $260 per cow per year. This does not include other sources of CPF revenue from fees, the sale of energy, fertilizer, protein, etc.

R & D PROGRAM:

- **On-going R&D Activity:** While Bion’s technology is ready for full-scale commercial implementation, Bion is presently pursuing a number of near-term R & D efforts to fine-tune aspects of its technology to incorporate into installations projected to commence construction during the first half of 2006. The results from these R & D efforts will also be incorporated into a final engineering and cost analysis, including modeling of the by-products requirements and cash flow. Lastly, the results from this R & D effort will result in focusing R & D towards further maximizing the value of the by-products such as organic fertilizers and single cell protein feeds.

Specific R&D efforts currently underway include:

- **Solids Product Utilization:** Identification of optimum target market utilization for the captured solids, including an organic fertilizer as well as the potential for a single cell protein feedstock that can be used as a feed in various CAFO and other high-value animal markets such as fish and pet foods;
- **Solids Process Production Process:** Refine process engineering and platform integration in support of solids separation and drying for the identified target product uses, taking into account the various climates and solids product market opportunities;
- **Water Purification for Reuse:** Refine lab bench trial analysis that supports the economic viability of producing an effluent that can be discharged to groundwater or treated and reused by the herd; and
- **Energy Optimization:** Significant opportunities exist for Bion to capture value through a combination of peak period reduction and energy production (complementary anaerobic digestion). At 40%-60% of Bion's system operating costs (including debt service), energy is the single largest individual cost associated with Bion process implementation. Bion anticipates reducing system energy cost through use of process engineering refinements to reduce peak period usage and by maximizing use of off-peak rates. The Company will work with the local electric utility to ensure its operations achieve the lowest possible energy cost, while mutually exploring opportunities to create value through on-site production of renewable energy via methane capture.

MARKETING

According to the USDA, in 2004 there were approximately 1,300 dairy operations in the U.S. with greater than 1,000 cows. These dairies milk approximately 46% of all U.S. dairy cows. Meanwhile, approximately 500 dairies with more than 2,000 cows represent the fastest growing segment of the industry with a 5-year compounded annual growth rate in number of operations at 14%.

Based upon these demographics, Bion projects a realistic short-term target market at approximately 300 dairy producers (for retrofits and/or participation in CPFs and/or DPs). The target includes those dairies with the highest number of cows and therefore the greatest herd concentrations in the nation. These producers simultaneously face a disproportionately high degree of environmental pressure. Bion has contact information for these dairies and will do a combination of outreach directly as well as through their producer associations, milk marketing cooperatives, and agricultural/environmental engineering firms.

California has the greatest concentration of dairy cows in the world. At the same time, California's South Coast Air Quality Management District (SCAQMD) is widely recognized to be the most rigorous air management district in the world. Upon review of Bion's published, peer-reviewed data (see www.biontech.com) and additional requested data, Bion received a letter from California's South Coast Air Quality Management District (SCAQMD) dated February 1, 2005 stating that Bion's 'NMS microaerobic animal waste treatment process' qualifies under SCAQMD's new Rule 1127 dealing with Emissions Reductions From Livestock Waste. SCAQMD states that Bion's process "demonstrates significant reductions from anaerobic manure storage lagoons" and "VOC and ammonia emissions are significantly less than one pound per cow per year." This recognition of Bion system's environmental performance is being utilized to facilitate Bion's marketing efforts and as part of the BACT process.

In addition, the initial CPF project in California and the FODF joint venture installation have been selected for their high visibility with our target market. Bion's potential customers/dairy partners will be acutely aware of these projects from permitting through construction and operations. These dairy operators will be in a position to uniquely recognize the economic significance of the environmental solution that Bion brings to the industry.

Market opportunities for retrofits to large dairies, herd expansion and construction of CPFs to service 10,000+ cows in small geographic areas exist in California, Texas, New Mexico, Washington/Oregon and Idaho.

The primary market opportunities for integrated dairy parks are those states that produce corn that has historically been produced largely for export outside of those states. In addition, the large dairy states which are importing corn (California, Texas, New Mexico, Washington/Oregon and Idaho) would benefit from having CPFs and/or DPs in which an ethanol plant utilizes the corn already being imported to produce energy and operates as a feed mill for the dairy cows.

Glossary

Aerobic – with an abundance of oxygen
Anaerobic – with no oxygen
Anoxic – with very little oxygen
AQTF – Air Quality Task Force – a joint EPA/USDA task force
AWMS - a facility that employs Bion's Animal Waste Management System technology to process and remove odors and other polluting releases to air and water associated with confined animal feeding operations (CAFO's)
BACT – Best Available Control Technology
CAA – Clean Air Act
CAPEX – Capital Expenditure
CARB – California Air Resources Board
CAF/CAFO – Confined Animal Facility/Confined Animal Feeding Operation. CAFO's are high density animal rearing facilities where food and water is delivered to each animal and its waste is removed
CNMP – Comprehensive Nutrient Management Plan
CO_2 - Carbon dioxide
CPFs – Central Processing Facilities – a facility geographically located near a cluster of CAFOs which receives and processes the wastes from 5,000+ cows and integrates the Bion technology for waste management and soil production with renewable energy production (methane and/or ethanol depending on size).
CWA – Clean Water Act
CWT – 100 pounds of milk
DP - Dairy Park – a vertically and/or site integrated industrial park consisting of an assemblage of large dairies (~1,000 to ~4,500 dairy cows each) utilizing Bion's AWMS technology which are linked to other related activities such as a grain-based ethanol manufacturing plant, an anaerobic digester/methane co-generator, and/or an ice cream or cheese making plant.
EBIT/DA – Earnings Before Interest, Taxes, Depreciation and Amortization – an indicator of cash flow.
EPA – Environmental Protection Agency
EQIP - Environmental Quality Incentives Program is a grants program administered by the USDA's NRCS under the Farm Bill
ERCs – Emission Reduction Credits – tradable credits provided under the CAA to use market forces to incentivize the cleaning of the air. An operation that produces less air pollutants than an industry baseline is awarded ERC's. To pollute the air beyond an industry baseline, one has to purchase ERC's.
Ethanol – a renewable fuel, made from corn, which can be blended 10% with gasoline (E10) as an automotive fuel for gasoline powered cars or up to 85% (E85) for Flexible Fuel Vehicles (of which there are 6 million in the USA) that can burn gasoline or E85
First Generation – also referred to as Big Slow systems - a large Bion AWMS with a long hydraulic retention time (in contrast to a High Rate AWMS)
FODF – Fair Oaks Dairy Farm in Indiana
GPY – Gallons per year
Greenfield – brand new versus an existing (Brownfield) or retrofit

GWG – Greenhouse Warming Gases such as CO_2, NOx & CH_4,
High Rate – a compact Bion AWMS with a hydraulic retention time on the order of 20 days (in contrast to the First Generation Bion AWMS's)
JV – Joint Venture
K – Potassium
Microaerobic – a system that has some but not a lot of dissolved oxygen– in between aerobic and anaerobic
M – Million
MBTU – Million British Thermal Units – a measure of energy
N – Nitrogen
NMOC – Non-methane Organic Compounds – similar to VOCs but includes acetone and other compounds not on the VOC list.
NOP – National Organic Program – the program for Organic Certification under the USDA
NOx – Nitrous oxides – a criteria air pollutant
NMS – Nutrient Management System – another name for AWMS (see above)
NRCS - Natural Resource Conservation Service – a division of the USDA
NPDES – National Pollutant Discharge Elimination System
N:P:K – Ratio of Nitrogen:Phosphorus (as P2O5):Potassium in fertilizer
OMRI – Organic Materials Research Institute
P – Phosphorus
Retrofit – a Bion AWMS placed onto an existing farm that utilizes a portion of the existing waste systems including parts of the existing anaerobic lagoon(s), tanks, pumps, screens and related subsystems
R&D – Research and Development
SCAQMD – South Coast Air Quality Management District in California
Second Generation a high-rate complete mix Bion system with computerized monitoring and controls on the key process parameters
SJVAPCD – San Joaquin Valley Air Pollution Control District in California
Solids – the harvested solid materials from a Bion process
Solubles – the soluble fraction recovered from the spent corn after the recovery of the ethanol
SOx – Sulfur dioxide – a criteria air pollutant
TNRCC – Texas Natural Resources Conservation Commission
Tonnes – 1,000 kilograms = 2,204 pounds = 1 metric ton
USDA – United States Department of Agriculture
VFAs – Volatile Fatty Acids
VOCs – Volatile Organic Compounds – as per the EPA definition - a criteria air pollutant which is an ozone precursor
WDG – Wet Distillers Grain – the wet, high protein by-product that remains after corn is made into ethanol that can be used as a high protein animal feed. Also referred to as 'spent corn', supplied with or without Solubles.

Supplemental Information (from 10/24/05 Offering Document)

Up until recently CAFO's have largely ignored their environmental problems, in part because solutions have been both expensive and hard to find, and in part because they have been allowed to. For many years CAFOs have not been effectively regulated. However, ignoring the problem is increasingly unacceptable, as most CAFO activities, from continuation of existing operations through construction of new facilities, require permits involving review of environmental impacts. Site selection, size of operation, marketing, financing structure and sources, expansion and integration (vertical and/or horizontal), are now subject to environmental review as a critical component of CAFO permit decisions.

In addition, CAFO's are subject to increasing pressure from generally successful law suits launched by environmental and public interest organizations, such as recent decisions by the 9th Circuit Court of Appeals (California) and the 2nd Circuit Court of Appeals (New York). These decisions clearly hold that there is no basis for exempting CAFOs from the provisions of the Clean Air Act and the Clean Water Act. Courts in major CAFO industry states have taken similar positions.

Due to increased public and regulatory scrutiny of airborne contribution to greenhouse warming, ground-level ozone production, acid rain and asthma, and water-borne contribution to nitrogen, phosphorus and pathogen pollution to surface and ground water, the dairy industry is now rapidly being challenged to respond in California, New York, Florida, Wisconsin, Idaho, Texas and New Mexico (the major dairy states). Similar changes in practice are also being required of swine, poultry and feedlot CAFO's in applicable states.

In anticipation of increasingly rigorous changes in the public and regulatory approach to CAFOs, Bion developed a cost effective, patented environmental compliance technology. Bion's first generation technology (which has been installed on over 20 large dairy and hog farms) has been adapted by Bion for use in relation to the waste streams of all categories of CAFOs.

A second generation, high-rate Bion system installed on a 1,300 cow dairy farm in Texas was subjected to an independent, third party performance review conducted by a team of scientists/engineers from regulatory agencies, Land Grant Universities and private industry. This independent, third party review validated Bion's technology regarding elimination of almost all pathogens and polluting releases to air, and demonstrated reductions in nitrogen and phosphorus nutrient releases to water by up to 80%. All of the system's performance data is available at http://www.biontech.com/. No other technology for CAFO waste/pollution remediation has such independent, peer-reviewed data to support claims of pollution reduction to Bion's knowledge. No other technology is even claiming to provide a comprehensive solution to the polluting emissions to air and releases to water associated with CAFOs.

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VALUE FOR THE EXISTING DAIRY INDUSTRY

For years, producers have used their land to assimilate livestock waste as an integral part of a Comprehensive Nutrient Management Plan (CNMP). However, according to the USDA, only 2% of large dairies have sufficient land to assimilate the waste stream nutrients (primarily nitrogen and phosphorus) to remain in compliance with existing regulations as they are increasingly enforced. Compounding the problem, newly proposed ASAE standards pending adoption by the USDA reflect that there is actually at least 20% - 30% more nitrogen and phosphorus discharged per dairy animal than previously believed. As a result, CAFO's will require additional land to remain in compliance with the waste stream from their existing herds. Many dairy operations that are currently in compliance will no longer be so. As a rule of thumb, in the Northeast and Midwest, each dairy cow requires approximately two acres of land for adequate handling of its associated waste stream, depending upon local soil conditions and the nature of farming activity. In CA, the acreage requirement has been significantly less since it is possible to farm throughout the year. In the Midwest where land costs can run close to $2,500 per acre, these requirements for additional land can drive added capital costs for compliance to as much as $5,000 per head. In California, land costs are considerably greater.

The cost of environmental compliance will place an increasing burden on the cash flow of dairy CAFOs, unless they can find economic relief through operational efficiencies. Bion's technology, not only solves the environmental problem, but also provides the basis for increasing herd size while maintaining environmental compliance. Increased herd size results in increase cash flows to cover the cost of the environmental solution. Compliance technologies like other dairy operating costs are very sensitive to scale. The ability to increase an operation's herd size will also serve to further reduce per animal cost of compliance.

Dairy industry adoption of Bion's technology will initially involve support for environmental compliance and permitted herd expansion at existing CAFO operations. Similarly, Bion technology will be utilized to support permitting of new, large-scale facilities that cannot otherwise get the required permits. Bion's technology will support much larger dairy herds where expanded herd density makes economic sense. Where a producer is currently environmentally compliant, Bion's technology will support herd expansion by as much as three-fold without need for additional land (assuming contiguous land were available).

Bion's environmental technology's capital and operating costs are sensitive to scale. As an example, dairies that achieve a herd size of 8,000 - 10,000 dairy cows will be able to access a capital cost advantage of 20-30% over smaller 3,500 cow dairies assuming use of a Bion environmental system including anaerobic digestion. Economic integration of renewable energy production is generally unavailable to smaller herds, as it is also sensitive to scale with regard to both capital and operating costs. One scenario for increasing scale and decreasing the cost per animal for implementing Bion's technology would have adjoining dairies utilize a Bion CPF as their model.

USDA NRCS Approval: In April 2005, the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) issued new National Conservation Practice Standards for biological treatment systems, which qualify Bion's environmental compliance technology process for funding under its Environment Quality Implementation Program (EQIP). The EQIP program provides direct farm support in the form of grants to cost share up to 75% of qualified conservation practices, not to exceed $450,000 to any individual during the term of the Farm Bill.

Bion had provided substantial input to the NRCS in their recent review of applicable waste stream technologies, including the results of our third-party, peer reviewed demonstration project in Texas. The new practices are embodied under the new Amendments for the Treatment of Agricultural Waste (Code 591), Liquid/Solid Waste Separation Facility (Code 632) and Waste Treatment (Code 629) which is a new standard intended to address the installation of alternative animal waste treatment systems and processes.

As such, Bion's entire system now qualifies under the USDA NRCS Environmental Quality Incentives Program (EQIP).

Integration Opportunities: Additional opportunities for Bion and it producer clients to leverage value from Bion's technology occur where the herd concentration in a local area is sufficient to integrate specific complementary technologies that have been developed for Bion's CPF and DP initiatives. As an example, approximately 70,000 dairy animals currently reside on farms in a small section of Kern County near Bakersfield, California. Kern County may well represent a prime example of the kind of area that will support significant available integration opportunities, such as ethanol, through the use of Bion's environmental compliance technology.

Ethanol made from corn is rapidly replacing the toxic gasoline additive MTBE. At present wholesale gasoline prices, dairies will need to recover the non-nutritive ethanol value of the corn they feed their cows, and Bion's proprietary technology creates the possibility of maximizing this economic opportunity. A 40,000 milking cow dairy herd (plus its dry cows and heifers) will be able to consume the spent corn/wet distillers grain that yields ethanol value of $40-$60M annually. As ethanol production continues to expand, the energy value of corn will begin to drive up its price in the marketplace which will negatively impact dairy producers unless they look to opportunities like Bion's integration approach as a logical incorporation into their business model and revenue stream.

To create and maximize this opportunity, Bion's technology will be required to permit herd concentration without negative environmental impact while creating a feed by-product for the dairy herd that does not contain excess nutrients or unsaturated fats that limit its inclusion in the feed ration in comparison to corn. Bion has been working with University of Nebraska and FODF on feed trials, as well as on the development of other feed by-product opportunities.

By eliminating the need to dry the spent corn (wet distiller's grain) at a properly sized and integrated ethanol facility, Bion's technology will allow a $12-16 million capital cost reduction compared with a typical stand-alone 40 million gallon per year ethanol plant that would have a capital cost of $48-55 million.

Additional benefits from herd concentration and vertical integration not presently quantifiable involve the elimination of environmental and litigation risk as well as the long-term preservation of the land value of farms for future development. Environmental liability cleanup costs could significantly impair the future value of these assets.

Participation in a Dairy Park holds a number of significant value opportunities for the dairy operator (all of which are made possible by Bion's technology). The structure of the Dairy Park will provide the producer with the ability to manage a large herd with significantly reduced need for capital at the same time that his access to capital will be increased based upon the elimination of environmental risk. Operating within the structure of a long-term lease, the DP will also provide the dairy operator with reduced risk and access to a stable market for his milk. The combination of reduced market and environmental risk, along with reduced cost of operations and decreased requirements for capital, should prove to be extremely attractive to dairy producers. It is anticipated that Bion will have direct ownership interests in the dairy herd and milk production in the context of some Dairy Park developments (but probably not in the initial DP).

THE ECONOMIC OPPORTUNITY FOR BION

Bion's core business opportunity starts with its role as a technology partner to the dairy (and other CAFO) industry where large herd concentrations exist or can be created. Bion will provide the technology to support environmental compliance for existing herds as well as achieve economies of scale from increased herd concentration at existing and proposed dairy operations. Bion will also provide the technology, management and resources to successfully develop large-scale, integrated ag-production complexes that take advantage of the energy (anaerobic digestion and ethanol), feed (spent corn) and other business opportunities (such as solids conversion to both fertilizers and other products) available from herd concentration.

In addition, Bion also anticipates access to some level of value from ERCs in the future. Air and nutrient credits will be available to industries that produce environmental results beyond regulatory requirements, but are not yet readily available to the CAFO industry. That could change if the industry offers environmental remediation in return for emission reduction credits (ERCs) and / or nutrient credits as a way to pay for it. Greenhouse Gas Emission Credits are now trading on the Chicago Climate Exchange at $2-$5 per ton/year for non-Kyoto signatory based credits (for countries such as the U.S.) and $24-$30 per ton/year for Kyoto signatory based credits (including Canada). Bion believes that our technology will produce reductions on which to base credits of approximately 4 - 10 tons/year per dairy cow.

The Retrofit Business: Bion defines its "retrofit" business as the opportunity to support existing and new dairy operations achieve environmental compliance while optimizing herd size for economic benefit. Bion believes that its potential retrofit market exceeds one million dairy animals out of the present U.S. total herd of 8.5 million. California currently represents the largest dairy market in the world with two million dairy cows. 70,000 dairy animals currently reside in Kern County near Bakersfield, California, which, therefore, represents a prime example of the kind of area that will support significant integration opportunities leveraged through the use of Bion's environmental compliance technology.

As technology provider, Bion will be responsible for construction and operation of these retrofit projects, and anticipates generation of revenue from multiple sources, including:

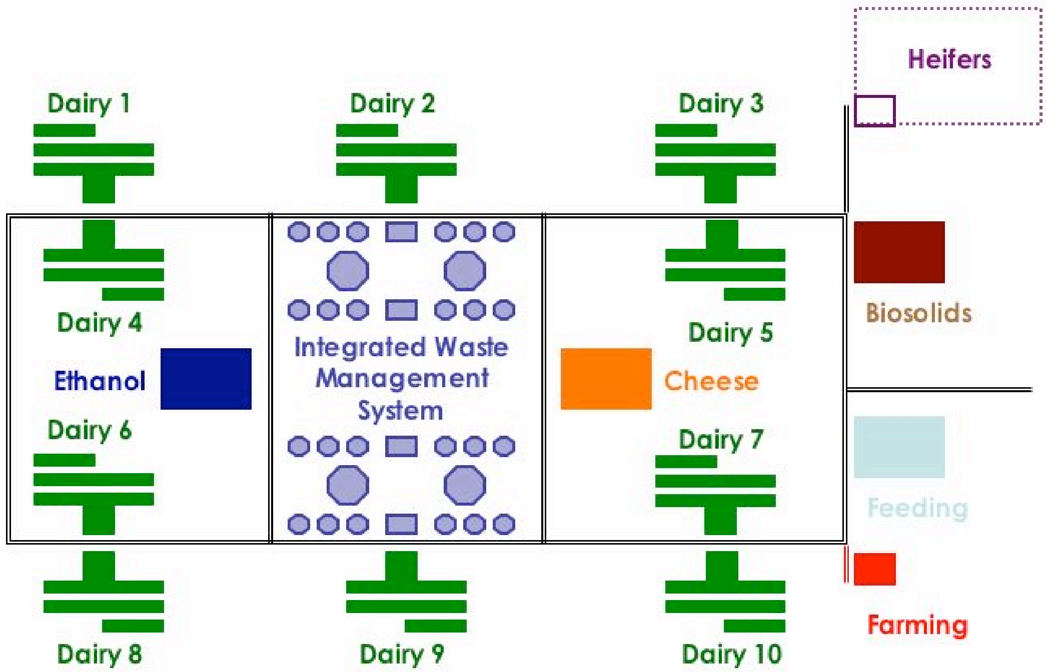
- One time technology license fees of approximately $200-$250 per cow;
- Annual fees in the $200-250/year per cow;
- Possible installation O&M service contacts;
- Environmental credits; and
- Development of markets for its processed solids as either an organic fertilizer or a high protein feed product.

Bion can also provide its environmental technology through centralized manure treatment facilities (CPFs) to that portion of the dairy industry (smaller farms and farms located in small, concentrated geographic areas) that would otherwise bear significantly greater capital and operating costs per unit of production if implementing environmental compliance technology individually. Bion believes that implementation by smaller dairies will require restructuring on a local level to enable them to achieve a minimum percentage of the available benefits of herd concentration and scale to justify implementation of Bion's technology for environmental cleanup.

The "Dairy Park" Business : The larger, long-term opportunity for Bion remains in the development of a proprietary business, referred to as Dairy Parks (DPs). DPs are greenfield, large-scale, integrated projects that can be populated by the end product producers (i.e.—cheese, milk or ice cream plants, etc.) and large dairy producer groups with Bion providing development services along with the environmental technology integration. Development of these large, multi-function ag-production facilities will involve integration of complementary business opportunities such as ethanol and anaerobic digestion. Bion projects that its proprietary Dairy Park business will eventually house (at minimum) an additional 500,000 cows beyond those served through its retrofit and CPF business (approximately 12 Dairy Parks).

Bion expects to retain an equity position in certain components of the projects it develops DPs. Integration opportunities in which Bion intends to retain an equity position include the production and marketing of solids, ethanol and distiller grains feed products as well as energy generation, and, in some DPs, the dairy herd/milk production and end-product user.

Conceptual Integrated Dairy Park Layout



Bion's role in the Dairy Park business will have evolved from that of a technology provider and financial partner limited to waste management and possibly renewable energy, to include the activities of developer/ integrator and joint venture participant. As a developer, Bion would secure the site, local and state permits and financing for all aspects of the project. Bion would secure the dairy producers and end product manufacturers, such as a cheese plant, to occupy and lease the facilities. In certain instances Bion may elect to partner directly with the other DP participants and as a result own a direct equity interest in the dairy herd and/or end product producer. In return, these participants may seek such a business JV relationship to diversify and gain access to Bion's more stable and predictable cash flow components of user fees, renewable energy and feed mill activities.

It is important to note that in a DP, Bion's technology creates the integration opportunities that significantly reduce the capital and operating costs for every DP participant. In particular, Bion anticipates that revenues from its "Dairy Park" business will be generated from:

- Revenues as detailed above, including license fees, annual fees, marketing of solids and capture of environmental credits;
- Increased access to lower-cost capital; and
- Its equity position in selected components of the integrated facility.

-

Other Initiatives: Bion has a number of other initiatives under negotiation/discussion including a potential demonstration hog project in Canada with a major hog producer. Canada is a Kyoto

Treaty signatory. As a result, new large livestock projects in Canada, as well as for all Kyoto Treaty signatories, will have to use technology that mitigates emissions of greenhouse gases.

Intellectual Property

In June 21, 2005 Bion was awarded patent # 6,908,495 titled **Low Oxygen Organic Waste Bioconversion System.** The authors are Bion's Technology Director, Dr. Jere Northrop, PhD., who received the initial patents on earlier versions of this process starting in 1988, and Dr. James Morris, PhD, P.E., Bion's Chief Technology Officer.

This patent is a 'divisional' (extension) of our previous process patent #6,689,274 issued on February 10, 2004 and provides considerably wider protection than the initial Bion biological process patent. With this publication and issuance, Bion's technology now has protection under nine (9) US patents, one Canadian and one US patent pending (Bion biological phosphorus removal patent application). In addition, it is anticipated that Bion will also be receiving parallel patents from a number of other targeted countries and the European Union.

Other patents owned by Bion include the following:

US Pat No	Date issued	Title
4,721,569	1/26/88	Phosphorus Treatment Process
5,078,882	1/7/92	Bioconversion Reactor and System
5,472,472	12/5/95	Animal Waste Bioconversion System
5,538,529	7/23/96	Bioconverted Nutrient Rich Humus - CIP of A3
5,626,644	5/6/97	Storm Water Remediatory Bioconversion System – CIP of A3
5,755,852	5/26/98	Bioconverted Nutrient Rich Humus - CIP of A4

Canadian Patents

1,336,623	8/8/95	Aqueous Stream Treatment Process (Canada)

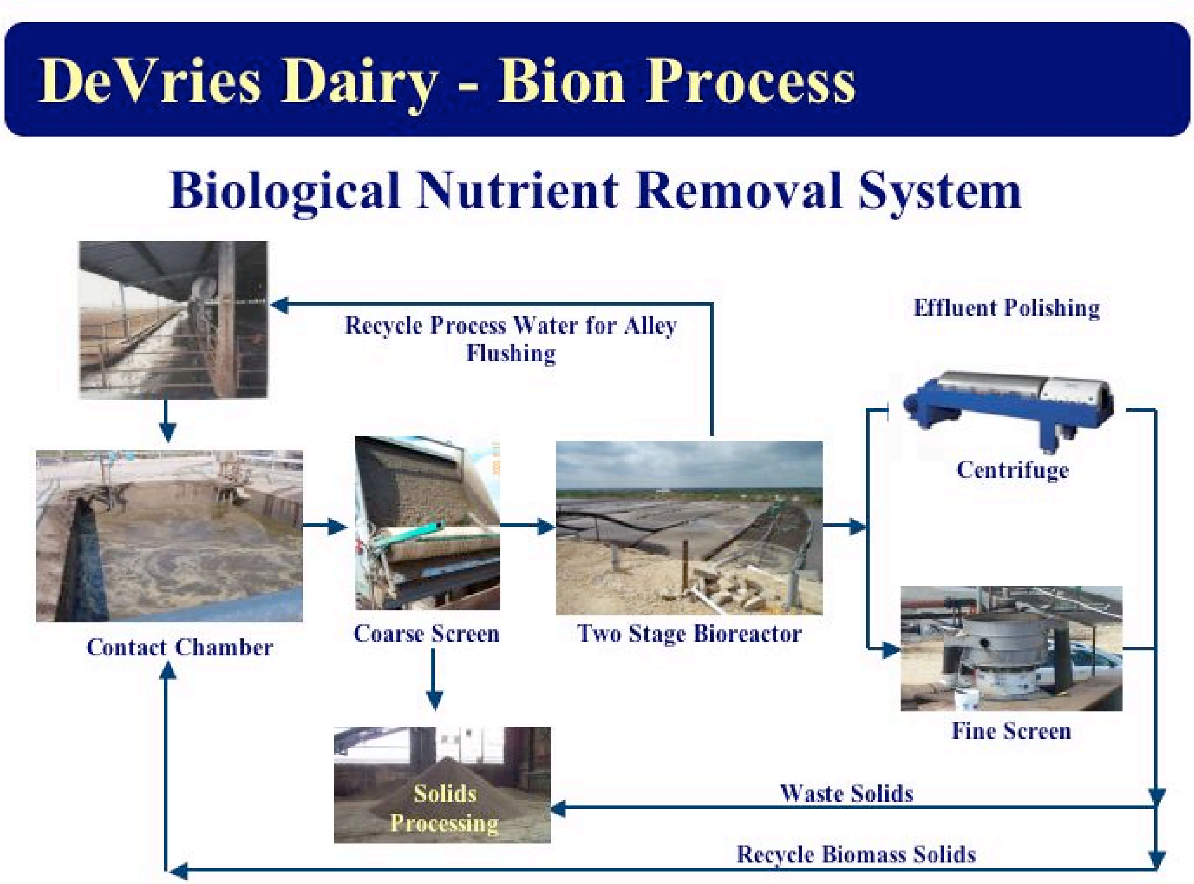
FUTURE EQUITY FINANCING

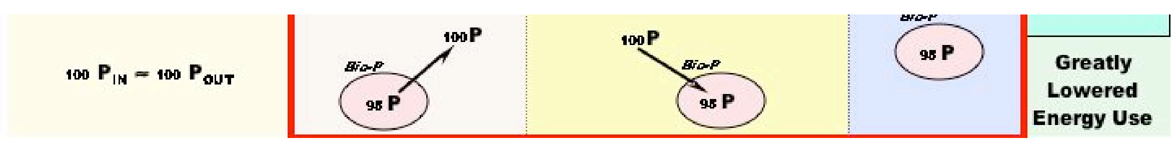
To meet future requirements for capital, Bion has entered into an investment banking relationship with Ardour Capital Investments ('Ardour') pursuant to which Ardour will serve, commencing this later this Fall, as Bion's financial advisor with regard to raising capital through the equity markets. Ardour will assist Bion in raising both equity for corporate uses and the equity component required for upcoming project financing.

Ardour provides a wide range of financial services for both public and private energy technology companies. Ardour also supplies investors with an independent brand of research not traditionally found within the securities industry. Ardour has made a commitment to be a leading research institution in the Energy Technology/Alternative Power sector. For more information, go to: www.ardourcapital.com.

Air and Water Testing Results from DeVries Dairy

The following is a system diagram of a Bion system and a diagram showing the underlying biochemistry:





During early 2004 a team of independent experts was assembled to design a protocol to determine the releases to water and emissions to air of Bion's high rate animal waste treatment system installed at the 1,300-cow DeVries Dairy in Dublin, Texas.

The protocol, data and reports, which were published in final form on December 22, 2004, are downloadable from www.biontech.com.

Third Party Review and Demonstration Scrutiny: The independent team that developed and/or approved the protocol and subsequently reviewed all performance data involved the following scientists:

- Lynne H. Moss, P.E., DEE; Mark Gould, P.E. DEE; Clyde Burnett, P.E. DEE - Camp, Dresser & McKee
- Richard Nicolai, PhD, P.E. South Dakota State University
- Richard Stowell, PhD, University of Nebraska - Lincoln
- William Clarkson, PhD, P.E. Oklahoma State University - Tulsa
- Kevin Young, P.E. J.R., Wauford & Co.

Other parties who provided input into the testing protocol and accepted the testing protocols included:

- Raymond Loehr, PhD, University of Texas
- Ron Heavner, USDA/NRCS/CED
- Dave Warner, San Joaquin Valley Unified Air Pollution Control District.

John R. Smith and Anna M. Rodrigues of the Texas Commission on Environmental Quality witnessed water and air sample collection.

MidWest Laboratories analyzed collected water samples and Ace Laboratories analyzed collected air samples. In both cases, the laboratories used are certified laboratories and are entirely independent of Bion.

In addition, representatives of numerous Congressional offices, the Mayor of Waco, and representatives from numerous environmental groups, including the Sierra Club and Waterkeeper Alliance, visited the operating Bion system at the Devries Dairy.

Summary Results: In summary, the water results showed that only 4% of the original Phosphorus input and only 10% of the original Nitrogen input remained in soluble form in the effluent, 40% of the Nitrogen being converted to inert Nitrogen gas and the remaining Nitrogen and Phosphorus incorporated into solid form. On a whole farm basis, the Bion System produced a 74% reduction of nitrogen and a 79% reduction of phosphorus. The air results show that the Bion system limited emissions as follows: (in pounds per 1,400 pound dairy cow per year):

- Ammonia 0.20
- Hydrogen Sulfide 0.56
- Volatile Organic Compounds 0.08
- Nitrogen Oxides 0.17

These emissions represent a reduction from published baselines by 95%-99%

Based upon these results, Bion received a letter from California's South Coast Air Quality Management District (SCAQMD) dated February 1, 2005 stating that Bion's NMS microaerobic animal waste treatment process qualifies under SCAQMD's new Rule 1127 dealing with Emissions Reductions From Livestock Waste.

Because of this great concentration of cows and the ongoing litigations, regulation promulgation, and specifically as a result of a settlement agreement between the SJVUAPCD and Western United Dairymen, a trade association, new research was undertaken to address the dairy industries challenge to the California Air Resources Board that the existing emission factor of 12.8 pounds of VOCs per cow per year overstated the actual releases.

New research was conducted with the results provided to a Dairy Permitting Advisory Group, which consisted of representatives of the dairy industry, regulators and environmentalists who made recommendations to the Air Pollution Control officer of SJVUAPCD. In August 2005, the Air Pollution Control Officer come out with their VOC revised emission factor which is 19.3 pounds of VOCs per cow per year. As a result, dairy cows emit more VOCs in the Central Valley than cars and refineries combined.

This research found that the composition of the emissions previously measured as NMOC or VOC (volatile organic carbon) included significant amounts of acetone (which is not in the EPA VOC definition) and did not include a number of reactive gases of concern which are components of VOCs but not measured by the established standard VOC sampling and analytical techniques. Compounds unmeasured included some alcohols, volatile fatty acids (VFAs), phenols and amines. This California research thus indicated new techniques for more precise sampling and analysis of VOCs.

Based upon the methodologies that were developed for the research which supported the new emission factor, Bion retested the VOCs emitted by its process in DeVries Dairy.

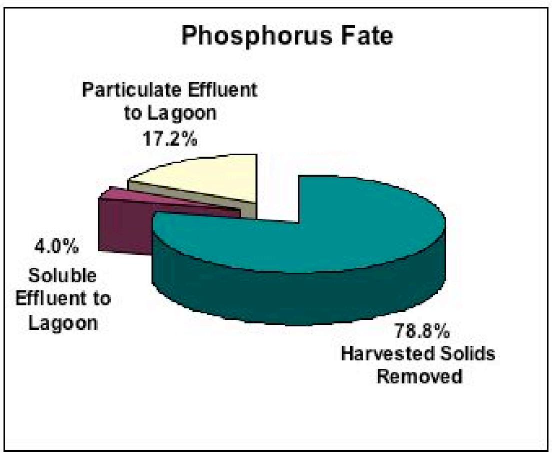
These independent lab results document non-enteric emissions of approximately 0.08 pounds per 1400 pound dairy cow per year of Reactive Organic Gases (ROGs) or 80 lbs per year for a 1000 cow dairy from the Bion system prior to discharge to the storage lagoon serving the DeVries 1250 cow free-stall flush-lane dairy in Dublin, Texas.

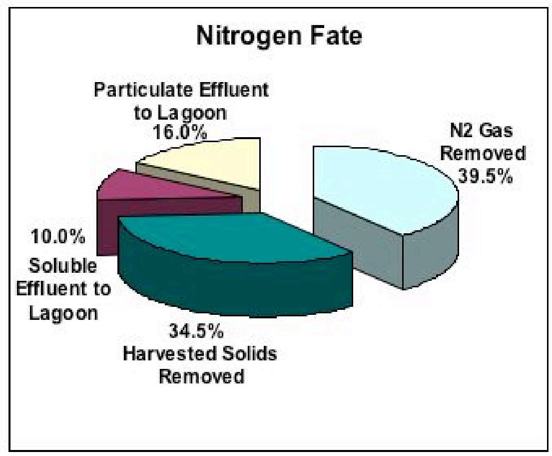
To incorporate these findings into its recent study, Bion used Columbia Analytical Laboratories in Simi Valley California (www.caslab.com) that had prepared standards, and developed and published methods for sampling and analyzing these categories of VOCs. In addition to a total volatile organic compounds measurement based upon gas chromatograph mass spectroscopy data, the library of additional standards and tests consisted of 17 VFAs, 13 amines, 10 phenols and cresols, methanol, ethanol, isopropyl alcohol, acetone, and methane. The sampling involved the collection of composite emissions over a 48 hour period in vacuum canisters as well as in a variety of sorbent tubes. Sorbent tubes allow the air being sampled to flow through media having a selective affinity for the target compounds sought, trapping them to then be released and analyzed in the laboratory. The technical improvements incorporated into the new study resulted in detection limits in the parts per billion range (ppb) for each specie or component of VOCs.

Using these more accurate techniques, and computing all non-detect values as producing emissions at one-half the detection limit, resulted in the currently reported value of approximately 0.08 pounds VOCs per cow per year.

Nitrogen and Phosphorus Pollution Reduction

- On-farm P Levels Reduced by 79%
- On-farm N Levels Reduced by 74%





BION NMS™ RESULTS FOR AIR EMISSIONS

Total System Average Emissions In Lb/1,000 Lb Animal-Year		
	7/12/05 – 7/14/05	**4/20/04-7/15/04**
Methane - CH_4	**28.81**	**27.49**
Hydrogen sulfide – H_2S	**0.48**	**0.40**
Ammonia – NH_3	**0.43**	**0.14**
VOCs	**0.057**	**NA**
NMOCs	**NA**	**0.020**

Regulatory Background

The Clean Water Act (CWA)

In enforcing the Clean Water Act, new regulatory requirements as of April 2003 by the Environmental Protection Agency (EPA) mandate that dairy CAFO's of 700 cows or more apply for a National Pollutant Discharge Elimination System (NPDES) permit. Among other parameters, these permits require the applicant to quantify their current releases. To regulate and control their animals' releases to fresh and groundwater, CAFO's must develop and implement site specific nutrient management plans to ensure proper and effective manure and wastewater management, including compliance with the Effluent Limitation Guidelines. Failure to do so will now bring enforcement action. CAFO's are now required to secure water permits as well as being regulated as to their discharges. If they exceed their permit allowances, they can be shut down and/or be subject to large fines.

CAFO farmers have been spreading manure on land as the way to dispose of those nutrients (principally nitrogen and phosphorus). Depending on the location, they require 1-2 acres of farmland per dairy cow cultivated with crops to allow manure application at a non-polluting agronomic rate at which crops/land would supposedly assimilate these nutrients. Under the new regulations, CAFO's must now meet nutrient application standards for disposal of their manure which requires the land to be tested for its ability to absorb nutrients as well as the manure to be tested to determine the nutrient load. As a result, many existing dairy farms cannot meet this standard and either need to acquire or rent additional land for disposal or need to transport solids to other locations. Lastly, the land application of manure is now being regulated to limit application to those seasons when an uptake crop is actively taking nutrients from the ground. This requirement demands additional manure storage capacity (and related costs).

A June 2003 US Department of Agriculture (USDA) Economic Research Service report states that only 2% of dairies have an adequate land base to meet a strict phosphorus-based standard of the new EPA regulations. As a result, the costs of either acquiring additional arable land, at an average of $2,000 per acre, or trucking and disposing of the manure off site, becomes a large additional cost to the existing dairy industry.

The Clean Air Act (CAA)

The Clean Air Act, among other things, regulates the emissions by "Stationary Sources of Criteria Air Pollutants," such as acid rain, smog and ground-level ozone causing gases. In the past, CAFO's had been exempted from the Act. Yet farms are a major source of air pollution, especially in places like California's central valley. Dairy manure and its decomposition produce the Criteria Pollutants of methane, sulfur dioxide (SOx), ammonia, which becomes nitrous oxides (NOx) and other gases.

In May 2002, a successful suit against the EPA resulted in a settlement/ruling that there was no basis for excluding CAFO's for regulation under the CAA. Denying an appeal by the California Farm Bureau of the lower court ruling, the Federal Ninth Circuit Court in California reaffirmed on July 15, 2003 that CAFO's are Stationary Sources of Criteria Air Pollutants and they must now gain permitting for and regulate their releases to air under the CAA. In the ruling the court stated that "blanket exemptions from regulation for entire industries ... violate the Clean Air Act." The farming exemption, the court ruled, had helped guarantee that residents of the state's central valley "will continue to breathe air that fails to meet national health-based standards." California's farms must now regulate polluting emissions from farms.

In September of 2003, Senator Florez's bill SB 700 became law in California. This legislation provides that CAFO's will no longer be exempted from having to employ Best Available Technology (BAT) in mitigating the waste releases from farm animals (primarily dairy cows in California). Farmers developing new farms are regulated as of January 1, 2004, and existing dairies need to comply by January 1, 2006. The existing law now requires that dairies fully implement solutions to these polluting releases irrespective of costs.

In Oct 2004, the 10th Circuit Court ruled that, just like in other parts of the Comprehensive Environmental, Response, Compensation, and Liability Act, the term "facility" should be given a broad reading when weighing whether animal farm emissions have to be reported. In this instance, the court's ruling meant that all the ammonia emissions from an Oklahoma pig-farming operation, consisting of two separate contiguous farms and numerous buildings and emissions points, will be aggregated together to determine whether those emissions triggered federal reporting requirements.

In June 2005 in California, the Air Resources Board (CARB) ruled that dairies larger than 1,000 cows in non-attainment areas and 2,000 cows in attainment areas will be regulated for their emissions to air.

In August 2005, the SJVAPCD, in response to a settlement agreement with the dairy industry brought on by a suit which charged that there was no basis for using CARBs placeholder VOC emission factor of 12.8 pounds per cow per year, ruled that there are instead [at least] 20.6 pounds of VOC emissions per cow per year, making the VOCs from cows in Central Valley greater than cars and refineries combined. This near doubling of the threshold which the dairy industry had claimed was too high by half, set the stage for the awareness by the California dairy industry that dairies are going to be seriously (and not just perfunctorily or cosmetically) regulated for their emissions. Shortly after this, new litigation (currently pending) commenced against a dairy claiming that they had begun construction of a facilities expansion without getting a permit.

In January 2005, California also passed rules requiring a 30% reduction in Greenhouse Warming Gases from cars and light trucks over the next 12 years. While it does not specifically apply to CAFOs, these are the first Greenhouse Gas regulations in the United States and Bion's process mitigates 9.3 tonnes of Greenhouse Gases per cow per year.

CAFO regulations in other states are following similar paths to California. For example, in March 2005, a Florida appeals court today ruled that industrial style dairies can no longer dump manure-polluted waste into state waters and directed the Florida Department of Environmental Protection (DEP) to start enforcing water protection laws.

There are many pending litigation cases in other states charging that CAFO's should be regulated under the CAA just like any other industry. The Company believes that other states, which neither have the resources to undergo this litigation nor the millions of dollars to research and develop their own CAFO regulations, will adopt a version of the California legislation (and regulations adopted pursuant thereto).

For all intents and purposes, dairy farming has suddenly changed. On a nationwide basis, CAFO's releases to water are starting to regulated. It is expected that soon CAFO's releases to air will also be regulated nationwide. The need for a process that provides a comprehensive solution to polluting releases to water and emissions to air is apparent.

International Law

The Kyoto Treaty, which is a global compact on Greenhouse Warming Gases has been ratified. Countries that are signatories and companies that do business in signatory countries must make provision for mitigation of Greenhouse Warming Gases including carbon dioxide, methane and nitrous oxides (NOx) in the construction of any new CAFO facility. CAFO's produce carbon dioxide, methane and NOx. While CAFO's are considered to be 'carbon neutral' from a carbon dioxide perspective (the carbon dioxide that the animals respire is equal to the carbon dioxide taken up by the plants which the cows eat), the methane and NOx produced by CAFO's must be mitigated. On a molecule-to-molecule basis, methane and NOx's contribution to climate change are respectively 21X and 310X, greater than the impact of carbon dioxide.

Europe is already not meeting its commitments for Greenhouse Gas reductions and, as a result, prices of Carbon Credits have gone up (to $28 per tonne per year as of Oct 5, 2005). Based on the documented, published reductions of methane and NOx produced by the Bion process (see www.biontech.com), the Bion process offsets the equivalent of 9.3 tonnes of Greenhouse Warming Gases per cow per year. At recent price levels, this reduction has a potential value to Bion equivalent to approximately $260 of carbon credits per cow per year.

Emission Reduction Credits, Nutrient Credits and Carbon Credits

Emission Reduction Credits (ERC's) are a potentially large revenue stream which may be generated by the Bion AWMS technology under certain political, regulatory and economic circumstances which are not yet fully in place. To date the Company has neither applied for nor has it been granted ERC's for any of its existing projects. To a large extent, the purpose of the Texas installation and trials was to provide for third parties' documentation of emission levels from the Bion AWMS which can then be used to calculate the available ERC's once a scientific, regulatory baseline has been adopted

Emission Reduction Credits

On March 29, 1993, the Chicago Board of Trade added a new tradable commodity to its array of frozen orange juice and pork belly futures – permits to pollute the air. Under a sealed bid system $21.4 million was paid for the right to emit 150,010 tons of sulfur dioxide from the purchasers' smokestacks (a primary cause of acid rain). The money went to companies that used low sulfur coal or Best Available Technology in pollution remediation.
Created by the CAA as a way to use market forces (and not government handouts) in offsetting the releases of air pollutants, ERC's have been traded throughout much of the country since 1993. Now that dairy emissions are to be regulated, the Company anticipates that its installations will be able to realize revenues from ERC's once dairy industry "baselines" are established and federal and state policy makers finalize and implement ERC procedures presently under development by the Air Quality Task Force (AQTF) (a joint EPA/USDA task force). The AQTF has endorsed the trading of ERC's from agricultural sources, but to date no specific regulations enabling trading have been adopted. Since CAFO's are now designated in California as Stationary Sources of Criteria Air Pollutants (such as acid rain causing, smog producing and ground level ozone causing gases), the ERC provisions of the CAA should apply.

While credits are often sold directly from the producer/owner of the credit to a party wishing to use the credit, they are also brokered. Cantor Fitzgerald Environmental Brokerage Service, Natsource and Evolution Markets, among others, trade these credits.

An active trading market in air pollution emission reduction credits exists throughout much of the country and around the world. For example, the ERC market price index of trades for thirty year contracts through Cantor Fitzgerald Environmental Brokerage Service in October 21, 2005, were at $24,500 per ton of NOx ERC's , VOC's (like methane) traded at $8,000 per ton, and SOx at $5,900 per ton for reductions in the San Joaquin Valley, California. NOx ERC's have already been awarded for emission reduction on diesel engine emission reductions used on agricultural projects in central California for $25,000 to $40,000 per ton of annual reduction for long-term contracts.

As the impacts of Acid Rain and Ozone Causing gases are regional, the value of the ERC's is different in different air management districts. According to Cantor Fitzgerald Environmental Brokerage Services, NOx ERC's, for example, on October 21, 2005, traded for $55,000 per ton in San Diego, CA, more than twice the price in the San Joaquin Valley.

Bion's AWMS process mitigates the releases of methane, nitrous oxides, ammonia and hydrogen sulfide. To the extent that the AWMS mitigates these releases compared to a regulatory/scientific baseline, the Company will be able to own and trade these credits in the future. Bion is closely monitoring developments in this area.

Greenhouse Gas – Carbon Credits

Like the CAA, the Kyoto Treaty has a provision for the earning and trading of carbon dioxide emission reduction credits – carbon credits. In anticipation of its ratification, carbon credits have been trading for several years.

In January 2005 the European Union carbon credit trading program commenced, The market for these credits has been predicted to grow to $40 to $100 billion per year. Europe is already not meeting its commitments for Greenhouse Gas reductions and, as a result, the prices of Carbon Credits has gone up (to $28 per tonne as of Oct 5, 2005). With the known reductions of methane and NOx for the Bion process, the Bion process offsets the equivalent of 9.3 tonnes of Greenhouse Warming Gases per cow per year. At current levels, this is the equivalent of $260 of carbon credits per cow per year.

AgCert, a privately owned company, has been awarded an approved protocol for taking animal manure, placing it a lined hole in the ground, flaring the methane gas which results, and earning tradable carbon credits. Bion believes that CAFO operations utilizing its technology in Kyoto signatory countries (including Canada) will be able to qualify for such credits. Bion is in the early stages of evaluating the business opportunities this potentially creates for the Company.

Nutrient Credits

Current EPA regulations under the Clean Water Act require that dairy CAFO's of 700 cows or more secure permits for their nutrient releases to water. It is anticipated that this will become the basis for the eventual widespread trading of "nutrient credits" in the United States.

In the Brazos River watershed, a subsidy with an economic effect on agriculture similar to credits has already commenced. In this watershed district, high concentrations of phosphorus in the water (and soil) represent the major pollution problem. The problem is so severe that, in addition to limiting the size of dairy farms, innovative regulators at the Texas Natural Resource Conservation Commission (TNRCC) have indirectly implemented the equivalent of a nutrient credit by subsidizing soil/manure sales that remove the nutrients from the watershed.

The TNRCC has reserved a portion of its federal Clean Water Act, Section 319(h) grant funds for incentive payments (rebates) to governmental purchasers (grantees) of composted dairy manure originating from the North Bosque and Leon River watersheds. This program is part of a joint state and federal non-point source pollution abatement initiative. Through composting excess livestock manure and selling the product to state and local agencies for erosion control and landscaping purposes, this project reduces the impairment of water resources both where the manure originates and where the compost is used.

This program pays $5 per cubic yard of composted manure. Approximately 6 cubic yards of composted manure is produced per dairy cow per year in a Bion AWMS. The existing, full-size Texas Bion retrofit AWMS facility may be able to take advantage of these "nutrient credits" if the Company elects to keep it in operation after the testing period has been completed.

It costs $22, on average, to remove one pound of phosphorus from the liquid waste stream in a municipal treatment facility in the U.S. today. With 37 pounds of phosphorus in the manure of a 1,400# dairy cow per year, it would cost $814 per year to remove that much phosphorus using municipal wastewater technology.

In another "nutrient credit" equivalent type program, the Brazos River Water Authority is currently offering for a limited time, $35 per dairy cow to dairies to physically remove the manure from the watershed area so that the nutrients do not re-enter the Brazos River.

There are 32 different local nutrient trading programs around the United States. To help save the Chesapeake Bay, in April 2005 Virginia instituted a statewide nutrient credit trading program. Other states are following suit.

The Company believes that at some point in the not to distant future, offset credits will probably be established to incentivize nitrogen and phosphorus removal from watersheds in much of the country. This will enable municipalities (and their taxpayers) to offset the economic burden on municipal utilities by eliminating the need to spend this much on nutrient remediation. Based on results of the AWMS at the Texas installation and in prior installations, the Company believes that the Bion AWMS will remove phosphorus and nitrogen at a small fraction of the cost of other treatment processes, thereby providing the economic and technical basis for profitable trading of "nutrient credits" in the future to the benefit of the Company, the dairy industry, the municipalities and the environment.

Competition
The Company knows of no other technology/company that makes a claim that its technology comprehensively mitigates the polluting releases to water and emissions to air from CAFOs. Further,the Company has not seen any peer reviewed data or data resulting from independent laboratory testing which indicates that there are other commercial technologies out that mitigate CAFOs polluting releases to water and the emissions to air to the extent of the documented reductions by the Company's technology.

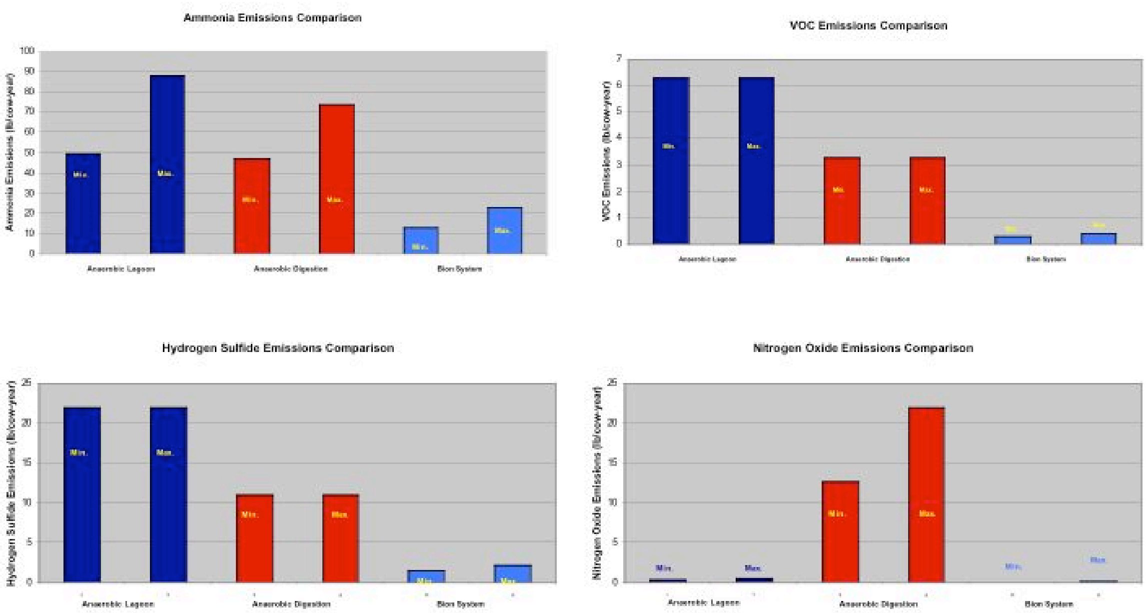
Anaerobic digestion technology is sometimes mistakenly considered a pollution control technology, but it is an energy solution, not an environmental solution. It captures the energy value from the manure but does not significantly mitigate the polluting emissions to air nor the releases to water. Compared to Bion's technology which has been documented to reduced nitrogen and phosphorus releases by 74% and 79%, respectively, anaerobic digestion creates releases of only 5-10%. While Bion's technology reduces polluting gaseous releases to the atmosphere by 95-99+%, anaerobic digestion produces far lower reductions (and may, in fact, increase methane emissions).. (See ww.biontech.com and the July 2005 report commissioned by Western United Dairymen and produced by Sustainable Conservation titled Biomethane from Dairy Waste, by a paper authored by John H. Martin, Jr. PhD for the US EPA AgStar program written March 2003 titled, A Comparison of Dairy Cattle Manure Management with and without Anaerobic Digestion and Biogas Utilization and by the April 2004 draft Best Available Control Technology (BACT) Dairy Operations Evaluated by: Lead Engineer – Carlos Garcia for the SJVAPCD.)

Below is a table prepared by Bion using data from the DeVries operations for Bion and by John Martin for an EPA AgStar Report for Anaerobic digestion.

Releases to Water: Bion System vs Anaerobic Digestion*
Fate of Nitrogen (N) and Phosphorus (P)
***based upon EPA AgStar Study by J Martin, PhD**

	Bion System	Anaerobic Digester
N released as inert N_2 gas	**40%**	**0%**
N removed in organic solids	**34%**	**5%**
Balance of N in effluents	**26%**	**95%**
P removed in organic solids	**79%**	**5%**
Balance of P in effluents	**21%**	**95%**

Anaerobic Lagoon & Digester vs Bion's Microaerobic Process



Bion does not see Anaerobic digestion as competitive to Bion but complementary as an anaerobic system can be sited upstream of a Bion system and sized to economically harness the methane and then send its effluents to the Bion system for treatment.

The EPA Region IX in California has put together a group of stakeholders called the Dairy Manure Collaborative to evaluate various manure management technologies. The list of candidate technologies which address one or several aspects of manure management are as follows:

Company	Website
Advanced Concept Technologies	
Agricultural Modeling & Training Systems	www.agmodelsystems.com (active June 1 2005)
Agricultural Sustainable Energy Tech.	www.aset.us
Agricultural Waste Solutions	N. A.
Agrimass Enviro-Energy	www.agrimassenviroenergy.com
Agrimass-Induced Blanket Reactor	www.agrimassenviroenergy.com
AgSmart	www.agsmart.com
Air Diffusion Systems	www.airdiffusion.com
Baumgartner Environics - Nitrification/Denitrification (NDN) Nutrient Management System	www.beiagsolutions.com
Baumgartner Environics - Bio-CurtainÒ plus Electrostatic Particulate Precipitation Management System	www.beiagsolutions.com
Bencyn West	www.bwisolutions.com

Bigadan	www.bigadan.com
Bio Cap	www.beiagsolutions.com
Biogas Technology	www.greenfinch.co.uk
Bion Dairy Corp.	biontech.com
CH2M Hill	www.ch2m.com/composting
Coaltec Energy	www.cdp.siu.edu
Engineered Compost Systems	www.compostsystems.com
Everstech Consulting (UK)	www.everstech.com
Flex Energy	www.flexenergy.com
Haskell Edwards	
HumaCal	midwesternbioag.com
Integrated Separations Solutions	isepsol.com
Jeesung Livestock	www.jeesungle.com
Kyte Centrifuge	www.kcentrifuge.com
Lanstar Enviro	
Natural Aeration	CIRCUL8.com
Nutrient Control Systems	integrityagsysems.com
Omnifuel Technologies	www.downstreamsystems.com
Primenergy	www.primenergy.com
Pro-Act Microbial	www.ProActMicrobial.com
Pyromex	www.ils-partners.com
Sprecher Architects	www.loewenwelding.com
Waste Technology Transfer	
Wildcat Manufacturing	www.wildcatmfg.com
WoodChips	
Sharp Energy	
Warren Hutchings	www.advancedaeration.com
Hydrolve	www.hydrolve.com
Organic Waste Management	
Octaform	www.octaform.com
Agriventures	
Baleen Filters	www.baleen.com
Tennessee Valley Authority	www.tva.gov/environment/envservices

We do not believe any of these competitors is able to produce the pollution mitigation results and the economic opportunities that result from installation of Bion's technology. However, we have not reviewed the full product lines of

APPENDIX 2

Description of Hypothetical Feeding Operation Layout

MEMORANDUM

DATE: August 1, 2007

TO: Philip K. Hopke, Shane W. Rogers, Stefan Grimberg

FROM: James Morris

RE: **Information responses to Hopke et al.**

~~~~~~

Information requested 7/29/07:

1) Module configuration for 14K beef finishing.
Generic feeding operation site plan with animal housing proximity, buffer zones, and neighbors considered.

2) Wetlands effluent discharge.

Response:

1) Beef Finishing Module 14K

There is no typical barn or module layout. The shape and distribution of housing units and waste management system components will be greatly influenced by the specific site(s) selected. Site topography, soil/geology and land uses will greatly influence design. However, some general statements and guiding principles about a generic feeding module are worth noting.

All six modules will likely be within an average distance of about ten (10) miles from the central ethanol production and feedstock storage units. It is anticipated that this central facility will have rail access to the St. Lawrence Seaway. The 14K Module sites will be in rural, low population density, agricultural locations in the northern tier of St. Lawrence County and western Franklin County.

Depending on site specifics, it is anticipated that each 14K Module will be allocated between 200 and 300 acres. Each module is likely to have four barns at 3.5K animals each. Each barn will occupy about 2.0 acres, and thus each of the distributed six 14K cattle feeding modules will occupy around 9.5 to 10 acres with ancillaries. The waste management system including all access roads, berms, storage (liquids and solids) and the constructed wetlands with phosphorous polishing will require in the neighborhood of 12 to 14 acres. As will be discussed in detail in the next section below, it is judged that the final effluent discharged from the entire waste management system will require between 40 and 180 acres under irrigation depending upon the specific soils and topography used. Considering the 22 to 24 acres for the housing

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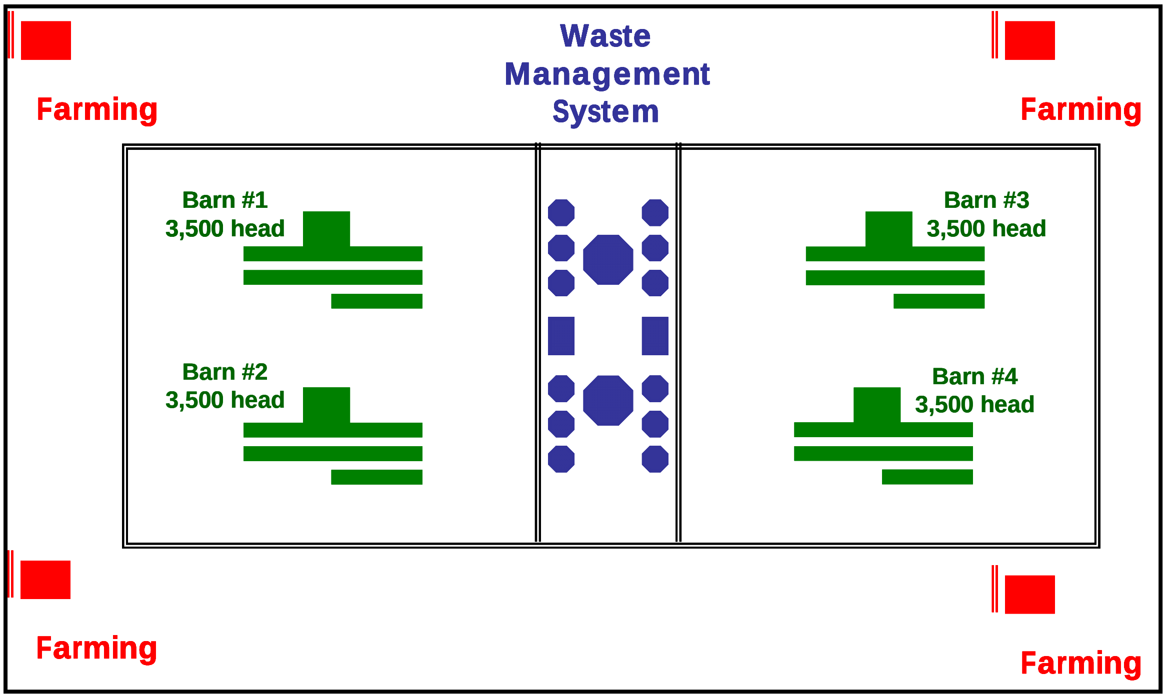
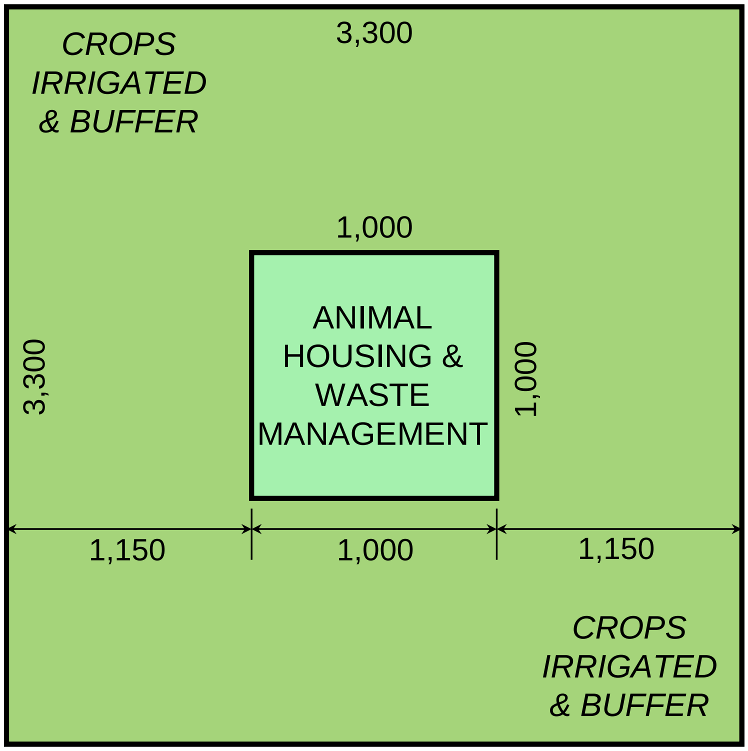
units and waste management system, it seems reasonable to expect that the entire farm module will occupy approximately 100 to 200 acres of the 200 to 300 acres allocated. A generic plan is presented below.



If for evaluation purposes a square configuration is assumed for the allocation of say 250 acres, the distance along each side will be about 3,300 feet. If the housing and waste management components are a square in the middle of the allocated module it would be about 1,000 feet on a side for an estimated needed 23 acres. Thus, the 1,150 feet remaining around the barns and pollution control can be occupied by the irrigated crops required for effluent disposal. This means that if modules were to be located adjacent to each other, there would be a minimum buffer distance between these control units and barns and the next source of 2,300 feet and to any neighboring fence-line of 1,150 feet. Reasonable site location should be able to secure separation distances several times these compact minimums in practice. Given the process for securing available land and the rural nature of the area in general, it is most likely these modules will be on the order of miles apart.



The beef finishing animals will consist of approximately 75% beef animals and 25% dairy steers being raised for beef production. This results in a typical module having three beef barns and one steer barn. The animals will be housed in barns that are for the most part totally enclosed, with controlled ventilation and temperature to minimize animal stress, but increase animal comfort to maximize weight gain and quality. Often the barn sides are arranged so that they may be opened during warm weather.

The entire floor of the beef barns will be slotted concrete. This system is already used in some of the newer more progressive installations. Manure will fall through the slots into collection channels below. The urine drains immediately of course and at 88%+ moisture most of the remainder of the manure flows readily through the slots with foot traffic moving the accumulating material down and into the removal channel below. The removal channels are equipped with continuous drag-out scrappers systems (some installations flush these channels as well). The residence times are typically on the order of a few hours in the channels before being deposited into the manure pickup pits at the end of each barn. The pits most often are equipped with mixers and the manure is removed using standard manure vacuum wagons three or more times daily. Active ventilation in the barns is arranged to draw air downwards through the slots and from outside through the storage pits and the removal channels (more or less a tunnel ventilation arrangement in the collection channels). The outlets to the channel ventilation may be managed as needed.

The dairy steer barns will have the same slotted floor system for about a third (or somewhat less) of the area with two-thirds (or the balance) being solid concrete. The slotted floors will be along the feed bunks. This area is where the animals are most active and move around while feeding. Consequently this is where most of the manure gets deposited and is removed through the slotted floor as in the beef barns. Dairy steers require the solid floor area due to their physiology (beef cattle do not). The solid area will receive bedding at a rate of around 5 lb dry solids per animal daily. Bedding removal occurs as a function of temperature at from 5 to 20 days or so. Animal health and well-being dictates that odors must be controlled and these modern units with near continuous bedding additions are low odor producers by design. Bedding material will be dry (~40% solids), very coarse, high cellulosic solids generated by the waste management system.

The specific location of all barns and waste management components at any given site will take into consideration proximity and location of the closest receptor sites (residences, etc.). To the extent possible predominant wind direction, site and surrounding topography, existing wooded areas, and other complimenting land uses which can serve a buffering function, will be carefully considered and used to the extent possible to reduce air emission impacts for all component layouts and designs.

It is worth emphasizing that these animal production installations will not be feedlots. There will be no animals housed in outdoor earthen pens with manure storage piles, which in wet weather many times results in mud up to the animal's bellies. Such feedlot configurations are not remotely similar to the animal production housing units to be built for the anticipated project.

2) Constructed Wetlands System Effluent discharge

Summary:

A 14,000 head beef operation effluent from a North American Wetlands Engineering (NAWE) vertical flow aerated constructed wetlands discharging 100,000 gal/day at 30/30/10/2 is judged to require between 40 and 180 acres to receive this discharge for crop irrigation depending on the specific soil conditions, slopes, etc.

Details:

The NAWE Vertical Flow Aerated Constructed Wetland will be designed to produce an effluent stream that is low in solids and nutrients such that hydraulic loading is the limiting factor for irrigation. The design effluent will contain on average 30 mg TSS/L, 30 mg cBOD5/L, 10 mg TKN/L and 2 mg TP/L at the discharge rate of 100,000 gal/day.

Maximum application on any given day is 16,000 gal/acre-day by NY/DEP standards for land spreading.

This is equivalent to 0.59 inches / day maximum on any <u>one day</u>. The generally applied rule of thumb is 1 to 2 inches <u>per week</u> or 5% of the permeability of the most restrictive soil layer.

USEPA models estimate that storage due to weather conditions will be required for about 130 days / year in the Massena area. This assumes application limited by rainfall and cold conditions. The cold conditions portion may be reduced but the full 130 days will be considered here to be conservative. Thus, 365 – 130 = 235 days are available for irrigating the

100,000 gal / day flow from the constructed wetland (the constructed wetland flow is also conservatively high as it does not account for reductions due to evapotranspiration in the wetlands) serving a 14,000 beef operation.

First look at the flow taken per average week if 235 / 7 = 33.6 weeks is used.

The flow is (100,000 gal/day)(365 days/year)(year / 33.6 application weeks) =
= 1,085,000 gal/week

(1,085,000 gal/week)(acre-inch / 27,152 gal) = **39.3** acre-inch/week

If the rule of thumb maximum of 1 inch/week is assumed (substantially less than the 0.59 inch/day of the NY/DEP maximum) then **39.3 acres** will be required.

Another conservative way to look at acreage required would be to assume that the entire flow could only increase the infiltration by 20% of the annual amount absorbed from rainfall. This approach assumes that the agronomic soils in the area could easily handle this 20% increase without significant mounding. The annual precipitation for this region is about 36 inches/year. If all the precipitation occurred on application days, then the 20% rate would be:

(36 inches/year)(0.20)(year/33.6 application weeks) = 0.22 inch/application week

This would require:

(39.3 acre-inch/week) / (0.22 inch/week) = 181 acres

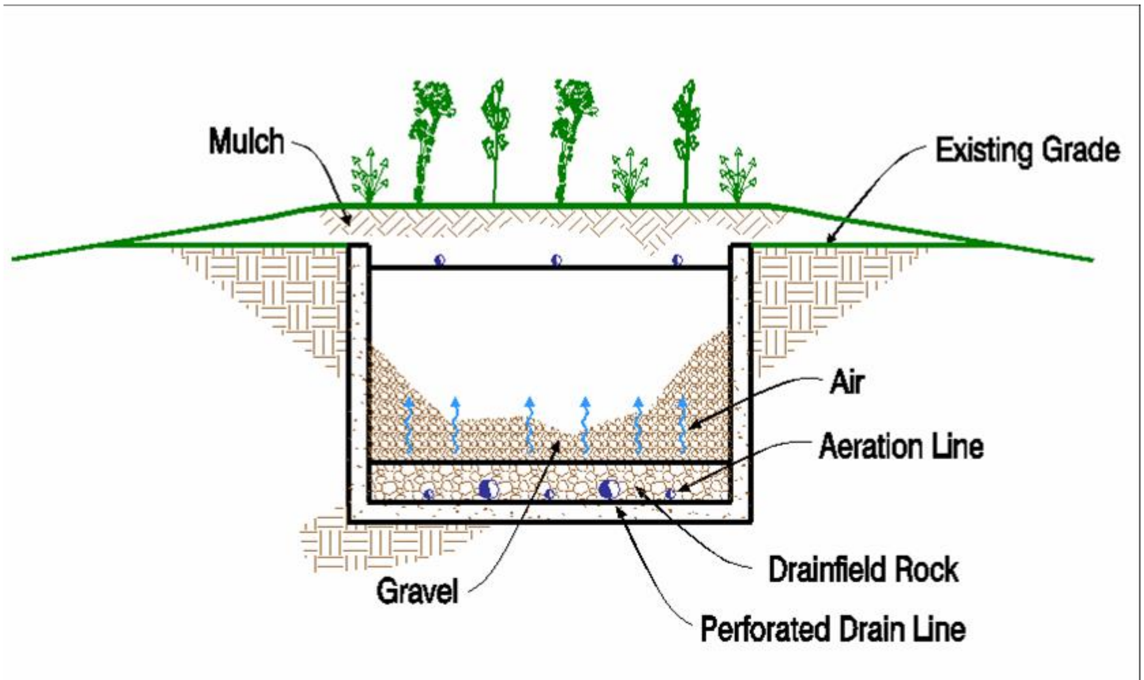
Another conservative estimate could be made based on the 5% rule applied to the most restrictive permeability of any layer of the design soil. A rate of soil permeability of 0.1 inches/hour is considered a slowly permeable soil. Agronomic soils that have low permeabilities are at about 0.3 inch/hour. If such a marginally permeable soil is in the acreage available then by the 5% rule:

(0.1 to 0.3 inch/hour)(24 hour/day)(7 day/week)(0.05) = 0.84 to 2.5 inch/week maximum load

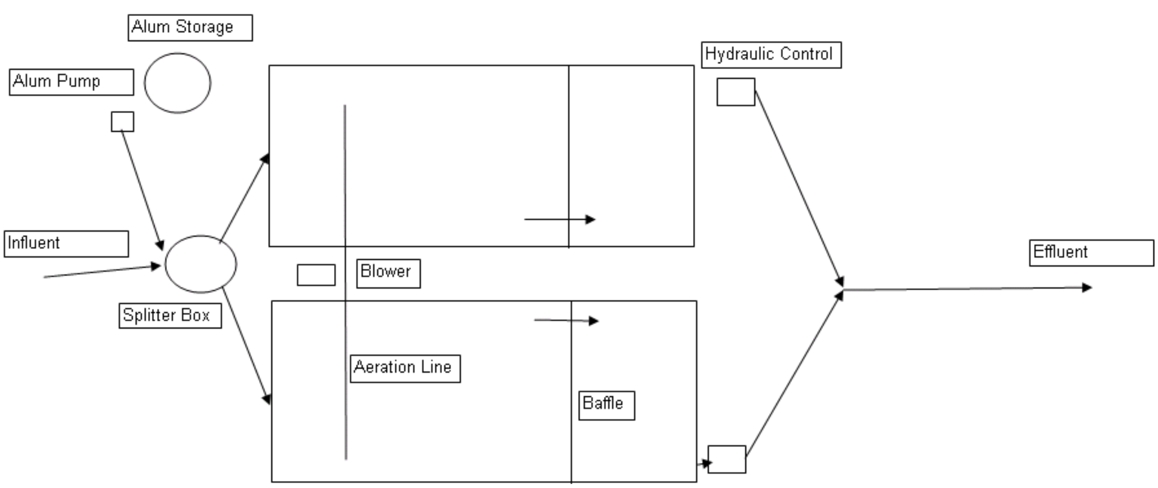
(just at or greater than 1 inch rule of thumb maximum)

Thus, for a 14,000 head beef operation effluent from a NAWE vertical flow aerated constructed wetlands discharging 100,000 gal/day, it is judged that between 40 and 180 acres will be required depending on the specific soil conditions, slopes, etc. Perhaps it is appropriate to note that for a typical installation without an environmental control system the acreage would be orders of magnitude larger.

Though descriptions and schematics of the constructed wetlands with phosphorous removal have been furnished previously, conceptual layouts are provided below for current context.



Conceptual cross-section of a typical vertical flow aerated constructed wetlands treatment cell as proposed for this project.



Phosphorus Removal System Conceptual Process Schematic.

APPENDIX 3

Bion Estimates of Odor Control Factors

MEMORANDUM

DATE: September 5, 2007

TO: Philip K. Hopke, Shane W. Rogers, Stefan Grimberg

FROM: James Morris

RE: **Information responses to Hopke et al.**

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Information requested 9/4/07:

We [the Hopke team] are working on the estimation of the odor emissions and have come upon a list of odor control measures and how effectively they mitigate odor emissions.

Odor Control Technology		Control Factor
No odor control technology		1.0
Biofilter on 100% of building exhaust air		0.1
Geotextile Cover (≥ 2.4 mm)		0.5
Straw or Natural Crust on Manure		
	4"	0.5
	8"	0.3
Impermeable Cover		0.1
Oil Sprinkling		0.8

1) We would like to get you estimate of the likely control factor that would be obtained by using the: a) slotted floor, b) frequent collection of the manure, and c) the use of the bioreactor (management system components).

2) Also as an aside, we were wondering about the plans for processing the cattle. We assume that the plan would be to butcher the cattle need the feeding operation so that the shipping is of the meat and not the cattle. We have not seen any indication of how that would work and since it would clearly create a number of additional jobs, we wondered what your thoughts were on how the beef would get to market.

Response:

1) Estimates of odor emission control factors

There is always some trepidation in approaching such a question because, to some unknown extent, it is quite likely that comparisons and estimates will be on an "apples to oranges" basis. However, a response will be offered hoping that the basis can be placed within a context that avoids "apples to gravel" bases.

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Your enquiry is based upon three waste system components, which can indeed have a direct impact compared to typical manure management approaches. It would seem the crucial key would be the formulation of the baseline animal husbandry situation used as the basis for comparison. When looking at the control factor table provided, it appears that these factors are being applied to several different or specific components of a management system or even to entirely different management approaches. The responses below are in the order of the most direct data and certainty of impact to defined system components, to the least.

c) Bion process bioreactor

There are two excellent sources of comparison for the specific potential odor causing agents of ammonia, hydrogen sulfide and VOCs.

The report available on the Bion web site, "DeVries Dairy Bion NMS Nutrient and Atmospheric Emission Quantification Project Analytical Approach Details and Results," presents the emission rates obtained directly from the Bion bioreactor. These emission rates are directly compared to the range of emission rates found from the literature in another document available on the Bion web page, "Dairy Farm Atmospheric Emissions Control Using a Microaerobic Biological Nutrient Removal (BNR) Process," by James W. Morris, Ph.D., P.E., Jere Northrop, Ph.D., George W. Bloom, P.E., and Stephen J. Pagano. (Paper is to be published in Proceedings of the American Society of Agricultural and Biological Engineering 2007 International Symposium on Air Quality and Waste Management for Agriculture.) If a copy of this was not provided directly to you please accept our apologies. (For your convenience a copy has been attached to this email.)

Please direct your attention to Table 3 on page six of the Air and Waste paper.

<u>Ammonia:</u>

The direct measure of ammonia emissions from the Bion process is 0.091 Kg NH_3/cow-yr. If the facility's (whole farm) entire manure management system from voiding by the animal through, and including, emissions from solids and final liquid effluent applied to cropland as predicted by a simple modeling effort by Bion and the San Joaquin Valley Air Pollution Control District's Permit Division (SJVAPCD/PD) is considered as the basis, the facility served by a Bion system will emit 2.0 Kg NH_3/cow-yr is predicted. If the direct Bion emissions are compared to the anaerobic lagoon emission rage of 20 to 40 Kg NH_3/cow-yr then the reduction by the Bion process is 99.5% to 99.8%. This would seem to give an **ammonia control factor of <u>0.01</u>** for comparison to the table values you provided, <u>compared to an anaerobic lagoon</u>. If the whole farm emissions of ammonia of from 79.1 to 132 Kg NH_3/cow-yr from an entire facility are compared a reduction of from 97% to 98% is expected. This appears to give an **ammonia control factor of <u>0.02</u>** for comparison to the table values you provided, <u>compared to emissions from an entire facility served by an anaerobic lagoon</u>.

<u>Hydrogen Sulfide:</u>

Similarly, direct Bion process emissions were measured to be 0.18 Kg H_2S/cow-yr. The Bion and SJVAPCD/PD model predicts 0.84 Kg H_2S/cow-yr for an entire facility served by a Bion system. Thus, when compared directly from the Bion process and directly from an anaerobic lagoon at 10 Kg H_2S/cow-yr the reduction would be 98%. For an entire facility the expected reduction would be 92%. This would seem to give a **hydrogen sulfide control factor of <u>0.02</u>** for comparison to the table values you provided, <u>compared to an anaerobic lagoon</u> and a **control factor of <u>0.08</u>** <u>compared to emissions from an entire facility served by an anaerobic lagoon</u>.

<u>VOCs:</u>

Again, direct Bion process emissions were measured to be 0.036 Kg VOC/cow-yr. The Bion and SJVAPCD/PD model predicts 1.3 Kg VOC/cow-yr for an entire facility served by a Bion system. Thus, when compared directly from the Bion process and directly from an anaerobic lagoon at 0.68 to 2.9 Kg VOC/cow-yr the reduction would be 95% to 98%. For an entire facility at 3.5 Kg VOC/cow-yr the expected reduction would be 63%. This would seem to give a **VOC control factor of 0.05** for comparison to the table values you provided, <u>compared to an anaerobic lagoon</u> and a **control factor of 0.4** <u>compared to emissions from an entire facility served by an anaerobic lagoon</u>.

The details behind these specific baselines and reductions are in the attached paper and / or on our website.

b) Frequent Manure Collection:

From the summary results for emissions measurements on page 49 of the DeVries document ("DeVries Dairy Bion NMS Nutrient and Atmospheric Emission Quantification Project Analytical Approach Details and Results") it is noted that even for parameters measured during the periods of likely highest emission rates there contribution "appears small in comparison to that coming from the bioreactors." Although no attempt was made to fully quantify the area mass emission rates it appears to be reasonably unlikely that significant additional average daily mass emissions occur for any of the parameters compared to directly from the bioreactor.

The DeVries system was flush lanes, thoroughly flush three times daily. Measurements in the barns were taken six inches above the lane, at the very beginning of flush cycles, when the full fresh manure load was just being moved and odor generation appeared to be the highest. The manure would leave the animal area continuously in the currently proposed design. The barn floors are expected to remain mostly dry as was the case for the flush lanes between flushings. Manure will be removed continuously from the collection trenches and collected at least three times daily or continuously pumped from storage (mixed only during pumping or removal).

Though anecdotal evidence suggests that odor generation from manure while resident in the animal housing units will be small compared to emissions from the process itself for this type of housing arrangement (and somewhat supported by the limited data gathered), there will be some odor generated from these units. If this proves inaccurate and substantial emissions were found to be produced by these units, then appropriate steps (such as biofilters or other management approaches) would be taken to mitigate these emissions. For this current exercise it would appear prudent to perhaps assign a conservatively high **odor emission control factor of <u>0.1</u>** to characterize the <u>impact of frequent manure removal</u>. If this odor potential were to be compared to a typical feedlot, having penned areas with stacked manure storage within the pens, and frequent wet conditions typical for installations in the northeastern United States, then the factor **should be judged appreciably less**. But in this case it is very difficult to know the appropriate baseline situation against which such an odor control factor is properly applied.

a) Slotted Floor:

Unlike the discussion for frequent manure removal in response (b) above, there is no data in hand to be considered. However, based on visits to barns employing this configuration and the claims made from various studies, it would appear that the effect of keeping the material continually drained and worked by traffic out of the animal housing unit and away from the animals themselves is substantial. The animals in such barns seem clean and odor levels very low.

In most other respects the considerations here are reflected in and tied to the frequent manure removal. It is anticipated that positive ventilation will induce air flow down through the slots for potential collection and further treatment if needed as mentioned above as well.

Thus again, for this current exercise it would appear prudent to perhaps assign a conservatively high **odor emission control factor of 0.1** to characterize the impact of slotted floors. If this odor potential were to be compared to a typical feedlot, having penned areas with stacked manure storage within the pens, and frequent wet conditions typical for installations in the northeastern United States, then the factor **should be judged appreciably less**. But, as in the previous case, it is very difficult to know the appropriate baseline situation against which such an odor control factor is properly applied.

2) Market Path for Animal Products Produced (aside)

Bion does not currently have specific plans to include a beef cattle slaughter facility with its integrated project in St. Lawrence County. At least initially, beef cattle will be shipped out of the region to appropriate existing facilities for slaughter. Any future change to this configuration will require a full regulatory review of the proposed facility at that time. In any event, it appears that activities in support of the further handling and processing of animal products would not at all likely have an impact on livestock-based air emissions or odor generation from farm operations. Nor does it seem probable that such activities would have any significant odor generation impact upon the anticipated emissions from a 250-300 acre livestock facility having 14,000 head of beef finishing animals.