

REPORT OF THE GOVERNOR'S
BLUE RIBBON
CITIZENS *PFIESTERIA PISCICIDA* ACTION COMMISSION
NOVEMBER 3, 1997

The Honorable Harry Hughes, Chairman
The Honorable Bernie Fowler, Vice Chairman
Senator Brian Frosh
Delegate Ronald A. Guns
William C. Baker
The Honorable Clinton S. Bradley, III
Frederick W. Nelson, Jr.
The Honorable Lloyd L. Simpkins
Dr. Alfred Sommer
Dr. Dolores Margaret Richard Spikes
Dr. John Toll
Joseph C. Bryce, Commission Staff

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INTRODUCTION

In the Fall of 1996, and again in the Spring of 1997, Pocomoke River watermen reported finding lesions on high percentages of their fish catches from the lower Pocomoke. Typically, lesions on fish can be attributed to several different causes, including injury, secondary infections, toxic chemical effects, viral infection and potentially toxic dinoflagellates. After months of comprehensive water quality testing, in the late Spring it was suspected that Maryland's waterways faced a difficult challenge from little-known but potentially harmful microorganisms, *Pfiesteria piscicida* and closely related species. On August 6, 1997, hundreds of dead and dying fish were found in the Pocomoke River near Shelltown. The fish kill, which continued for 4 days, prompted State and local officials to close a portion of the Pocomoke River from August 7 through August 13. Water samples taken at the time of the fish kill tested positive for the toxic dinoflagellate, *Pfiesteria*.

Throughout the Spring and Summer, officials from the Department of Health and Mental Hygiene worked with the local health departments on the Lower Eastern Shore to learn about *Pfiesteria* and to evaluate persons who had concerns about their contact with fish with lesions. These activities led to the creation of a Medical Team, headed by Dr. Glenn Morris. The Medical Team evaluated 13 people who had intensive exposure to the Pocomoke River or who complained of symptoms they believed were related to exposure to fish lesions.

A second fish kill began in Virginia waters of the Pocomoke Sound on August 26. Maryland officials discovered fish with lesions and low numbers of dead menhaden in portions of the Pocomoke, leading to the closure of the impacted segments of the River on August 27 and August 28. Fish, water, sediment and *Pfiesteria* samples confirmed the presence of toxic levels of a *Pfiesteria*-like organism. On August 29, Governor Parris N. Glendening was informed by the Department of Health and Mental Hygiene of the Medical Team's preliminary conclusions about the public health effects of exposure to the toxins released by *Pfiesteria* and *Pfiesteria*-like dinoflagellates. The Governor and the local health officer closed the Pocomoke River on August 29 from Powell Wharf Road to the Maryland State Line as a result of the Medical Team's preliminary conclusions and the continuing *Pfiesteria* activity on the River. The River was reopened on October 3, 1997 in accordance with the provisions of the River Closing and Reopening Protocol that the State implemented after input from medical and scientific experts.

On September 10, 1997, Governor Glendening and the local health officer closed Kings Creek off the Manokin River in Somerset County after a significant number of menhaden were found in distress with *Pfiesteria*-like lesions. Four days later, a portion of the Chicamacomico River in Dorchester County was closed after a similar discovery of distressed fish. Tests revealed the presence of toxic *Pfiesteria*-like dinoflagellates in both waterways.

On September 15, 1997, Governor Glendening appointed the members of the Blue Ribbon Citizens *Pfiesteria* Action Commission. The Commission was issued a broad charge and asked to report back to the public, the Governor and the General Assembly by November 1, 1997. The Commission held 12 meetings, all of which were open to the public, in Annapolis, Princess Anne and Chestertown. A copy of the Commission's membership roster, the Charge to the Commission and the agenda from each meeting are attached as Appendix 1. A chronology of events is attached as Appendix 2.

APPROACH OF THE COMMISSION

Maryland's experience with *Pfiesteria* has received national attention. Maryland's seafood industry struggled immediately after the fish kills, due to consumer uncertainty about the safety of eating fish. State, federal and private efforts to restore consumer confidence are in progress. Tourism on the Eastern Shore has suffered, as the Commission heard at the public hearing held at the University of Maryland Eastern Shore. Media attention on agriculture and the poultry industry has led to unfortunate and baseless speculation that Maryland may lose a portion of this large industry.

Impacts of *Pfiesteria* have been felt by the entire seafood industry – from the waterman who catches the fish or the charter boat captain who guides the recreational fisher through our waters, through the restaurant worker who serves the meal and the retailer who sells the fish. Another large industry, tourism, will suffer if people are not confident that the Chesapeake Bay and its tributaries remain safe to swim in, fish in and recreate on. The poultry industry is a large and welcome employer on the Delmarva Peninsula and agriculture is a respected part of the history and culture of Maryland and its Eastern Shore. Nothing is gained if Marylanders and this Commission are forced to choose between the environment, the seafood industry, the poultry industry, tourism and agriculture. All of these things can thrive and coexist if we all work together.

The Commission, therefore, has been mindful throughout this process that all Marylanders are in this together. No one person or industry is responsible for causing this problem or for polluting the Bay, and altering one type of behavior or practice is not going to make these problems go away. Every environmental problem has many causes and widespread effects. With creative thinking and partnership, however, such crises can have diverse, broad-based solutions that are implemented by many people. The Commission's recommendations are meant to be fair, practical and the responsibility of every Marylander.

The Commission also recognizes that the *Pfiesteria* problem will not be solved overnight. Just as most environmental problems occur for many reasons, such problems occur over periods of time and can only be addressed over time. Maryland should not expect to be free of toxic outbreaks of *Pfiesteria* in the Spring and Summer of 1998. In fact, the experience in North Carolina and in other states leads us to the conclusion that toxic outbreaks of *Pfiesteria* affecting fish may well occur again next year. Maryland's 1997 experiences should enable us to continue to manage this problem effectively and protect the public if these outbreaks recur. Many of the Commission's recommendations involve additional research needs and endorse technologies or management approaches that are not yet fully developed or implemented, in recognition of the need to implement a continuing and evolving solution.

The Commission also recognizes the need to be guided by science in addressing this problem. The Commission has asked for input from many of the leading scientists in Maryland, the region and in the federal government. We believe that the findings and recommendations contained in this Report are based on the best available scientific information and we strongly encourage continued and intense research into the many issues surrounding *Pfiesteria*.

Throughout its deliberations, the Commission has been concerned about the need to solve environmental and economic challenges on a regional and, when appropriate, national basis. The Chesapeake Bay and its tributaries do not reside in Maryland alone. The Commission believes that the convening of the Governors' Summit in Annapolis on September 19, 1997 was an important symbolic and substantive step towards regional cooperation. The quality of the water in the rivers in Pennsylvania, Delaware, West Virginia, Virginia and Maryland has an impact on the Bay and on the downstream waterways in adjacent states. Similarly, the grain and poultry farmers on Maryland's Eastern Shore are in close and direct competition with farms in neighboring states. The poultry industry has a major impact on the region and competes nationally.

The Commission urges the states in the region to work together to implement the common sense solutions offered in this Report. Permanent and constructive solutions will only be achieved if we find regional solutions to regional problems. Similarly, we encourage the federal government to adopt national solutions to many of these problems so that Maryland's industries and citizens are not put at a competitive or economic disadvantage because of our efforts to preserve this precious natural resource.

Throughout this Report, the Commission offers recommendations that will cost money. In some instances, the Commission was able to easily identify possible sources of necessary funds. In other instances, we suggested possible funding sources. It is apparent that it will be necessary for the State to devote additional resources to address the issues raised in this Report. Governor Glendening has indicated a willingness to propose such spending, as evidenced by the State's expenditures on seafood marketing, cover crops, additional positions and health studies, as well as the considerable staff time that has been spent on *Pfiesteria* by personnel in the Governor's Office and the Departments of Agriculture (MDA), the Environment (MDE), Health and Mental Hygiene (DHMH) and Natural Resources (DNR). For many of these recommendations, including the equipment necessary for the use of the phytase enzyme and the establishment of composting pilot projects, it may be possible to utilize existing economic development programs in the Department of Business and Economic Development (DBED). Some recommendations call for the expansion or funding of established programs in MDA, MDE and DNR. Innovative programs may be implemented in cooperation with Maryland Environmental Service and the Maryland Department of Energy. The Delmarva Poultry Industry, Inc. has, so far, pledged to spend \$1 million over 4 years and has indicated a willingness to be flexible on the use of the money. In implementing these recommendations, the State should explore all possible State and federal agency options, industry contributions and the development of private sector opportunities and markets.

THE SAFETY OF MARYLAND SEAFOOD

Maryland has received national attention for its efforts to respond to the toxic outbreaks of *Pfiesteria* and to inform the public about the organism and the health impacts associated with exposure to the toxins emitted by this dinoflagellate. An unfortunate result of this attention has been a negative impact on sales of Maryland seafood. Ironically, some merchants advertised the fact that their seafood was harvested in North Carolina, not Maryland, despite the fact that North Carolina's experience with *Pfiesteria* has lasted longer and been more severe than our State's experience.

The Commission finds that all of the best available scientific evidence leads to the conclusion that Maryland seafood remains safe to eat. This conclusion is drawn after a careful evaluation of testimony presented to the Commission and research conducted by the federal Food and Drug Administration. The Maryland Department of the Environment has been testing fish tissue samples taken from Pocomoke River fish for PCBs, metals and pesticides. Department officials testified before the Commission on September 24 and October 17, 1997, that most values were below detection levels, and all values were well within the range safe for human consumption. This information is attached as Appendix 3.

Dr. George Hoskin, Director of the Division of Science and Applied Technology, Office of Seafood, Food and Drug Administration, testified that federal studies have not revealed any dangers associated with eating seafood from Maryland. Dr. Hoskin indicated that existing research seems to show that seafood is not a "vehicle" for transmitting the toxins produced by *Pfiesteria*. Dr. Fred Shank, Director of FDA's Center for Food Safety and Applied Nutrition, testified before Congress on September 25, 1997 that FDA has tested crabs from the Pocomoke River and "found no evidence of toxicity attributable to *Pfiesteria*." Dr. Shank also testified that "to date, no evidence has been identified to suggest a hazard for human consumption of seafood associated with *Pfiesteria*."

It is certainly understandable that citizens have expressed concern about the safety of seafood at the time a new and mysterious microbe was identified in Maryland's waters. As is often the case, such concerns can be overcome once information is provided about the issue and myths are addressed and adequately explained. Maryland acted quickly to partner with the private sector to educate the public about the safety of Maryland seafood and to initiate a comprehensive seafood marketing campaign. The Commission endorses the State's efforts to market the quality and safety of our seafood. We encourage the State to continue its enhanced education and marketing efforts, and we encourage restaurateurs, retailers and distributors to continue to participate in these efforts.

The Commission recognizes the importance of our seafood industry to Maryland's economy. It is terribly important that those who make a living on the Bay are supported during these challenging times. Senator Sarbanes testified that the Maryland Congressional delegation is seeking the establishment of a disaster relief fund in the Department of Commerce's Economic Development Administration to assist watermen through economic hardship resulting from this type of environmental disaster. The delegation is also seeking annual funding for the National Fisheries Institute to assess the economic impact of these occurrences on key coastal waters, and to work with the states to develop enhanced seafood marketing plans to promote seafood sales domestically and internationally. The Commission supports the efforts of Senator Sarbanes and Maryland's Congressional delegation to secure \$1 million in federal aid for Maryland's seafood industry, as Senator Sarbanes described to the Commission. There is precedent for such aid, and we encourage

the Department of Commerce and the National Fisheries Institute to expedite the approval of Maryland's request for federal assistance.

PFIESTERIA: THE ORGANISM, TOXIC OUTBREAKS AND THE ROLE OF NUTRIENTS

The knowledge about *Pfiesteria* is evolving and will likely not be brought to a satisfactory level for many years. As the Commission began its work, we recognized that we would not have every answer to every complex question. This Report and our recommendations are necessarily based on the status of the science as of this date. It is our hope that the Report will be used as a departure point for the efforts of Maryland and the nation to understand and manage this problem. One of our most important functions will be the identification of unanswered questions and our thoughts on how science should approach the study of this fascinating organism. We have a responsibility, however, to summarize our collective knowledge about *Pfiesteria* and the many peripheral issues at this time.

At the request of Chairman Hughes, Dr. Donald F. Boesch, President of the University of Maryland Center for Environmental Science, convened a forum of noted scientists from this region to examine the existing body of scientific work on *Pfiesteria* and *Pfiesteria*-like organisms. The group issued a report, attached as Appendix 4, and presented its findings to the Commission on October 17, 1997. After much discussion, the Commission adopts the scientific findings and conclusions contained in the forum's report, The Cambridge Consensus, named for where the forum was held.

Although the Commission adopts the findings of the Cambridge Forum, it may be helpful to highlight portions of their findings. *Pfiesteria* and related dinoflagellates are protists; single-celled eucaryotic micro-organisms. They are not strictly plants or animals, as they do not have their own capacity for photosynthesis. Bacteria have been observed within the cells of *Pfiesteria piscicida*, perhaps as symbionts. Research is needed to determine whether symbiotic bacteria play a role in toxin formation, as is believed to be the case with some other dinoflagellates.

The Commission received much testimony regarding the possible role of nutrients in the development and proliferation of *Pfiesteria* populations, and in the transformation of the organism into a toxic stage. The role of nutrients in algal blooms around the world is well documented. Laboratory research conducted by Dr. JoAnn Burkholder, the scientist credited with the discovery of the organism, has demonstrated that the growth of non-toxic stages of *Pfiesteria* can be stimulated by the addition of inorganic and organic nutrients. Field studies conducted by Dr. Burkholder have demonstrated a correlation between phosphorus-rich waste outfalls and high concentrations of non-toxic *Pfiesteria*. Dr. Burkholder also testified about a discharge event from a swine waste lagoon that led to an algal bloom, the proliferation of *Pfiesteria* and a subsequent fish kill. These findings were carefully reviewed by the scientists participating in the Cambridge Forum.

It is important to note, however, that not all toxic outbreaks of *Pfiesteria* occurred in nutrient-enriched waters. It is estimated that in North Carolina 75% of such outbreaks occur in nutrient-enriched waterways; 25%, therefore, occurred in relatively less enriched environments.

Currently, it is not clear what triggers *Pfiesteria* to transform into a toxic stage. The Cambridge Forum found, and the Commission agrees, that high nutrient concentrations are not required for *Pfiesteria* and *Pfiesteria*-like dinoflagellates to turn toxic. In fact, if suitable concentrations of *Pfiesteria* are present, toxic outbreaks can occur even if nutrient concentrations are relatively low. Scientists believe, and the Commission concurs, that the

primary stimuli for the transformation of the dinoflagellate into toxic stages are chemical cues secreted or excreted by the fish. In other words, fish must be present for a toxic outbreak to occur.

Simply stated, it appears that excessive nutrient loadings help create an environment rich in microbial prey and organic matter that the *Pfiesteria* use as a food supply. By increasing the concentration of *Pfiesteria*, nutrient loads increase the likelihood of a toxic outbreak when adequate numbers of fish are present. However, just as not every toxic outbreak of *Pfiesteria* occurs in nutrient-enriched environments, not every nutrient-enriched environment contains a high population of *Pfiesteria*. The Department of Natural Resources has developed a profile of a river that is vulnerable to experiencing a problem with toxic *Pfiesteria* outbreaks based on Maryland's experience, particularly in the Pocomoke River (attached as Appendix 5), and based on the characteristics of other rivers that have had problems with dinoflagellates. This profile has been reviewed by the scientists participating in the Cambridge Forum. A vulnerable river segment has shallow, quiescent waters with salinity and temperature levels within the organism's tolerance range. The slow-moving, shallow water and increased light availability allow algae to utilize nutrients that have perhaps entered the waterway upstream. *Pfiesteria* prey on the abundant algae, while menhaden and other fish prey in the same area on plankton that thrives under similar conditions.

During the course of the Commission's deliberations, citizens have suggested possible direct or indirect contributing factors for the Commission to examine. It has been suggested that pesticides may contribute to the proliferation of *Pfiesteria*. Fish tissue, water and sediment samples analyzed by the Department of the Environment (and referred to earlier in this Report), however, do not support this theory. Analysis of these samples consistently and almost uniformly failed to find toxic contaminants at potentially harmful levels. Similarly, it is unlikely that copper or other trace metals are responsible for reducing populations of other organisms that may feed on *Pfiesteria*-like dinoflagellates, therefore contributing to the outbreaks of toxic *Pfiesteria*. Sampling data indicates that copper and trace metal levels are not high in the Pocomoke River. Further, as the Cambridge Forum concluded, in organic-rich waters such as the Pocomoke, copper and other trace metals get surrounded by large organic molecules, rendering the metals non-toxic even in high concentrations.

The Commission examined nutrient trends and attempted to determine why these outbreaks started to occur this year. One factor, which is obviously beyond anyone's control, appears to be the unusually wet weather Maryland experienced in 1996 and during the early part of 1997. This large influx of freshwater into the Bay and estuarine rivers brings with it larger than normal amounts of nutrients from the land. Similarly large freshwater flows also occurred in 1993 and 1994.

The Cambridge Forum reviewed data from the Chesapeake Bay Monitoring Program dating back to 1986 and water quality sampling data from the Maryland Department of Natural Resources in the Pocomoke River, Kings Creek and the Chicamacomico River during June to September 1997. The Forum found that nutrient concentrations in the tidal rivers of Maryland's Lower Eastern Shore are high relative to other rivers with similar salinity. Sampling data taken during and immediately after fish lesion events and fish kills indicate that these areas were zones of high algal abundance. Analyses suggest that nutrient concentrations in the lower portions of some Lower Eastern Shore tidal rivers have increased over the last 12 years. This conclusion can be stated with a greater degree of statistical certainty for nitrogen than for phosphorus, although phosphorus levels in most Eastern Shore waterways have remained level, at best, over this period.

To address nutrient loading problems, one must understand the sources of nutrients in the Bay and its tributaries. The Commission was presented with testimony on this issue by Dr. Walter Boynton and Dr. Boesch. Dr. Boynton presented Bay-wide data on where nitrogen and phosphorus come from, and what happens to these nutrients. Dr. Boynton's nitrogen analysis (attached as Appendix 6) suggests that 12% of nitrogen enters the Bay through acid rain, 28% comes from point sources and 60% arrives from diffuse land sources. Dr. Boesch presented a pie chart on nitrogen loading from human sources (attached as Appendix 7), which estimates that 21% arrives from atmospheric deposition, including that deposited on the land, 9% results from urban runoff, 28% comes from sewage and 42% is from agricultural sources. These figures do not include nitrogen that might naturally runoff from the land. Dr. Boynton's analysis of phosphorus loading (attached as Appendix 8) determined that 7% of the land and air based phosphorus loading comes from acid rain, 35% is from point sources and diffuse land sources account for 58% of the load. In addition, the Bay must handle an additional load of phosphorus equivalent to 37% of that it receives from land-based sources from the Atlantic Ocean.

The Department of Natural Resources and the Department of the Environment presented pie charts that specifically illustrate nitrogen and phosphorus loads in Lower Eastern Shore waters and in the Pocomoke River watershed (attached as Appendix 9). The agencies estimate that approximately 70% of the nitrogen and 70% of the phosphorus load in Lower Eastern Shore waters comes from agricultural sources. While point sources account for only 4% of the nitrogen load, these sources account for approximately 22% of the phosphorus. Urban and residential runoff is the source of approximately 6% of these nutrients.

In the Pocomoke River watershed, approximately 82% of the phosphorus load and 74% of the nitrogen load is from agricultural sources. Urban and residential runoff accounts for 7% of the phosphorus and 9% of the nitrogen. Point sources account for 2% of the nitrogen and 9% of the phosphorus in the watershed.

The Cambridge Forum carefully stated their overall conclusion, a conclusion that is quoted in full below:

In the long term, decreases in nutrient loading will reduce eutrophication, thereby improving water quality, and in this context will likely lower the risk of toxic outbreaks of *Pfiesteria*-like dinoflagellates and harmful algal blooms.

As this Report noted earlier, nutrient reduction will not entirely eliminate the risks of toxic outbreaks of *Pfiesteria* in Maryland or anywhere else in the country. However, after considering the best available science, the Commission concludes that decreasing nutrient loads in the Bay will likely reduce the risk of these outbreaks. In addition, the Commission strongly shares the belief of scientists and the public that reducing the nutrient levels in the Bay is generally good for aquatic life, human health and water quality and should be a focus of our pollution control efforts.

PROPOSED LAND-BASED SOLUTIONS TO THE NUTRIENT LOADING PROBLEM

Nutrients from Urban and Residential Sources

The Commission strongly feels that a wide range of practices contribute to the challenges facing the Bay and its tributaries, and solutions to the problems impacting the Bay need to be addressed State-wide. It is important that everyone realize that the actions taken by each of us has an impact on the Bay. On October 17, 1997, the Commission examined the potential impact of nutrient runoff from lawns, golf courses and other non-agricultural land as a result of fertilizer application.

Approximately 20% of Maryland homeowners utilize the services of a commercial lawn care company. In an attempt to enhance the appearance of lawns across the State and across the country, homeowners apply nutrients to their property. Similarly, golf courses and other landowners apply fertilizer to grass to improve its appearance. Most of the time, fertilizers are applied by commercial applicators without regard to nutrient need analysis as determined by soil sampling. Homeowners often apply fertilizer on their own, some following the instructions on the product more carefully than others. This frequently results in the overapplication of nutrients and/or the deposition of fertilizer on impervious surfaces, which create the possibility of direct runoff of the fertilizer to our waterways and, eventually, the Bay.

Just as nutrient management plans for farms are based on soil samples, the Commission believes that commercial fertilizing professionals should apply nutrients only at a level determined by the needs of the lawn. The soil samples required for this analysis are relatively inexpensive. The Commission recommends that commercial fertilizer applicators be required to perform soil tests prior to fertilizing lawns and other grassy areas. The application of fertilizer should be limited to the amount of nutrients needed to maintain a healthy grass, as determined from the soil analysis.

The Commission understands that most homeowners choose for various reasons to either refrain from fertilizing their lawn, or apply commercially available fertilizers on their own. We believe that homeowners, like commercial fertilizer applicators, are interested in applying only the amount of fertilizer necessary to meet the needs of the grass. This saves money and helps protect the environment. If homeowners and lawn caretakers were provided more comprehensive information about the proper handling and application of fertilizers, nutrient loading as a result of these practices would be reduced. The Commission encourages the State to work with fertilizer manufacturers and retailers to conduct an informational campaign on lawn care needs, proper fertilizer application techniques and the importance of keeping fertilizers off of impervious surfaces. Nutrient Loading from Point Sources

As the testimony of Dr. Boesch and Dr. Boynton points out, point source discharges are a significant source of nitrogen and phosphorus loads in the Chesapeake Bay. However, on the Lower Eastern Shore, the impact from point source discharge is considerably less significant, particularly for nitrogen loads. Point source discharges are regulated by the Department of the Environment.

According to the testimony of MDE Secretary Jane Nishida, there are 4 wastewater treatment facilities and 7 "relatively small" industrial point sources in the Pocomoke River watershed. In response to the toxic outbreaks of *Pfiesteria*, the Department of the

Environment reviewed its permit compliance and whole effluent toxicity monitoring data records for the past two years. The Department also inspected the facilities on the Shore and collected water samples near the discharge points. The Department has determined that all permit violations at these facilities have either been brought into compliance or action is currently being taken to bring the discharges into compliance.

Efforts are currently underway to secure federal funding for the local share of improvement costs for the Pocomoke City and Snow Hill wastewater treatment plants. The Commission has focused its attention on the nutrient loading problems in Lower Eastern Shore tributaries because of the *Pfiesteria* problems in those waterways. The Commission is also interested, however, in reducing nutrient loads from all point sources in the Chesapeake Bay watershed. The Commission encourages the Department of the Environment, working with the Department of Natural Resources, to identify those watersheds that are vulnerable to toxic outbreaks of *Pfiesteria* according to our current knowledge of the organism and the conditions conducive to its turning toxic. State, local and federal resources should be targeted to implement BNR at treatment plants in those watersheds.

On-Site Sewage Disposal Systems

According to the 1990 census, over 340,000 housing units in Maryland rely on on-site sewage disposal systems (OSDS) to dispose of household sewage. Over 40 million gallons per day of OSDS effluent is discharged to the State's groundwater. Although current regulations require that the effluent be properly treated to remove bacterial contamination that could threaten human health, as much as 80% of the nitrogen in the effluent may reach groundwater. Recent estimates from the Chesapeake Bay Watershed Model indicate that nitrogen from OSDS enters Chesapeake Bay at the rate of approximately 3.7 million pounds per year. This represents about 6 percent of the total nitrogen loading to the Bay from Maryland.

The Commission believes that the nitrogen loading from OSDS can be significantly reduced through the use of cost-effective best management practices (BMPs) applied to existing and newly constructed OSDS. BMPs can vary widely in effectiveness and cost, ranging from regular maintenance pumping of septic tanks and/or inexpensive effluent filters (costing \$100s) to recirculating sand filter systems (costing \$1,000s). The Commission recognizes that the specific type of BMP used will need to vary depending on the type of OSDS used and the natural characteristics of the proposed site. In most instances, some type of BMP can be appropriately applied to reduce nitrogen loading to the groundwater.

The Commission recommends that the Maryland Department of the Environment require that best management practices be employed in the design and construction of all new on-site sewage disposal systems, using appropriate policy changes and/or regulatory amendments. Mandated practices should include improving the performance of septic tanks by establishing standards for water tightness and by requiring multi-component tanks and/or effluent filters. The Department should work with local health departments to develop a list of mandated best management practices and an implementation schedule.

AGRICULTURAL ISSUES

At the request of Chairman Hughes, Dr. Thomas A. Fretz, Dean of the University of Maryland College of Agriculture and Natural Resources, convened a group of scientists to advise the Commission on the current scientific thinking on the movement of nitrogen and phosphorus in an agricultural setting, alternatives for managing and controlling nutrients on farms and options for using and handling poultry litter. A copy of the Agricultural Science Group's Report, *The Agricultural Perspective*, is attached as Appendix 10. Portions of the Report are summarized and relied upon below.

The Nutrient Management Program administered by the Maryland Department of Agriculture and the University of Maryland since the late 1980s has concentrated on assisting farmers to manage nitrogen. At the time of the establishment of the Program, nitrogen appeared to be more problematic than phosphorus, as it was thought that phosphorus losses could be controlled through soil erosion control measures.

Crops require varying amounts of phosphorus relative to nitrogen depending upon the crop produced. The amount of phosphorus contained within organic sources of nutrients, such as manure, compared to the levels of nitrogen within the manure, does not usually correspond to the nutrient needs of crops. If these organic materials are used to meet the nitrogen needs of the crop, phosphorus is overapplied. If the use of the organic material is limited to the phosphorus needs of the crop, nitrogen is underapplied and commercial fertilizer must be added to meet the needs of the crop.

Nitrogen and phosphorus behave differently in soil. A certain portion of nitrogen will volatilize and enter the atmosphere. In addition, inorganic and organic forms of nitrogen are lost through surface water runoff and through soil erosion. Finally, soluble nitrogen compounds can leach through the soil-water system if the nitrogen is not used by the crop or if it migrates below the root zone of the crop. Although many accepted best management practices for controlling nitrogen have been developed, wider use of these practices can further limit nitrogen losses from agricultural land.

Phosphorus is generally found in two forms, particulate phosphorus and soluble or dissolved phosphorus. Particulate phosphorus binds to the soil and can move with surface runoff as soil erodes. Dissolved phosphorus can enter waterways with surface water runoff even if soil erosion is controlled. As the testimony of Dr. Frank Coale revealed, the dissolved phosphorus problem has largely been ignored as efforts to control particulate phosphorus and soil erosion have been the focus of control measures. Recent research also indicates that there is a potential for phosphorus leaching into groundwater on sandy soils with high phosphorus contents. Dr. Coale also testified that 70% of the soil samples tested at the University of Maryland test "high" or "very high" for phosphorus. The phosphorus levels on the Lower Eastern Shore are the highest in the State.

It is important to note that Maryland farmers were not aware of the recently discovered science regarding the potential movement of dissolved phosphorus. As Dr. Coale and the Agricultural Science Group point out, this science has been recently developed and farmers have not been previously advised that dissolved phosphorus is a concern.

The Commission recognizes the need to implement best management practices that are consistent with the best available science. Most of our current practices are directed at the control of nitrogen. The Commission shares the belief of the scientific community that our

future efforts should be expanded to apply our current scientific knowledge not only to the control of nitrogen, but also to the control of phosphorus migration.

Simply stated, land-based phosphorus can be kept out of the Bay and its tributaries by: (1) keeping excessive levels of phosphorus off the land by refraining from applying unnecessary phosphorus or applying it at lower levels; (2) containing phosphorus on the land and keeping it out of the water once it is on the land and; (3) removing excess phosphorus from the land.

Controlling Phosphorus – Keeping Excessive Levels off the Land

1. Nitrogen- and Phosphorus-based nutrient management planning.

As stated by the Agricultural Science Group, it is possible to develop nutrient management plans for farms by using either nitrogen or phosphorus as the limiting nutrient. By its very nature, nutrient management planning must focus on the particular needs of the soil for the crop being grown. For many farms across Maryland, phosphorus levels are not a concern, and it is likely that the prime consideration will be the nitrogen needs of the crop. For many other farms, however, there is a need to limit the addition of phosphorus and to consider nitrogen and phosphorus needs when applying fertilizers.

The Commission recommends that Maryland adopt a phosphorus-based and nitrogen-based nutrient management system. Phosphorus-based nutrient management plans should be used for fields that have excessive soil-test phosphorus levels and a strong potential for phosphorus loss based on a phosphorus index. Moving to a phosphorus-based nutrient management program should help farmers avoid the inadvertent overapplication of phosphorus that has occurred when organic fertilizers are applied to a field to meet the nitrogen needs of a crop.

The Commission also heard testimony that because Maryland does not currently consider phosphorus in nutrient management planning, phosphorus has been unnecessarily overapplied when farmers are advised to apply a “starter” fertilizer to their crops at the beginning of a growing season. These commercially available starter fertilizers include phosphorus as well as nitrogen. Often, a crop does not need the phosphorus that is in this fertilizer. It is intended that the move to phosphorus-based nutrient management planning will eliminate this practice on soils with excessive levels of phosphorus. The Commission also heard testimony that this practice may be on the decline, as farmers are finding that the starter fertilizer enhances the appearance of the crop in the early part of the season but has little or no effect on the yield of the crop in the long-term.

The Commission’s overriding goal in this effort is to reduce the unnecessary application of nitrogen and phosphorus so that these nutrients do not exceed levels that the crop needs and the land can retain, in order to ultimately prevent nutrient migration to our waterways. The Commission recommends that the State enroll all farmers in nutrient management plans by the year 2000. These nutrient management plans should be fully and demonstrably implemented by 2002, contingent upon the State supplying the appropriate level of education, outreach, technical support and financial resources necessary to meet these goals. In the event that resources are not sufficient to meet the statewide goals, the State should focus its initial efforts on Maryland’s most severely nutrient-impaired watersheds.

The Commission recommends that the Governor convene an oversight committee consisting, at a minimum, of the Secretaries of the Departments of Agriculture, Natural Resources and the Environment, a member of the Senate of Maryland and a member of the House of Delegates to oversee the development and implementation of appropriate nutrient management programs and best management practices. The plans should be responsive to developing scientific findings and technological advancements. The oversight committee should also aggressively oversee the research into and the development of alternative uses of animal manure, including transporting, composting, burning and marketing of manure and manure-based products. The oversight committee should work closely with the agricultural community, the animal growing and dairy industries, the General Assembly, the

environmental community, the private sector, the Department of Business and Economic Development, Maryland Environmental Service, the Maryland Department of Energy, Maryland's public and private universities and other appropriate State, federal and local agencies. The oversight committee should report semi-annually to the public, the Governor and the General Assembly on the progress on these items.

As noted above, it is very important to expedite research into alternative uses of manure and the development of markets for manure and manure-based products. The success of the State's nutrient management program is directly related to the State's ability to provide alternative outlets for manure that a farmer may not be able to apply to his or her land because of the needs of the crop and the recommendations of the nutrient management planner. The Commission stresses the importance of developing alternative uses for manure in conjunction with the movement to nitrogen- and phosphorus-based nutrient management planning. The oversight committee should report to the Governor and the General Assembly on January 1, 2000 on the status of the program, the implementation of alternative uses for animal manure and the ability to meet the schedule outlined by this Commission.

In order to make immediate progress in the redistribution of manure, the Commission recommends the establishment of a pilot program aimed at transporting chicken manure from the Lower Eastern Shore. We recognize that this is a temporary alternative and that it will require the cooperative efforts of the State, the agricultural community, the poultry industry and the private sector to make it a success. The Commission is encouraged by the Delmarva Poultry Industry's intent to contribute \$1 million over 4 years to research needs and DPI's willingness to apply some of this money to this type of pilot program.

For farmers who primarily or exclusively utilize commercial fertilizer for their crop needs, the implementation of phosphorus-based nutrient management planning will most likely have no financial impact on their businesses. Farmers who utilize manure to meet their crop needs and who have high phosphorus levels in their soil will be impacted if they are unable to apply manure to their crops and alternative markets for manure are not developed. The implementation of these nutrient management plans should consider the economic impact on the farmer. This economic impact consideration should include an evaluation of additional costs to the farmer, as well as offsetting benefits from the sale or distribution of the manure and financial benefits received from the State or federal government through cost-sharing programs, cover crops and other assistance.

Approximately one-half of current nutrient management plans are developed by the University of Maryland and one-half are developed by private sector consultants retained by individual farmers. The Commission was concerned to learn that copies of privately-developed nutrient management plans are not submitted to the Department of Agriculture or the Cooperative Extension Service. The Commission believes that copies of all nutrient management plans must be submitted to the Department and to the Cooperative Extension Service in its role as a scientific and educational agency, in a manner that protects the privacy of the individual farmer. The Commission also believes that nutrient planning standards and guidelines developed by the University of Maryland must be utilized by all Cooperative Extension Service planners and private sector planners.

The Commission is also concerned about the Department's inability to review the plans developed by contractual private sector nutrient management planners because only one employee has been assigned oversight and monitoring responsibilities. After nutrient management plans are implemented, extensive monitoring and evaluation of the effectiveness of the plans must be conducted. As demonstrated by the recent University of

Maryland survey, attached as Appendix 11, it is possible to design oversight tools to evaluate the implementation of nutrient management plans. The Commission is also aware of the recent formation of "teams" of MDA employees and Department of the Environment employees. The Commission endorses this "team" approach and recommends that this approach be expanded in order to conduct more comprehensive oversight of nutrient management plans. These evaluation teams should semi-annually report their findings to the public, the Governor and the General Assembly.

2. Use of the phytase enzyme in chicken feed.

One method of reducing the amount of phosphorus applied to the land is to reduce the amount of phosphorus in animal manure. An advantage of commercial fertilizer is the ability to control the mix and amount of nutrient applied to the soil. As Dr. Coale, Dr. Brodie and the Agricultural Science Group pointed out, however, the consistency of manure is unpredictable and manure often contains a disproportionate amount of phosphorus relative to nitrogen. To the extent that manure is used as a fertilizer, lower levels of phosphorus in the manure will lead to lower levels of phosphorus being applied to Maryland farms.

The most encouraging proposal the Commission heard in this area was the use of the phytase enzyme in the feed. Like humans, swine and poultry are not able to utilize the full phosphorus content of plant-source feed ingredients such as corn. It is estimated that chickens can use only 30% to 40% of the phosphorus in feed. The remaining 60% to 70% is in the form of phytate phosphorus, which requires the enzyme phytase to break down to forms of phosphorus available to animals. Chickens do not secrete phytase, so the phosphorus in the form of phytate passes through the chicken and into the chicken waste. The 30% to 40% of usable phosphorus is not sufficient to meet the dietary needs of the chicken, so feed mills add inorganic phosphorus to feed to maximize the growth potential of the animal. Application of the phytase enzyme to the feed will enable chickens to break down and utilize the phytate phosphorus in the corn, reducing the need to add inorganic phosphorus to the feed and, therefore, the amount of phosphorus in the manure.

The Commission strongly recommends that phytase be added to feed supply as soon as possible. The Commission encourages the industry, the State, surrounding states and the federal government to work together to implement the necessary technology as soon as possible. The phytase enzyme is currently used in the United States in fish feed and is used in Europe. Use of phytase can produce an immediate reduction in the amount of phosphorus in chicken manure, perhaps by as much as 20-25 percent. The Commission urges that the industry work with the public sector to invest in necessary capital improvements. The Commission recommends that Maryland (and surrounding states) establish a cost-sharing program to assist in the conversion of these feed mills. We recommend that, at the very least, this practice should be used at all feed mills on the Delmarva Peninsula, in an effort to reduce the amount of phosphorus that is available to be applied to the land and, eventually, reach the Bay. We also encourage the federal government to examine the implementation of a national standard in this area.

The Commission recognizes the need for additional research in this area. We believe that this limited research can be completed rather quickly. For example, the Commission is familiar with the work of Dr. Jeannine Dennis-Harter at the University of Maryland Eastern Shore, among others, in the field of poultry nutrition and the reduction of nutrient inputs into feed. The Commission encourages the State and the industry to adequately fund such work at the University System of Maryland so that the use of the phytase enzyme can begin as soon as possible. We also recognize the need for longer-term research into the

interaction between the feed, the phytase enzyme and the use of low phytic acid corn, which is discussed below.

3. Manure storage sheds and dead bird composters.

Another method of reducing nutrient loading is the proper storage of nutrient-containing manure before it is applied to the field and the use of environmentally-friendly disposal methods for dead animals. The recent Preliminary Characterization of Agriculture in the Pocomoke Watershed survey conducted by the Maryland Department of Agriculture (the Agriculture Assessment, attached as Appendix 12), estimated that 73% of farmers with animals in the watershed utilize a waste storage structure. Testimony from the Delmarva Poultry Industry, Inc. stated that 57% of farmers on the Delmarva Peninsula use these structures. The Agriculture Assessment mentions that storage sheds are a very successful and popular part of the Maryland Agricultural Water Quality Cost-Share Program (the MACS Program).

The Agriculture Assessment indicates that many farmers who do not raise animals apply manure to their fields. The survey revealed only 67% of the farmers raise animals, but 85% of farmers applied manure in 1997. Further, 22% of the farmers who grow animals sell or give away all of the manure produced by their animals. The current MACS Program only provides cost-share benefits for manure storage structures constructed on animal farms. Farmers who apply manure but who do not grow animals are not eligible for assistance. The Commission recommends that the MACS Program be expanded to allow non-animal growers who store and apply manure to be eligible to receive State assistance for the construction of manure storage sheds. Of course, the State should be careful not to invest money in such structures if the land on the requesting farm does not need additional phosphorus as determined by the phosphorus-based nutrient management plan recommended by the Commission earlier in this Report. The expansion of the MACS Program in the manner we describe is important as the State seeks to limit the application of additional phosphorus to land that does not need it, and as the State explores the redistribution of manure to farms that can use it, as we discuss below.

4. Litter treatments.

Advancing technology has reduced the frequency of required whole poultry house cleanings. Poultry manure accumulates in the bedding of the poultry house for several years. Nutrients accumulate as the manure accumulates. While nitrogen levels stabilize after the third flock of birds, phosphorus levels continue to increase. Techniques are being developed to apply a litter treatment that will stabilize manure phosphorus into environmentally inactive forms. The Commission encourages the University System of Maryland and the industry to develop and, when appropriate, implement the use of such litter treatments.

5. Low phytic acid corn.

It is estimated that a low phytic acid corn will be commercially available by the year 2000. Like the use of the phytase enzyme, use of this corn could reduce the need to add inorganic phosphorus to the feed. This, as discussed above, limits the amount of phosphorus in the manure. Growers will incur an additional cost to grow the crop, reflecting the need to maintain the unique identity of the seed and the corn. This identity will also have to be preserved in the marketplace and at the feed mill. However, to the extent that use of the product reduces the need of the feed mill to add inorganic phosphorus to the feed, there will be some reduced costs as well.

The Commission recognizes that the use of low phytic acid corn may be a viable and important part of the effort to reduce the phosphorus content of the manure. Unfortunately,

at this point it is a longer-term approach to the issue and is not ready for implementation. As noted above, we encourage the continuation and the expansion of the chicken nutrition research that is being conducted at our Universities. We believe it is particularly important that researchers begin evaluating the interaction between the phytase enzyme and the low phytic acid corn, so that phosphorus reduction efforts can begin as soon as technology becomes available.

Controlling Phosphorus – Keeping Excessive Amounts off the Land – Alternative Uses

1. The distribution problem.

The Commission recognizes that manure is not simply a waste product of the chicken or other livestock. Animal manure has economic value to the farmer who has access to the product and can apply it to the land. Use of the manure as a fertilizer helps the farmer meet the nitrogen needs of his or her crop. As we have mentioned several times, however, this has had the unintended and unfortunate effect of elevating phosphorus levels in several areas of the State. The Commission is also conscious of the fact that the commercial value of the manure is a function of its composition, its volume and the distance it needs to be transported.

The Commission received very instructive testimony from Dr. Herbert L. Brodie regarding farm animal manure nutrients (attached as Appendix 13). Dr. Brodie displayed a chart, Figure 12 in his testimony (attached as Appendix 14), that displayed poultry production in the 3 Lower Eastern Shore counties from 1987-1992. Dr. Brodie's data show a slight decline in the number of chickens produced during that period, but a more dramatic decline in the number of farms that raised chickens and the number of acres on which chickens were raised. Simply stated, while chicken production may have declined slightly, it has been increasingly concentrated on fewer acres. Dr. Brodie speculated that since 1992, poultry production "has likely expanded but stayed concentrated like other portions of the economy [have] since 1992."

According to the Agriculture Assessment, it appears that the application of manure on farmland is also concentrated. The survey showed that, in 1997, 85% of the surveyed farmers applied manure to their crops and the manure was applied to 42% of the cropland. The Commission notes that the Agriculture Assessment is a "snapshot" of practices in one crop year. The Assessment was not intended to analyze trends in manure application and crop rotation. Dr. Brodie conducted an analysis of the nitrogen and phosphorus of cropland by region (attached as Appendix 15). This chart demonstrates that the phosphorus content of the manure produced on the Lower Eastern Shore is more than sufficient to meet the phosphorus needs of the land in the region. Despite that fact, a small amount of sludge and several thousand tons of commercial phosphorus are applied in the region. The nitrogen in the manure is nearly sufficient to meet the nitrogen needs of the region. However, a small amount of sludge and a large amount of commercial nitrogen were applied to the land. Dr. Brodie's chart also illustrates that several regions of the State could utilize the nutrients in the manure from the Lower Eastern Shore to meet the nitrogen and phosphorus needs of the region's crops.

This testimony points out the apparent need to better manage and distribute the nutrients contained in animal manure. The Agriculture Assessment notes that, when asked what influenced the decision to apply manure to the field, 21.7% of the farmers said "disposal needs" influenced the decision, and 34.9% said that the fact that the "field was open" was a factor. The Commission is aware of the Delmarva Poultry Industry's Manure Clearinghouse. The Commission encourages the expansion of this program. We recognize that redistribution of the manure and alternative uses of the manure become very important as we move towards a phosphorus-based nutrient management program.

2. Alternative uses – composting.

The Commission is interested in maximizing the efficient use of the nutrients contained in

animal manure in an environmentally-friendly way. Composting manure has several advantages. Temperatures during composting will destroy pathogenic organisms and the composting process will minimize the odor of the manure. Post-composting steps to add nutrients and to pelletize the manure can create a marketable fertilizer. Transporting composted litter also helps address some of the biosecurity issues that are present in the transportation and commingling of raw litter.

The Commission is aware of several "pilot" composting projects in Maryland and elsewhere. The Commission encourages expedited research into composting, post-composting processing and the market potential of a composted product. The Commission urges the industry, the State and the private sector to collaborate on these solutions.

3. Alternative uses – burning.

The Commission heard testimony that poultry litter is used as fuel in the United Kingdom. While earlier attempts at burning litter apparently encountered emissions problems, technology has likely solved that issue. Fuel needs can likely be met on a large scale, as is being explored by Maryland Environmental Service and DNR for the Eastern Correctional Institute (a copy of the MES proposal is attached as Appendix 16), or on a small scale, as evidenced by the demonstration project that is examining the use of poultry litter as a fuel source to heat broiler houses. In order to be viable options, these projects must have an adequate supply of litter, be in compliance with all environmental standards and be affordable.

Burning litter disposes of the manure and leaves a certain amount of ash that can be used to make artificial soils, as a component of a fertilizer mix or as a poultry feed additive. The Commission is encouraged by the prospect of burning the manure, and encourages further research and demonstration projects on this issue. Controlling Phosphorus – Keeping it on the Land and Out of the Water

There will always be a certain amount of phosphorus on the land and, in many areas of the State, phosphorus should be added to the soil to promote healthy crop growth. It is important to properly manage the phosphorus on the land to limit its migration into our waterways. As the Agricultural Science Group pointed out, many best management practices are currently used to control phosphorus migration through soil erosion, including no-till farming, contour/strip cropping, grass waterways, buffer zones and other structural controls. Based on the testimony presented to the Commission, we believe that the use of some of these methods need to be reevaluated, refined or increased.

1. Tillage practices.

Based on scientific advice that was generally accepted at the time, many farmers moved to no-till or reduced-till practices. This practice reduced soil erosion and particulate phosphorus movement. New evidence suggests it is possible that the practice may concentrate phosphorus at the soil's surface and thereby increase the amount of dissolved phosphorus that is available to move in surface water runoff.

The Commission encourages the University of Maryland and the Department of Agriculture to continue to work with the agricultural community to evaluate the effectiveness of current agronomic practices such as no-till to balance the techniques for minimizing soil erosion, surface water runoff and leaching of nutrients from agricultural land.

2. Buffer zones.

As noted above, grassy strips, buffer zones and wooded land are proven methods of limiting

nutrient surface runoff into our waterways. The Commission is encouraged by federal and State efforts to increase resources for the Conservation Reserve Enhancement Program (CREP). This program will provide increased payments to farmers who treat certain environmentally sensitive land in order to voluntarily restore wetlands, establish stream buffers and retire highly erodible land from production. This will promote forest buffers and other important conservation programs on Maryland farms. Under the current Conservation Reserve Program, many Maryland farmers were reluctant to participate because the per acre dollar amount was too low. It is hoped that the use of increased incentives, funded with approximately \$170 million in new federal money over 15 years and over \$25 million in State money, will increase participation rates.

The Commission urges the State to aggressively market CREP and to sponsor outreach and educational programs designed to maximize farmer participation. The Commission encourages all interested Marylanders to participate in publicizing this voluntary opportunity. Of course, the Commission urges farmers to participate in CREP.

Controlling Phosphorus – Removing it from the Land

Although it is not the preferred method of controlling nutrient loading, it may sometimes be helpful and necessary to take steps to remove phosphorus from over-enriched soils. The Agricultural Science Group presented several remediation options, most of which still require extensive research and development.

1. Drainage ditches.

Many farms are served by field drainage ditches. In soils where soluble phosphate is reaching drainage ditches, it is theoretically possible to chemically precipitate the phosphorus out of the water by using crushed limestone. The cost associated with this technique should be minimal, but the chemical dynamics of the procedure need to be better understood before its use can become widespread.

The Commission encourages the University of Maryland to work with the agricultural community to establish demonstration projects and to conduct expedited research into this process in order to better understand the chemical dynamics and the end result impact on the precipitated phosphorus.

2. Phytoremediation.

The Agricultural Science Group also presented interesting information about a technique known as phytoremediation. This process involves the use of unique plants that have the ability to concentrate high levels of certain elements in plant tissue. Currently, there are no known “hyperaccumulators” for phosphorus. The Commission recognizes the potential value of phytoremediation and recommends further research into the identity and collection of the appropriate plants so that this technique can be explored.

3. Tillage.

Tillage holds promise as a site-specific technique for reducing phosphorus levels in the upper layers of soil. Tillage would “turn over” the soil, burying the phosphorus below the soil surface but within the root zone of the crop. In order for this technique to work, the subsurface soil must have a lower phosphorus content than the surface soil, and the subsurface soil must be conducive to supporting crop production. Further, this assumes that leaching of phosphorus through the soil column would not be significant. The Commission encourages the University of Maryland and the Department of Agriculture to continue research in this area and perform demonstration projects if appropriate. Reducing Nitrogen

The Commission's focus on phosphorus should not be interpreted as a lack of concern about nitrogen and its role in nutrient loading in the Bay and in the development of algal blooms. As stated earlier, we need to remain focused on controlling nitrogen levels in the soil and in the water. As the Agricultural Science Group noted, many best management practices are directed at limiting nitrogen losses.

The Commission heard testimony from Dr. Russell B. Brinsfield, a summary of which is attached as Appendix 17, about the need to focus on reducing nitrate leaching. Dr. Brinsfield pointed out that nitrate leaching losses occur even when all crop yield goals are met and all best management practices and a nutrient management plan are implemented. Dr. Brinsfield estimates that the utilization of cereal grain cover crops can reduce nitrate leaching losses by 60% following a corn or soybean crop. Unfortunately, the Agriculture Assessment determined that only 45% of surveyed farmers utilized cover crops as a best management practice. The Commission strongly encourages the regular use of cover crops as a best management practice.

Governor Glendening provided \$2 million for a cover crop program during the Fall planting season. The goals of the program were to provide drought assistance to farmers in areas of Maryland that had severe crop damage this year, to provide a feed crop for livestock farmers who suffered from the drought and to remove excess nutrients that were built up in drought-stricken soil and nutrient-enriched areas on the Eastern Shore. The Commission supports Governor Glendening's actions on cover crops. The Commission strongly recommends that the State implement a continuing cover crop program designed specifically to limit nitrate leaching and to prevent nutrients from entering the Bay and its tributaries. The State program we envision will necessarily differ from this year's program, because of the current program's multiple goals. We anticipate a meaningful level of support for a program designed to meet the specific goal of nutrient reduction. Participants in the program should not be permitted to assist crop growth by adding nutrients from organic or commercial fertilizer.

The Commission also notes the State's unsuccessful efforts to partner with the federal government on this cover crop program. The Commission encourages the federal government to provide support for Maryland's cover crop program, possibly through the Environmental Quality Incentive Program.

Personnel Needs

There has been a well-documented decrease in the number of positions in the Department of Agriculture. The Commission understands that this decrease is reflective of the general downsizing of State government because of the recession in the early part of this decade and the workforce reduction that resulted from the passage of early retirement legislation in 1996. A common theme throughout many of our recommendations and from the testimony and correspondence from many people in the agricultural community is the need for outreach to and education of the individual farmer. The farmer relies on the University and the Department of Agriculture for the status of science and the evolution of new and improved agronomic practices.

This Commission is proposing significant changes in nutrient management planning and is encouraging the State to expand participation in and support for cost-sharing programs. These recommendations will not work unless the State and the agricultural community work together to implement them. The Agriculture Assessment estimated that additional existing measures to address potential water quality problems could be implemented on one-third of

the surveyed farms. The Assessment noted that earlier studies identify “lack of information as the main reason a [best management practice] is not adopted.”

The Commission believes that participation in MACS cost-sharing programs such as manure sheds, dead bird composters and CREP improvements, as well as programs such as cover crops and nutrient management planning, can be enhanced by increased outreach and technical assistance. The Commission encourages the State to provide an appropriate and meaningful level of support to the Department of Agriculture and the Cooperative Extension Service in order to increase the use of existing best management practices and to otherwise implement the recommendations of this Commission.

The Commission does not intend to micromanage on this item. However, the Commission believes that efficiencies can be achieved if the Department of Agriculture reevaluates the division of labor between Department employees, Soil Conservation District employees and Cooperative Extension Service employees. The Department should explore the possibility of cross-training employees and expanding duties of employees. As noted elsewhere in this Report, the Commission endorses the MDA and MDE “team approach” and believes that efficiencies can be achieved using this approach, enabling the Departments to work together to meet and evaluate the goals set forth in this Report.

PUBLIC HEALTH ISSUES

Surveillance and Early Warning Systems

It is very important to note that Maryland has received national recognition for its attention to the public health aspects of the toxic outbreaks of *Pfiesteria*. It goes without saying that we must all focus our attention on protecting the watermen and the public from the dangers associated with the toxins emitted during fish kill and fish lesion events.

In the early portion of this Report, the Commission noted the existence of a Medical Team that has been active in the State's investigation. A copy of the Medical Team's Medical Evaluation of Persons With Exposure to Water Containing *Pfiesteria* or *Pfiesteria*-like Dinoflagellates was presented to the Commission and is attached as Appendix 18. The Medical Team's Report was the culmination of the State's early efforts to understand the potential impact on human health of exposure to *Pfiesteria* toxins. A summary of the State's focus on the health impacts of these toxins is attached as Appendix 19.

Evidence presented to the Commission strongly suggests that toxins released by *Pfiesteria* in the Chesapeake Bay watershed and elsewhere can produce human consequences, primarily manifested as cognitive impairment, particularly impacting short-term memory abilities. Some evidence suggests that human health can be impaired by exposure to toxin levels in the water in which distressed and lesioned fish have been observed, but fish kills have apparently not occurred.

The Department of Health and Mental Hygiene established a surveillance system in June 1997 to gather information about human illnesses that may be related to toxic outbreaks of *Pfiesteria*. As of late October 1997, 146 persons have reported illness, exposure to diseased fish or exposure to waters that have been the site of suspected *Pfiesteria* activity. The Commission believes strongly that a comprehensive and effective surveillance system must be in place to ensure timely warnings to the public of the possible need to close waterways that may be posing a threat to individuals. The State should maintain a central registry of all potential and confirmed cases of possible clinical manifestations of toxicity from *Pfiesteria*. The information in the registry should be regularly analyzed and appropriate epidemiological studies should be initiated to provide a basis for the exercise of sound public health decisions.

As with any new public health threat or disease, there is a need to educate physicians about the possible signs of exposure to *Pfiesteria* and its toxins. The Department of Health and Mental Hygiene sent a letter to Eastern Shore physicians in early June 1997 to describe the known symptoms and to encourage health care providers to report suspected illnesses related to *Pfiesteria* to the Department through the local health officers. The Department, local health officers and members of the Medical Team have also been engaged in regional educational presentations to explain this problem. The Commission strongly encourages the continuation of this outreach effort to physicians and other health care providers, particularly in the impacted areas. The Department should review its questionnaire for reporting exposures and illnesses to be more specific and useful in detecting possible *Pfiesteria* related illnesses. The Department has provided staff support to the State's toll-free *Pfiesteria* hotline in order to offer guidance to citizens who call to report symptoms or possible exposure to the toxins emitted by *Pfiesteria*. The Commission notes the importance of screening callers for possible symptoms and the subsequent collection of pertinent information. To the extent that it is necessary to provide additional medical-oriented support to the hotline, the Commission urges the Department to take appropriate action.

The Commission is concerned that, given our present level of knowledge concerning the risks associated with human exposure to *Pfiesteria* toxins, it is conceivable that individuals may be suffering from exposure to levels of toxin that produce a subclinical level of disease that is not readily apparent to the individual, but may nonetheless be affecting their health. The current river closing policy being followed by the State and local health officers takes into account increasing levels of distressed or lesioned fish, regardless of the presence of actual fish kill activity. This appears to be the proper approach to protecting public health, considering the state of our knowledge of the long term impact of extended exposure to low levels of toxins, as described above. Of course, this procedure requires continued monitoring of the fin fish in the Bay and our tributaries, as described below.

The Commission notes that Maryland is fortunate to have access to outstanding federal, State and private institutions that can assist our efforts to implement a comprehensive surveillance system and to undertake much-needed epidemiological studies. The recommendations of the Commission in the area of public health should be implemented by the appropriate State and local authorities with the technical advice and consultation of appropriate federal agencies (including the National Institute for Environmental Health Sciences and the Centers for Disease Control and Prevention), the University of Maryland and Johns Hopkins University.

Research Needs Specific to Public Health Concerns

As noted above, the Commission is concerned about the possible development of symptoms and illnesses that are not easily identifiable and that may result from low-level, long-term exposure. The Commission recommends that vigorous and wide-scale clinical and epidemiological studies be conducted to better define the clinical and subclinical manifestations of varying degrees of exposure to *Pfiesteria* toxins. The State should immediately proceed with these studies in consultation with the appropriate federal, public and private institutions.

Earlier in this Report, the Commission discussed the safety of Maryland's seafood and the need to inform the public about the continued safety of Maryland fin fish and shellfish. The public is entitled, of course, to sound scientific advice on this matter. Preliminary studies and fish tissue sampling indicate that seafood remains safe to consume and it is not believed that fish are a vehicle for transmitting the toxin. The Commission urges expedited laboratory and epidemiological studies to identify and quantify the presence of toxins in edible seafood, including fin fish. These studies should focus on shellfish that are traditionally filter feeders, such as oysters and clams.

FUTURE SURVEILLANCE, MONITORING AND ASSESSMENT NEEDS

Bay-Wide Rapid Response to Fish Health and *Pfiesteria* Problems

A Bay-wide rapid response capability is required to protect the health of Maryland's citizens by identifying affected water, attributing causes of the problem as soon as possible, providing data to officials making decisions on waterway closures and continuing to monitor problem areas to determine when a waterway's condition has returned to safe levels. The heightened awareness of the *Pfiesteria* problem has led to hundreds of reports of potential problems throughout the Bay and its tributaries that must be evaluated, including extensive field and laboratory testing. This surveillance is also critical for epidemiological studies and the identification of areas that might be in need of environmental management initiatives. The hotline and rapid response program established by the Department of Natural Resources during the Summer of 1997 allowed for the immediate identification and implementation of actions necessary to protect public health during *Pfiesteria* outbreaks on the Pocomoke River, Kings Creek and the Chicamacomico River.

The Commission recommends that the Department of Natural Resources continue to work in cooperation with the Maryland Department of the Environment to comprehensively monitor the Bay and its tidal tributaries for signs of fish health problems and/or *Pfiesteria*-like organisms. This monitoring would include the continuation of the 24 hour a day hotline and the fulfillment of the responsibilities of State agencies under the recently adopted revised Protocol for Closing and Reopening Rivers Affected by *Pfiesteria* or *Pfiesteria*-like Organisms. Of course, this effort should utilize the most recent research techniques for identification of *Pfiesteria*-like organisms and their toxins and include information on water quality that can be used to further clarify the relationship between environmental conditions and toxic outbreaks.

Comprehensive Evaluations of Impacted Regions

Several areas of the State appear to be particularly affected by the threat of *Pfiesteria*-like organisms. In these areas, there is a need to better understand the relationships between fish health, *Pfiesteria*-like organisms, water quality and regional pollutant sources so that management initiatives can be developed and implemented with a high degree of certainty. Where management initiatives have already been implemented for impacted areas, there is a further need to track the environmental response to ensure that conditions are, in fact, improving. This longer-range capability would be used to verify the effectiveness of these initiatives. This type of work is currently ongoing for affected areas of the Lower Eastern Shore through an interagency team of State and federal representatives (The Lower Eastern Shore Study Team) chaired by the Department of Natural Resources. This team has presented its findings to the Commission concerning fish health, *Pfiesteria*, water quality and pollutant sources and has been working closely with outside scientists including the State's Technical Advisory Committee, the Cambridge Forum and Dr. JoAnn Burkholder.

The Commission recommends that the current comprehensive evaluations of impacted regions continue, led by the Study Team chaired by DNR. The Commission further recommends that this Team include representatives from DNR, MDE, MDA, DHMH and other State, federal, public and private entities that are necessary to provide needed expertise and resources. The scope of the Team would include fish health, *Pfiesteria*-like organisms, water quality and pollutant sources. These evaluations would be targeted to answer the following key management questions:

What is the nature of the fish health problem in affected areas?

What is the extent and duration of significant (to human and fish health) levels of *Pfiesteria*-

like organisms?

What is the nature of the relationship between water quality and any other key factors and the presence of *Pfiesteria*-like organisms?

What are the principal water quality problems related to *Pfiesteria*-like organisms and what are the sources or causes of these problems?

Based upon the existing profiles of impacted waterways and the latest research, are there watersheds that may be vulnerable to toxic outbreaks of *Pfiesteria*-like organisms?

In areas where management measures have been implemented to reduce nutrient loading and, consequently, the likelihood of outbreaks of *Pfiesteria*-like organisms, are these measures having the desired effect? The Study Team should be responsible for submitting periodic reports to State, legislative, local and federal officials.

Pollutant Source Investigations and Monitoring of Corrective Actions

Since the toxic outbreaks of *Pfiesteria*, the Maryland Department of the Environment has intensified its monitoring and inspection of point sources in impacted watersheds. The Commission recommends that the Department of the Environment continue its enhanced permit compliance inspections and monitoring of these sources. These efforts are necessary to reassure the public that pollution sources continue to be properly controlled in impacted areas and that problems are quickly identified and corrected.

As noted above, the Board of Public Works recently approved three additional positions in the Department of Agriculture and three additional positions in the Department of the Environment to work cooperatively in the evaluation of agricultural operations in impacted watersheds to ensure that various best management practices are properly implemented. As previously stated, the Commission endorses this cooperative effort. Follow-up inspections and monitoring should be carried out as necessary to ensure that identified problems are corrected and that management measures are properly implemented.

FUTURE RESEARCH NEEDS

Research Needs -- the Federal Role

The Commission believes it is appropriate and necessary for the federal government to assume a lead role in the research on the biology, environmental requirements, effects and mitigation of effects of *Pfiesteria*-like dinoflagellates. This regional problem is part of a national problem related to algal blooms and overenrichment of coastal waters. As such, it requires a national approach based on partnerships involving the traditional roles of the federal government to support science of national importance and the states to support excellent university research facilities and maintain faculty expertise. Maryland has developed world-class research capabilities in biological, environmental, agricultural and medical research in its public and private universities. The Commission encourages the federal agencies to work in partnership with the University System of Maryland, the State's private institutions and Maryland state agencies, under the principles of merit review, to address the critical research needs identified in the federal research strategy.

The Commission is grateful to the national authorities who testified before us and who shared with us the drafts of the national strategy, National Harmful Algal Bloom Research and Monitoring: An Initial Focus on *Pfiesteria*, Fish Kills and Public Health (attached as Appendix 20), and we strongly endorse the strategy and hope it will receive full support from the Administration and Congress. The Commission has reviewed the proposed federal research strategy and, along with the appropriate State agencies, offered comments on that plan, a copy of which is attached as Appendix 21. The Commission endorses the federal strategy and its eight objectives which address: (1) characterization of toxins; (2) detection methods; (3) the sources and consequences of toxins; (4) prediction methods; (5) management and mitigation of toxic outbreaks; (6) rapid response and monitoring; (7) information and education; and (8) data access. The Commission believes that research and monitoring that lead to more effective protection of human health, fish and fisheries and more effective controls of nutrients are of paramount importance. The Commission also urges the federal government to conduct research into the effect that dinoflagellates and/or algal blooms may have on animals that may not have contact with the water during the toxic phases of these organisms, but that may consume fish and shellfish from impacted waters.

The Commission has also made specific recommendations for research in the area of public health. The Commission believes that the Centers for Disease Control and Prevention has played, and can and should continue to play, an important role in the study of the human health impact of these toxins. The Commission recommends that, when federal funding becomes available for the CDC multi-state study, Maryland should be a full and active participant.

General Research Needs and Maryland's Role

The Commission was fully briefed on the current state of knowledge regarding *Pfiesteria*. There is much that remains to be learned about the biology of *Pfiesteria*-like dinoflagellates, their identity, their many stages of life, the factors that allow them to grow and change into toxic forms and the effects of their toxins on humans and aquatic organisms. There are reports of variations among *Pfiesteria*'s strains, so it is urgent to isolate Maryland strains in order to study those strains specifically and to compare them with strains from North Carolina, Florida and elsewhere. In addition, the Commission's evaluation has highlighted the need for research on more effective agricultural management practices consistent with current scientific knowledge. Witnesses before the Commission whose lives may be impacted by our recommendations have stressed that they are willing to accept changes if

they are based on sound science. In this situation, it is extremely important to launch a greatly expanded program of basic research at the national and State level.

Several research recommendations are highlighted in earlier portions of this Report. In addition to those recommendations, the Commission identifies the following high priority research topics:

1. Isolation, identification and classification of the species and strains of *Pfiesteria*-like dinoflagellates existing in the Chesapeake Bay and its tributaries. This must involve establishment of pure cultures and better means of rapid identification. A high priority is the development of gene probes based on the organisms' genomic sequences.
2. Isolation of toxins and the characterization of their chemical structures and pharmacological actions in humans and aquatic organisms. Such research is essential for both health and environmental effects research to proceed.
3. Determination of life histories and ecology of all *Pfiesteria*-like species, including their nutrition, responses to nutrients and expression of toxicity. More specific needs are identified in The Cambridge Consensus. An objective of this research should be to improve prediction of toxic outbreaks and target prevention strategies.
4. Characterization of human exposure risks to toxins of *Pfiesteria*-like dinoflagellates, including neurological, physiological and epidemiological studies.
5. Quantification of the transport of nitrogen and phosphorus leaching from manures, sludge and fertilizers and the effectiveness of improved nutrient management practices, including cover crops, manure management and more effective animal food formulations.

Maryland's universities, independent research institutions and State agencies are at the forefront of scientific fields relevant to addressing these research needs. The University System of Maryland, in particular, has already demonstrated leadership in addressing the *Pfiesteria* problem through estuarine science (the Center for Environmental Science), medical research (School of Medicine), agricultural research and extension (College of Agriculture and Natural Resources) and molecular biology (University of Maryland Biotechnology Institute). We note also the strong assistance of Johns Hopkins University in the public health aspects of *Pfiesteria*. The Commission recommends that these public and private institutions, on-campus departments and System-wide programs, particularly the Maryland Sea Grant College, coordinate their research and outreach activities regarding *Pfiesteria* to the maximum extent possible.

FEDERAL REGULATORY EFFORTS

The Commission heard testimony from Bob Perciasepe, Assistant Administrator, Office of Water, Environmental Protection Agency, that EPA is in the early stages of evaluating the animal feeding operation regulations that were developed in the 1970s. A national conference was held on this issue in April 1997, with the expectation that new permitting guidelines for confined animal feeding operations will be implemented by EPA early next year. EPA had been researching *Pfiesteria* in Florida and North Carolina prior to Maryland's experience with the organism.

In late October 1997, Vice President Gore directed EPA to develop a comprehensive regulatory and enforcement strategy to reduce nonpoint source pollution and to restore wetlands. Under the Vice President's directive, EPA must identify major sources of nitrogen and phosphorus in waters and develop a plan for reducing nutrient loading from the identified sources. Water quality guidelines are to be implemented by 2000. EPA is also being charged with expediting the development of new standards for sources of pollution runoff, including animal feeding operations.

Mr. Jim Lyons, Undersecretary for Natural Resources and Environment, United States Department of Agriculture, discussed the formation of a workgroup on agricultural operations and the environment to focus on these issues. The USDA is evaluating many of the same technologies and strategies that this Commission has discussed, including the use of the phytase enzyme in feed, the behavior of nutrients in soil, the handling and storage of manure, soil testing for phosphorus and the use of various best management practices.

As the Commission noted several times in this Report, Maryland's farmers and poultry industry compete with businesses across the country. While we must take appropriate steps to protect our watersheds, competitive factors warrant the development of national standards on many of these issues that are of concern across the country. The Commission strongly supports national efforts to address issues that are common to the national poultry and agribusiness industries. The Commission urges EPA, USDA and other federal agencies to keep the States informed of national regulatory plans. The Commission also notes the important federal role in providing support to the states as the states and the federal government work together to apply measures to reduce the environmental and economic impacts arising from toxic outbreaks of these dinoflagellates.

Adoption of the Commission's Report

No HTML File

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Appendix 1

GOVERNOR'S BLUE RIBBON CITIZENS *PFIESTERIA* ACTION COMMISSION

Governor Harry Hughes, Chairman

The Honorable Bernie Fowler, Vice-Chairman

The Honorable Brian Frosh, Senate of Maryland

The Honorable Ronald A. Guns, House of Delegates

Mr. William C. Baker, President, Chesapeake Bay Foundation

The Honorable Clinton S. Bradley, III, Talbot County Commissioner

Mr. Frederick W. Nelson, Jr., Somerset County

The Honorable Lloyd L. Simpkins, District Court Judge

Dr. Alfred Sommer, Dean, Johns Hopkins School of Public Health

Dr. Dolores Margaret Richard Spikes, President, University of Maryland Eastern Shore

Dr. John Toll, President, Washington College

Joseph C. Bryce, Commission Staff

Governor's Blue Ribbon Citizens *Pfiesteria* Action Commission Charge to the Commission

The occurrence of *Pfiesteria piscicida*. The Commission shall examine the characteristics of the Pocomoke River and its watershed, and the characteristics of the Manokin River and its watershed, to determine whether these waterways are uniquely vulnerable to toxic outbreaks of *Pfiesteria*. What is the likelihood of toxic outbreaks in these rivers in the future and elsewhere in Maryland? Is there a profile that we can apply to other watersheds in the State?

Nutrient management practices. Preliminary research indicates a relationship between the level of nutrients in a waterway and the presence of large populations of *Pfiesteria* in a toxic form. The Commission shall examine the relationship between nitrogen and phosphorous levels and the large-scale occurrence of *Pfiesteria*. The Commission shall evaluate the history and status of Maryland's nutrient management efforts and recommend methods for improving these practices. The Commission shall recommend the need to implement immediate measures, on a permanent or temporary basis, to minimize the risk of future toxic outbreaks in the Pocomoke, the Manokin watershed and elsewhere.

Innovative waste management methods. To the extent that the Commission determines there is a relationship between high levels of nitrogen and phosphorous and the large-scale occurrence of *Pfiesteria*, the Commission shall attempt to identify the major sources of nitrogen and phosphorous in the Pocomoke and Manokin watersheds and statewide. There has been speculation that sewage treatment plants and runoff from poultry and other animal manure are sources of these nutrients. If the Commission finds substantial evidence of this relationship, the Commission should recommend methods and a time line for further preventing nutrients from reaching Maryland's waterways. The Commission's recommendations shall include state-of-the-art alternative methods of transporting, composting, burning and otherwise disposing of these wastes. The Commission shall offer options for encouraging the development of alternative disposal methods and the need for cost-sharing programs to help accomplish these goals.

Public Health. While Maryland has received national recognition for its response to this crisis situation, the Commission should consider whether additional steps should be taken to protect the health of the many Marylanders who live, work and recreate on our waterways. Are there any early warning signs that Maryland and other States should be aware of in order to fully protect people from the apparent health risks associated with exposure to toxic levels of *Pfiesteria*?

Federal activity. The federal Environmental Protection Agency and other agencies are currently considering a plan to require permits for small animal feeding operations and may impose restrictions on how farmers handle livestock waste. The Commission shall examine the status of federal activity and evaluate the potential impact of federal activity on Maryland's environment, industries and the health of our citizens. The Commission shall determine whether additional or more immediate action is warranted in Maryland.

Interstate solutions. Our experience in the Pocomoke watershed illustrates that *Pfiesteria* and other threats to our natural resources often have causes and effects that transcend artificial State borders. Maryland has acted swiftly and effectively to protect its citizens and its waterways from this organism and will continue to encourage multi-State involvement in this issue. The Commission shall suggest additional mechanisms for regional cooperation on

nutrient reduction and the understanding of the environmental and public health threats posed by *Pfiesteria*.

Existing federal programs. The Commission shall evaluate Maryland's ability to use existing or additional federal programs to address this serious problem.

General considerations. During its deliberations, the Commission should consider the apparent threat to public health, the environmental conditions contributing to the toxic outbreak of *Pfiesteria* in the affected areas and long-term as well as short-term solutions to this phenomenon. The impact of necessary changes on impacted recreational and commercial industries should also be considered by the Commission. The Commission shall note which of its recommendations will require additional legislative authority to carry out.

Reporting requirement. The Commission shall issue a Report of its findings by November 1, 1997. Included in the Report shall be the following:

1. The Commission's conclusions on the above issues, including the immediate steps that must be taken to address this threat to public health and our natural resources, so members of the General Assembly and the public have the opportunity to review the Commission's recommendations in advance of any budget decisions or legislative initiatives.
2. A list of issues that require further scientific study or that the Commission needs to dedicate more time to before reaching a conclusion. The Commission should understand that because time is of the essence, the number of open issues should be kept to a minimum.
3. To the extent that some issues will require further study, the Commission should present a range of interim solutions to open issues.
4. The Commission shall prepare a list of topics that it believes warrant study but were not included in this charge.

Staff. The Commission will be staffed by Joseph C. Bryce, Governor Glendening's Chief Legislative Officer, with the full support of the staffs of the Department of Natural Resources, the Department of Agriculture, the Department of the Environment and the Department of Health & Mental Hygiene. Dr. JoAnn Burkholder has agreed to serve as a consultant to the Commission. The State will provide the Commission with the necessary level of support from the scientific community and any other expert assistance that the Commission and the staff deems appropriate.

AGENDA -- CITIZENS *PFIESTERIA* ACTION COMMISSION

The Honorable Harry Hughes, Chair

Tuesday, October 21, 1997, 7:00 p.m. Room 160, Lowe House Office Building, Annapolis, Maryland

The October 21, 1997 meeting of the Citizens *Pfiesteria* Action Commission will be a Commission work session.

- Chairman Harry Hughes, Opening Comments
- Discussion, Commission Members

Thursday, October 23, 1997, 9:30 a.m. Room 160, Lowe House Office Building, Annapolis, Maryland

The October 23, 1997 meeting of the Citizens *Pfiesteria* Action Commission will be a Commission work session.

- Chairman Harry Hughes, Opening Comments
- Discussion, Commission Members

Monday, October 27, 1997, 9:00 a.m. Room 160, Lowe House Office Building, Annapolis, Maryland

The October 27, 1997 meeting of the Citizens *Pfiesteria* Action Commission will be a Commission work session.

- Chairman Harry Hughes, Opening Comments
- Discussion, Commission Members

Wednesday, October 29, 1997, 9:00 a.m. Room 160, Lowe House Office Building, Annapolis, Maryland

The October 29, 1997 meeting of the Citizens *Pfiesteria* Action Commission will be a Commission work session.

- Chairman Harry Hughes, Opening Comments
- Discussion, Commission Members

Friday, October 31, 1997, 2:30 p.m. Room 160, Lowe House Office Building, Annapolis, Maryland

The October 31, 1997 meeting of the Citizens *Pfiesteria* Action Commission will be a Commission work session.

- Chairman Harry Hughes, Opening Comments
 - Discussion, Commission Members
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Appendix 2

Summary of *Pfiesteria* Investigations in Maryland

October 28, 1997

The Pocomoke River

- The Pocomoke River runs through Worcester and Somerset Counties. It is a scenic, tranquil Blackwater System, meaning that cypress swamps drain into the river. For decades, area watermen have made their living fishing and crabbing in the Pocomoke. The river also supports an abundance of other natural resources, including bald eagles.
 - Other businesses along the Pocomoke include canoe rentals, charter fishing, and bed and breakfast inns. The predominant land use in the watershed is agriculture, primarily chicken production and associated farming (corn and soybeans for chicken feed).
-

October 1996

- Pocomoke River watermen reported finding lesions on high percentages of their fish catches from the lower river.
 - Lesions can result from many factors, such as injury and secondary infections, toxic chemical effects, viral infection, and potentially toxic dinoflagellates such as the recently discovered *Pfiesteria piscicida*.
-

Actions

- Samples of lesioned fish, water, sediment and algae were collected by DNR scientists from the Pocomoke River and Sound in October 1996. Tests indicated water quality conditions were within healthy ranges, and tests for *Pfiesteria* were negative.
 - By end of October, 1996 Pocomoke River watermen had ceased fishing for the year and reports of lesioned fish ended.
-

Spring 1997

- Pocomoke River watermen again reported finding lesioned fish in their catches from the lower river.

Actions

- DNR assembled a state interagency team to investigate the problem under Governor Glendening's leadership. The team includes the Departments of Agriculture (MDA), Environment (MDE), and Health and Mental Hygiene (DHMH). The state team would work closely over the coming months with watermen and scientific experts to learn more about potential causes of the fish lesions. Interest groups, such as the Chesapeake Bay Foundation, were also asked to collaborate with the team.
- Representatives from the state team met with citizens from the Pocomoke River area in late May to discuss the state's investigation.
- DNR instituted an aggressive fish monitoring program throughout the length of the River which would continue on a monthly basis through October, 1997. Observers were sent out with watermen to document the occurrence of lesioned fish in their catches. Several samples were collected for *Pfiesteria* identification. All DNR samples tested negative. However, in May 1997, a water sample collected from the Shelltown area by a Washington area television station tested positive for *Pfiesteria* in Dr. Burkholder's lab.
- DNR set up a toll-free hotline in late May to the DNR/NOAA Cooperative Oxford Laboratory for individuals to report fish with lesions on a Bay-wide basis.
- DNR evaluates long term water quality data collected at two stations (Pocomoke Sound and Pocomoke City) monthly since 1986. Analysis reveals some shifts in water chemistry (high acidity and low salinity) resulting from above average precipitation throughout 1996. It is possible these conditions may have stressed Pocomoke fish.

June 1997

- Watermen continue to report incidences of lesioned fish and attention by public to baywide fish health concerns increases.

Actions

- MDE evaluates historical data for fish tissue collected on the Pocomoke River and analyzed for chemical contaminants. More samples of a wide variety of commonly consumed fish were taken on June 10. Analysis of historic and recently collected samples reveals no chemical contamination.
- June 15 DNR institutes intensive longitudinal water quality monitoring of 21 stations from the Pocomoke Sound to Snow Hill. Stations are monitored every 2-3 weeks until the end of October, 1997.
- Governor Glendening visited Pocomoke City on June 25. He toured the river, met with local watermen, officials and interested citizens, and emphasized his concern for the problem and commitment to finding solutions.

July 1997

Actions

- U.S. Senators Sarbanes and Mikulski have worked with EPA and NOAA to provide \$500,000 in funding to support the state's investigation.

- July 25 DNR collected sediment samples at 5 sites in the Lower Pocomoke River between Cedar Hall and Pocomoke Sound and evaluated for a suite of chemicals as part of an evaluation of the role that chemical contaminants may play. Analyses of these samples and historic samples found no evidence of significant contamination by heavy metals and pesticides.
- DNR had several regular meetings with commercial and charter boat fishermen throughout the spring and summer. Watermen were asked if they found unusual lesions on fish around the Bay. They reported seeing occasional signs of trauma like that seen in years past, as well as a bacteria common to stressed striped bass (rockfish) in the last few years. About 3 million recreational fishing trips are annually taken on the Bay, and tens of millions of fish are caught.
 - As an additional effort to gain Bay-wide information, in July DNR provided 1,500 watermen with surveys and data sheets to record fish lesions observed while on fishing trips; 12 surveys have been received reporting fish abnormalities, geographically distributed around the Bay.
 - DNR continues to monitor information received from recreational and commercial fishermen to determine if any unusual patterns develop that require further investigation.

August 1997

August 6

- Early in the morning on Wednesday, Aug. 6, hundreds of dead and dying fish were found by local watermen and on-board observers downstream of Shelltown at Williams Point, the lower Pocomoke River in Somerset County, Maryland.
- The kill continued for four days, with decreasing numbers of fish affected each day.
- Most of the fish were young menhaden; many had lesions. It was difficult to ascertain the total number of fish killed because of tides and gulls quickly eating the floating fish, but the estimate was 10,000 - 15,000.

August 26

- A second fish kill began in Virginia waters of the Pocomoke Sound outside the mouth of the Pocomoke River on Tuesday, Aug. 26.

Actions

- At the direction of Governor Glendening, the state team convened a summit on Aug. 1-3, 1997 at Salisbury State University to seek input from other experts on the state's investigation. More than 60 experts from five states reviewed data and critiqued and fine-tuned the state's action plans for narrowing the scope of causes for the fish lesions, and helped to develop possible solutions. Pocomoke River watermen, local elected officials, area business owners and other interested citizens also participated.

- At the summit, the state's newly-formed Technical Advisory Committee of water quality, algal, and fish experts chaired by Dr. Donald Boesch, President of the University of Maryland Center for Environmental Science, reviewed action plans. The committee concluded that many explanations are possible for the fish health problems on the Pocomoke, including physical irritation from microbial infections of stressed fish; harmful chemicals; secondary infections by bacteria, viruses, and fungi; *Pfiesteria piscicida*; and other microorganisms. The committee also surmised that it is unlikely that pollutants from regulated point source discharges are responsible for the lesions, but limited reviews are merited. Although there is no current data to provide a linkage, nonpoint source inputs were recommended by the committee as the primary focus of investigation. The state team will continue to work with the Technical Advisory Committee as new data and results are collected.
- August 5, DNR Secretary John Griffin met with Shelltown watermen to establish a field office on their property to allow quicker response to fish health outbreaks and rain events. This is in response to suggestions made by the Technical Advisory Committee.
- DNR and MDE field crews respond within hours to the August 6 and August 26 fish kills. Fish, water quality, and algal samples at collected at the time and place of the kills. Sampling continues daily until both kills cease. Algal samples collected during both kills reveal toxic levels of a *Pfiesteria*-like dinoflagellate.
- State and local health officials issued a public health advisory on Aug. 6. The public was notified to avoid all water contact in the area from Cedar Hall Wharf to the mouth of the river.
- When the fish kill continued for a second day, and because of reports from the area that the advisory was disregarded by some individuals, state and local health officials issued an indefinite public health closure order for the area at 4 p.m. Thursday, Aug. 7. The closed section of the river was patrolled by Natural Resources Police to help ensure compliance with the order.
- The closure remained in effect after the end of the fish kill on Aug. 9 until Wednesday, Aug. 13, when the river was reopened at 5 a.m.
- The state team held a public information meeting on Monday, Aug. 11 in Pocomoke City to brief citizens on investigation activities and enable them to ask questions of state officials.
- Water samples for chemical toxicants were taken in the Pocomoke River on August 7, 1997 during a major fish kill.
- Upon Maryland's investigation team findings of fish with lesions and low numbers of dead fish (menhaden) in Maryland waters from the Pocomoke Sound upriver to the Cedar Hall Wharf area on Aug. 27, health officials extended the public health advisory to Cedar Hall Wharf.
- On Aug. 28, after continued similar findings in the advisory area as well as further upriver, the public health advisory was extended to the Powell Wharf Road area.
- Following continued similar findings in the advisory area, in addition to preliminary health information released by the Department of Health and Mental Hygiene concerning its study of individuals being examined for possible health effects relating to river water contact, Governor Glendening closed the river on Aug. 29 from Powell Wharf Road to the

mouth and into the Pocomoke Sound to a line from Williams Point to the Maryland/Virginia State Line Marker "M."

- MDE and DNR collected water quality samples on August 18, 20, 21, and 22 after storm events to evaluate the role that runoff may play in determining water quality conditions in the river.
- U.S. Geological Survey contributed lab testing for chemicals.
- NASA donated a weather station to DNR's Shelltown field office, which enables staff to study any possible connections of weather conditions to the situation in the lower Pocomoke.
- NOAA has loaned a vessel and personnel assigned to the Shelltown command center.

September and October 1997

September 10

- Governor Glendening closed King's Creek off the Manokin River in Somerset County after a significant number of menhaden were found in distress with *Pfiesteria*-like lesions. Toxic levels of a *Pfiesteria*-like organism have been confirmed.

September 14

- Governor Glendening closed a portion of the Chicamacomico River near Drawbridge Road in Dorchester County after a significant number of menhaden were found in distress and dying with *Pfiesteria*-like lesions.

Actions

- The Technical Advisory Committee met again to review progress to date. DNR submitted a model to explain why *Pfiesteria*-like organisms may have caused fish health problems on the lower Pocomoke. The model suggests that nutrient enrichment set the stage for the toxic outbreaks. The model is generally well received by the TAC.
- Results of water samples from the Kings Creek and the Chicamacomico indicate the presence of toxic levels of *Pfiesteria piscicida* on the Chicamacomico and *Pfiesteria*-like organisms on Kings Creek.
- DNR initiated intensive water quality cruises on the Kings Creek/Manokin River and the Chicamacomico River similar to those carried out on the Pocomoke.
- More water quality samples are collected on the Pocomoke after a September 29-30 rain event.
- Maryland's Congressional Delegation continues to assess the need for additional federal assistance. The state team is using the federal money for extensive laboratory tests and field work.
- On Sept. 9, DNR expanded its toll-free fish health hotline. The new hotline is manned 24 hours a day by trained personnel who can take complete reports, as well as refer callers requesting specific technical information to the proper resources within DNR or its sister agencies. The new system is an improved customer service and information gathering tool that will help DNR better identify any potential patterns of fish health issues. DNR also instituted rapid response teams to

address calls requiring immediate attention. More than 3,000 calls have been received on the hotline; two-thirds of which have been from citizens with questions about *Pfiesteria* or consumption of seafood. Concerning calls reporting abnormalities on fish, DNR fish biologists have been able to determine when reports are likely not *Pfiesteria*-related by reviewing information from the angler, or by interviewing the individual in a follow-up call. Response teams have investigated more than 20 waterways. Investigations yielded healthy fish overall, with small percentages of fish with skin anomalies, lesions, or parasites in several cases.

- Governor Glendening broadened his action plan to help identify the causes of *Pfiesteria* toxicity and develop solutions to address it. The Governor has called on President Bill Clinton, Maryland's Congressional Delegation, Governors from nearby states, the U.S. Environmental Protection Agency, and other federal agencies to support Maryland's efforts to address this challenge. Additionally, the Governor has:
 - created a Blue Ribbon Citizens *Pfiesteria* Action Commission, chaired by former Governor Harry R. Hughes;
 - convened a Governor's Summit on September 19 to discuss a regional approach to the *Pfiesteria* issue;
 - approved a \$2 million emergency appropriation to help Maryland farmers plant cover crops;
 - and committed \$500,000 for a comprehensive marketing campaign to better inform seafood wholesalers, retailers, and consumers about the quality and safety of Maryland seafood.
 - Maryland's scientific and medical experts developed a new protocol for the closing and reopening of rivers affected by *Pfiesteria* or *Pfiesteria*-like events. In accordance with that protocol, Governor Glendening announced the reopening of the Pocomoke River on Oct. 3. Kings Creek was reopened on Oct. 17.
 - Maryland Department of Agriculture and University of Maryland have worked with Lower Eastern Shore farmers to evaluate agricultural practices. An initial report was released in October. A more inclusive assessment is currently underway.
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Appendix 3

TEXT UNAVAILABLE MDE Sampling Data

Summary of Results of Monitoring for Chemical Contamination in the Lower Pocomoke River

In response to the recent problems with toxic, *Pfiesteria*-like organisms in the lower Pocomoke River, State, Federal and University scientists have been sampling water, sediments and fish tissue for possible contamination by pesticides, metals and PCB compounds. Sampling is continuing; however, as of October 15, 1997, no significant levels of contamination have been identified. The results of these analyses are summarized below.

Water samples were taken in the Pocomoke River on August 7, 1997 during a major fish kill and again on August 18 following a second fish kill. Additional samples were taken in the river and in two small tributaries on September 29-30 following a rain event.

August 7, 1997: Of 34 substances tested for (including permethrin), only atrazine was detected in the August 7 samples, at levels well below those reported as harmful to aquatic life. In addition, ambient aquatic toxicity tests (2 species, acute tests) showed no toxicity due to 96-hour exposure to river water.

August 18, 1997: A composite sample was analyzed for 48 pesticides, only 18 were detected, all far below levels estimated to cause adverse biological effects.

September 29-30, 1997: Laboratory results have not been received.

Historical sediment sample data have been reviewed and on July 25, 1997, samples were taken at 5 sites in the Lower Pocomoke River between Cedar Hall and Pocomoke Sound.

Historical data (1986-93): As part of the Chesapeake Bay Tributary Monitoring Program, sediments have been tested in Pocomoke Sound (1986-93) and the Pocomoke River (1989-93). All contaminant concentrations were lower than, or similar to, other tributaries and were lower than levels reported as posing harm to aquatic life. A permethrin concentration of 34.1 ppb was observed in the Pocomoke River in 1991. Subsequent data for the same site in 1992 and 1993 was <0.6 ppb and 8.8 ppb, which are both low levels relative to other sites in the Bay.

July 25, 1997: In samples of sediments taken at 5 sites in the Lower Pocomoke, metals, pesticides and organic contaminants were found to be similar or low compared to other sites in the Bay. Sediment concentrations of arsenic, chromium and p,p'-DDE marginally exceeded National Oceanic and Atmospheric Administration screening concentrations, for which adverse effects on benthic communities were observed in less than 10% of samples tested (i.e. no toxicity in 90% of cases).

Historical data for fish tissue has been reviewed and samples of a wide variety of commonly consumed fish were taken from the Lower Pocomoke River on June 10, 1997.

Historical data: Samples in 1990 and 1994 revealed no contaminant levels of concern.

June 10, 1997: Fish samples were taken from the river and analyzed for pesticides, PCBs and metals. Most levels were below detection. A few metals were detected at levels well within human health standards.

Maryland Department of the Environment Toxic *Pfiesteria* Action Plan

Since the onset of the recent increase in the incidence of lesions on fish in the lower Pocomoke River, MDE has stepped up its efforts to determine the source of the problems and to ensure that human health and the environment continues to be protected to Maryland's high standards.

MDEs ongoing and planned efforts on the Pocomoke include:

Monitoring of edible fish tissue to ensure that it continues to be safe for human consumption.

- Samples of resident fish species were collected and analyzed for pesticides, PCBs and metals. Most values were below detection levels, and all values were well within the range safe for human consumption.
- Additional fish and shellfish sampling is underway now as part of the State's Pocomoke River Study

Monitoring of shellfish harvesting waters to ensure that open harvesting areas are not affected by *Pfiesteria*.

- There are no open shellfish beds in the areas affected by *Pfiesteria*. Beds in the lower Pocomoke have been closed since 1964 due to fecal coliform levels in excess of the State's conservative standards.

Working closely with the Department of Health and Mental Hygiene and local health officials to ensure that the appropriate health advisories are issued regarding water contact and fish consumption.

MDE Field Office staff are working in cooperation with DNR as part of the State's Rapid Response Team to carry out field investigations of lesion and fish kill reports.

- The Rapid Response Team has found significant numbers of menhaden with lesions in the lower Pocomoke, King's Creek (tributary of the Manokin) and the Chicamacomico River.
- Numerous other investigations in other Bay tributaries have not found fish with symptoms indicative of *Pfiesteria* contamination.

In addition, volunteers with biological experience from other MDE programs have been recruited to assist with fish kill investigations as required.

Inspection and monitoring of regulated sewage treatment plants and industrial discharges

- Reviewed records from the past two years of permit compliance and whole effluent toxicity monitoring data
- Inspected facilities and collected water samples for laboratory analyses.
- All permit exceedences have either been brought into compliance or action is being taken to correct them.
- Using procedures developed for the Chesapeake Bay tributary strategies, MDE has estimated the total nutrient loading from point (regulated) and nonpoint sources in the Pocomoke and Manokin watersheds

- Only 2% of the nitrogen and 9% of the phosphorus load is from point sources in the Pocomoke.
- Only 7% of the nitrogen and 1.5% of the phosphorus is from point sources in the Manokin

MDE is working to accelerate implementation of Biological Nutrient Removal (BNR) at waste water treatment plants on the Eastern Shore

- On August 11, 1997, in response to the problems with *Pfiesteria* in the lower Pocomoke, Senators Sarbanes and Mikulski announced that federal funding of \$2 million would be made available for the local share of Pocomoke City and Snow Hill waste water treatment plant upgrade costs.
- MDE is also focusing efforts on accelerating the implementation of BNR at 9 other treatment plants located on the lower Eastern Shore.
- Full implementation of BNR at these 9 major plants will result in a 168,000 pound per year reduction in nitrogen load from 1985 levels (3.5% of the Lower Eastern Shore's 1985 controllable nitrogen load).

Inspection of unregulated nonpoint source discharges or other pollution problems that are the subject of complaints.

- Any identified problems on agricultural land are referred to the Maryland Department of Agriculture (MDA) and the appropriate Soil Conservation District for correction.

In addition, three teams of inspectors from MDE and MDA are being deployed to conduct a comprehensive site review of farming practices and potential environmental impacts of agricultural operations on Maryland's Eastern Shore.

- MDE inspectors and MDA agricultural technicians will visit each farm operator to evaluate current practices and to recommend improvements if necessary.

MDE is continuing to closely regulate the use of sewage sludge on agricultural land

- No sewage sludge has been used on agricultural land in the Pocomoke watershed in the past year.
- A total of 2,800 tons of sludge was used on 13 farms in the Nanticoke watershed.
- All farms receiving sludge are required to have nutrient management plans and buffer zones around any adjacent water bodies.

Surveys of the shoreline to identify and correct potential pollution problems.

- Surveys include identification and evaluation of failing septic systems, broken pipes and any illegal discharges.

Monitoring of toxic contaminant levels in water and sediments

- Water samples taken during the August 6-9 fish kill and on August 18 following the fish kill showed no significant contamination of the water.
- An historical review of sediment monitoring data and sampling of 5 sites in the lower Pocomoke River on July 25, 1995 showed no significant contamination of the sediments.

- Additional toxic contaminant sampling is underway as part of the Pocomoke Study Plan.

As part of a cooperative effort with DNR to monitor Pocomoke water quality during storm events, MDE has initiated rain event triggered water quality monitoring in streams and ditches draining to the lower Pocomoke River.

- Water quality monitoring is being done at eight sites located in the lower Pocomoke Watershed, draining to the area most affected by lesions and fish kills.
- Storm flow measurement at time of sampling approximated based on velocity and depth of water in channel cross-section.
- Grab samples taken from the center of flow are being analyzed for nutrients and fecal coliform.
- Protocols have been developed to monitor for pesticides and possibly biological organisms (viruses and bacteria) to be identified based on the results of MDA's survey of farming practices.

MDE is currently investigating the possibility of developing an expanded nonpoint source pollution monitoring station network to cover a larger portion of the lower Eastern Shore. MDE's water quality modeling and geographic information system (GIS) staff have computed total point and nonpoint source loading estimates for the Pocomoke River and Manokin River which have both been affected by *Pfiesteria*.

Both watersheds are dominated by nonpoint sources, with 90% to 98% of the nitrogen and phosphorus loading coming from agricultural and urban/residential land uses in the watersheds.

More comprehensive computer modeling and watershed pollutant loading assessments, including water quality monitoring, are underway as part of MDE's efforts to develop Total Maximum Daily Loads (TMDL).

Appendix 4

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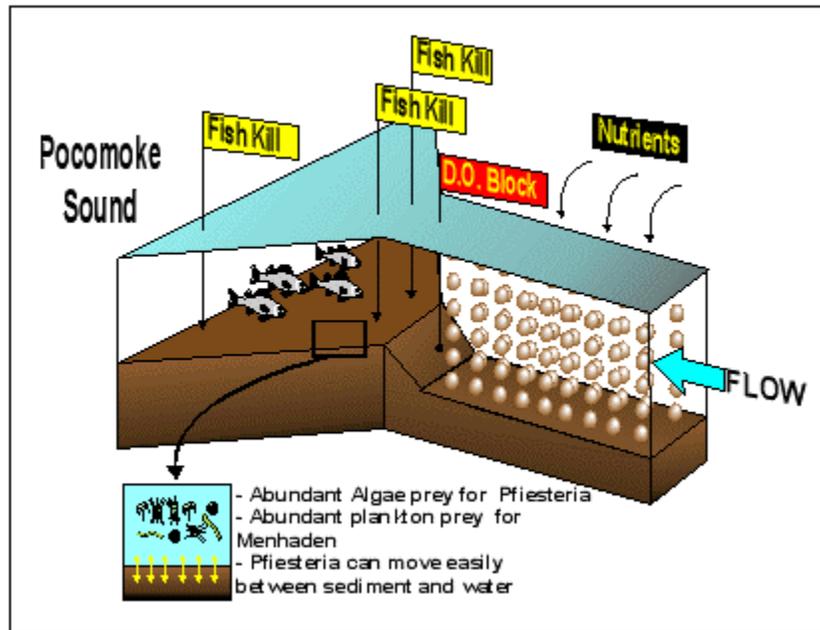
Appendix 5

Results and Conclusions

The toxic dinoflagellate *Pfiesteria piscicida* or a very similar species has been confirmed as the primary cause of the August 6 - 9 and August 26 - September 3 fish kills and fish lesion events on the lower Pocomoke River. At least 24 life stages of this species have been identified, all but 4 of which are completely harmless to organisms larger than other algae and bacteria. Only under certain environmental conditions will this organism briefly assume one of its toxic forms which may result in fish lesions and kills. Based on what we know of the biology of this organism and the habitat information that has been collected on the Pocomoke River, a hypothesis has been proposed to explain why toxic outbreaks of *Pfiesteria*-like organisms have recently occurred on the lower Pocomoke.

Shallower depths, more surface area, slower currents and increased light availability allow algae to utilize nutrients and bloom. Nutrients not utilized by algae in upper river because of depth, and limited light availability from suspended sediments and dissolved organic matter.

Pocomoke River Hypothesis



The Pocomoke River has some unique characteristics. It is deep from bank to bank, free flowing, and a blackwater system for most of its length. These factors prevent a significant algal community from developing in the mainstem of the River and, as a result, nutrients that enter the river from runoff and point sources are transported largely intact to the Sound. In the vicinity of Shelltown, the River widens quickly into a broad, shallow, and slow moving embayment, allowing algal communities to bloom. The resulting habitat in this area (warm, moderate salinity, calm, poorly flushed, nutrient enriched, and large algal community) is ideal for large populations of *Pfiesteria* to grow in its non-toxic forms. The final piece of the puzzle required for *Pfiesteria* to transform from its harmless to its toxic forms is large concentrations of fish; primarily menhaden. During the latter part of the summer, large schools of young menhaden begin to congregate in the lower portions of Chesapeake Bay tributaries. Plankton feeding menhaden probably find the Shelltown region attractive because of its high algae levels. The very low dissolved oxygen levels above Shelltown in the summer (a result of the small algal community and large bacterial community in the

mainstem of the River) may further concentrate fish in the Shelldown region by both driving resident fish out of the River and by blocking upstream movement of fish from the bay. All factors are now in place for *Pfiesteria* to assume a toxic form and cause lesion outbreaks and kills. Why did this happen now and not in previous years? 1996 was an extremely wet year (rainfall in the watershed was well above the 81 year average), and it is hypothesized that the resulting runoff contributed more nutrients to the River than previously.

The above is a hypothesis or model to explain why a *Pfiesteria*-like organism may have caused fish kills and lesions in the lower Pocomoke River. Maryland scientists are currently working with the Pocomoke River Technical Advisory Committee to develop experimental and monitoring techniques to test this hypothesis. Habitat conditions in other rivers and embayments that have experienced toxic outbreaks of *Pfiesteria*-like organisms will be compared to those in the Pocomoke to find common factors that trigger these outbreaks.

Appendix 6

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Appendix 7:

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APPENDIX 8

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APPENDIX 10:

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APPENDIX 11:

Nutrient Management on Crops Grown in the Pocomoke River Watershed

Cooperative effort between the University of Maryland
College of Agriculture and Natural Resources (AGNR)
and the Maryland Department of Agriculture

Study directed by
M. F. Smith
Professor, University of Maryland AGNR and Coordinator of Evaluation
October 28, 1997

Do Not Cite, Copy, or Distribute-- Results are Preliminary.

NUTRIENT MANAGEMENT ON CROPS GROWN IN THE POCOMOKE RIVER WATERSHED

Purpose:

The study of farmers in the Pocomoke region of Wicomico, Worcester, and Somerset Counties is an expansion of a statewide evaluation of the effectiveness of the Maryland nutrient management program. Of primary interest in that evaluation is the extent to which plan farmers are implementing their nutrient management plans. We also want to know if plan farmers are implementing practices different than nonplan farmers. Because the program has two delivery mechanisms, data were collected on each to determine comparative effectiveness, i.e., are the behaviors of farmers with plans recommended by the Cooperative Extension Service consultants different from those with plans recommended by private consultants (fertilizer representatives, sludge operators, independent crop consultants, and others).

Methodology:

The state study was designed to draw conclusions about the percentage of farmers (not acreage) implementing some practice or not with an accuracy rate of +10% with a 95% level of confidence; for example, a certain number of plan farmers are and the rest are not following the recommendations for application of nitrogen to corn. In the Pocomoke study, the accuracy may be closer to +5-7%. We will not be able to predict this with greater precision until further analyses are made.

The Maryland Department of Agriculture (MDA) provided a list of 475 farmers in the Pocomoke watershed. Duplicates were eliminated, as were those with out-of-state addresses, and those previously contacted on the state study. Everyone else on the list was contacted.

Farmers received communication from us that included a letter from their local county agent, a letter signed by Dr. Fretz and Mr. Riley (Dean, University of Maryland College of Agriculture and Natural Resources, and Maryland Secretary of Agriculture, respectively), and a one-page explanation of the purpose of the study and what would be expected from them if they chose to participate. They were telephoned to arrange interviews and then interviewed at the local Extension Office. Farmers who were willing but could not come to the office were interviewed at their farms.

Interviews took place between August 18 and September 26, 1997. They averaged 1½ hours per farmer. Those with nutrient management plans were queried on each individual

field in their plans--for some farmers that could mean 30 fields or more. We asked if they grew the crop recommended, if the yield goal was reached, if credits were taken for previous legume crops and manure use, if they used the type and amount of fertilizer (manure and commercial) recommended, and how much was used. If the farmer grew a different crop than the one recommended, the field was treated as nonplanned. We also asked about many practices associated with appropriate nutrient management.

Farmers were classified as "plan" farmers if they said they tried to follow ANY PORTION of their plans, regardless of how many fields might be in their plans; i.e., if they tried to follow the recommendations on at least one field, we called them a plan farmer. Whether or not they actually achieved recommended rates was not a consideration for classifying them as plan or nonplan farmers; that determination is being made as data are analyzed. Farmers were in no way coerced to participate. Participation in the nutrient management program is voluntary and participation in the evaluation was, also. Roughly 30% of the farmers who were eligible for the evaluation chose not to participate. Some refused because they said they had to comply with the survey MDA was conducting at the same time. They seemed to believe participation in the MDA survey was mandatory. Others did not participate for a variety of reasons: (1) they had negative feelings about participating in evaluations or about the "government" or about anyone asking questions about their private business; (2) they were unavailable on the days our interviewers were scheduled to be in their counties; (3) they were too busy because of farming tasks; etc.

Others were ineligible and therefore not interviewed because (1) they had no cropland; (2) they had less than 20 acres of cropland; (3) they were ill; or (4) they were unreachable, e.g., phone disconnected or bad address.

114 interviews were completed in the Pocomoke region: forty-three percent (49) were with farmers implementing some portion of their plans in 1996. The 65 farmers in the "no plan" group said they either did not have a plan or else were not following any portion of one in 1996. In this group, we believe nearly 70% have or have had a nutrient management plan for some portion of their acreage, even though they were not following one in 1996.

A Few Preliminary Results:

While the following results are preliminary and could change when all the analyses are complete, we do not expect the overall trends in the data to change to any significant degree. Other results will be presented at a later date.

- Farmers reported implementation data (crops grown and manure and commercial fertilizer used) on ca. 59,000 acres. They said they grew crops on 66,000 acres. The latter figure represents about 40% of the 170,000 acres of farmland in the Pocomoke.
- Manure was applied to about 44% of acreage (26,000 acres) for which implementation data were available.
- 89% of all farmers used manure somewhere on their farm land. The highest number was among CES-plan farmers where 93% used manure.
- For fields where manure was used on corn, 3.6 Tons/acre were applied overall: CES farmers applied 3.97 T/ac, private plan farmers applied 3.4 T/ac, and no-plan farmers applied 3.61 T/ac.
- Farmers using manure as a nutrient source used more total nitrogen, phosphorus, and potassium than did farmers using commercial fertilizer only. For example, across all farmers (plan and nonplan):

Corn	Nutrients Used			
		N lbs/ac	P lbs/ac	K lbs/ac
Acres receiving manure	166		228	176
Acres not receiving manure	142	11		78

Estimated nitrogen use was as follows:

--On corn, 156 lbs/ac overall

..CES plan farmers used 145 lbs/ac

..Private plan farmers used 166 lbs/ac

..No-plan farmers used 147 lbs/ac

--On soybeans, 18 lbs/ac overall:

..CES - 16 lbs/ac

..Private - 13 lbs/ac

..No-plan - 24 lbs/ac

--On wheat/soybeans double-cropped, 122 lb/ac overall:

..CES - 124 lbs/ac

..Private - 117 lbs/ac

..No-plan - 130 lbs/ac

Estimated phosphorus use was as follows:

--On corn, 139 lb/ac overall:

..CES - 207 lbs/ac

..Private - 115 lbs/ac

..No-plan - 127 lbs/ac

--On soybeans, 35 lbs/ac overall:

..CES - 19 lbs/ac

..Private - 35 lbs/ac

..No-plan - 44 lbs/ac

--On wheat/soybeans double-cropped, 105 lbs/ac overall:

..CES - 162 lbs/ac

..Private - 65 lbs/ac

..No-plan - 131 lbs/ac

- 82% of private-plan farmers complied with the recommendations given them for nitrogen use on corn. These farmers used ca. 152 lbs/ac compared to 191 lbs/ac for private-plan farmers who exceeded the 10% standard. A smaller percentage of CES-plan farmers stayed within the 10% limit, but compliers and noncompliers in the CES group used less nitrogen, i.e., 58% used 140 lbs/ac of nitrogen on corn compared to 174 lbs/ac for CES-plan farmers who exceeded the 10%.
-

APPENDIX 12:

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APPENDIX 13:

Farm Animal Manure Nutrients

Herbert L. Brodie, P.E.

Animal manure consists of a combination of feces and urine, wasted feed, bedding or litter materials, spilled water, rainfall, process water and just about anything else that falls to the floor where animals reside. The quantity of the manure and the nutrient content of the manure are highly affected by the type, size, age and function of the animal and the quality of the materials fed to the animal as well as the nutrients in the manure is affected by the various processes which occur between the point of defecation and the point of final utilization. The loss pathways are primarily through water caused erosion of manure on the soil of floor surfaces are volatilization of ammonia nitrogen.

Research has identified the properties of feces and urine for the various animals and has developed factors of probable changes during specific handling and treatment processes. This information can be used to plan the characteristics of manure through a specific farm design. However, each farm has a unique combination of physical biological and managerial circumstances which makes the prediction of nutrient utilization and loss form a large number of farms less sure. Each pathway has a different effect on manure and nutrient quantity. Dairy, poultry and other animal enterprises employing different manure management technologies must be approached with some caution.

On the other hand, farm nutrient management planning utilizes a laboratory analysis of the manure for nutrient content prior to manure application to the land. This allows nutrient application to be matched with crop need. The laboratory analysis is of the end product of the manure handling system and is independent of the variables of the farm. We have reviewed a large number of laboratory records and statistically defined the quality of manure from various animal types. However, there is insufficient information accompanying the samples which will allow relating the manure quality the kind or size of the animal production unit or the processes through which the manure might have passed. Therefore, the results of manure analysis cannot be related to animal numbers to predict nutrient loss between the animal and the point of manure utilization.

The prediction of nutrient production for the remainder of this discussion is based on the feces and urine as defecated by the animal without attenuation for treatment and handling processes of environmental losses.

A concept which allows comparison of different animal types, ages and functions is an animal unit. An animal unit is simply 1,000 pounds of body weight. Thus, a horse which weighs 1,000 pounds would be considered one animal unit. Four pigs weighing 250 pounds each would combine to be one animal unit. Animal units allow us to compare animal groups regardless of animal size. The quantity of manure produced by an animal unit of broiler chickens, swine and dairy animals is almost identical with layer chickens and beef cattle somewhat less. When we compare the number of animal units in a region we can then make a comparison of the quantities of manure which would be produced.

We can obtain animal number information from the U.S. Census of Agriculture. The information is presented in a variety of ways and one must understand both animal agriculture and the Census presentation before animal units can be correctly developed. The Census is discussed in a report "Nutrient Sources on Agricultural Lands" and I can provide a copy if desired.

Dairy cattle provide the greatest number of animal units. We have a substantial number of dairy animals and they are big animals so the combination of weight and number of head results in a large number. Meat type chickens (broilers, roasters and cornish) are the second greatest number of animal units. Although chickens are individually small in weight, the great number grown combines to produce a large number.

Chickens produced more nitrogen than the other animals because of the feedstuff combined with the inefficiency of the digestive process. Dairy and beef release almost 1/3 the nitrogen of the meat type chickens.

If we apply these nutrient production amounts to the animal units of the various animals we can see that although broilers were 32 percent of the animal units they produced 54 percent of the manure nitrogen in Maryland. Dairy cattle produced 34 percent of the nitrogen while being 44 percent of the animal units in the state.

We can look at phosphorus (as $P_2 O_5$) by production per animal unit and apply that to the animal unit distribution and see that broilers are responsible for 64 percent of the manure phosphorous in Maryland.

With that, we will review meat type chicken production more closely. From the Census we can develop an idea of the size of broiler production farms. The distribution of the birds sold by farm size indicates that 21 percent of the annual production occur on farms with less than 10 acres of land. Farms with 10 to 49 acres produce 30 percent of the birds. Thus, half of the annual meat type chicken production occurs on farms with less than 50 acres and therefore half of the phosphorus and nitrogen produced by the meat type chickens occurs on small farms.

There were 323 farms with less than 10 acres and 333 farms with 10 to 49 acres. Thus, 323 farms with a computed maximum of about 3,000 acres produce 21 percent of the nutrients. Or combined, 50 percent of the meat type poultry manure nutrients are produced on less than 19,000 acres. What do these farms do with the manure? We cannot be sure but we believe that most of these farms have arrangements with others to remove all or a portion of the manure from the originating farm.

The Census can be used to identify trends in production over time. In all counties the number of farms, the number of crop acres and the number of poultry production units decreased. Poultry production, however, decreased only in Worcester county while increasing in Somerset and Wicomico. The net result was a decrease in poultry production for the region and a concentrating of production on less farms and less land. This is expected because farms are businesses and like most other businesses of the period had to produce more with less. Production has likely expanded but stayed concentrated like other portions of the economy has since 1992.

Concentration of production is a factor which affects the ability to distribute nutrients. Sussex county Delaware produces the most meat type birds of any county in the country. However, Sussex is a very large county and the birds per acre are less than in Wicomico or Somerset counties in Maryland. Somerset with 1,203 birds per acre produces more manure nutrients than can be utilized by the crops grown. How much of these nutrients are lost or transported out of county is unknown.

We can consider transporting nutrients from nutrient rich areas to nutrient lean regions. To plan this we need to understand the nutrient budget of the regions of the state. Manure,

sewage sludge and chemical fertilizer must be included in the budget. The northern eastern shore relies heavily on fertilizer and is a candidate for receiving manure. The southern eastern shore should be importing less chemical fertilizer and requires distribution and export of manure. It should also be noted that sewage sludge is a very small portion of the nutrient budget when compared to manure and fertilizer.

In conclusion if we continue to concentrate animal production on less farms and less acres while importing more nutrients through feeds than we export in animal products than we can expect the inventory of stored nutrients with subsequent loss to the environment of increase.

Phone: 410-778-7676

Fax: 410-778-9075

hb23@umail.umd.edu

APPENDIX 14:

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APPENDIX 15

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Appendix 16:

PROPOSAL FOR BURNING POULTRY LITTER
AT THE
EASTERN CORRECTIONAL INSTITUTION COGENERATION PLANT
BY THE
MARYLAND ENVIRONMENTAL SERVICE
October 1997

I. INTRODUCTION

It is estimated that 290,000,000 chickens are raised every year in Maryland with approximately 300,000 1 tons of poultry litter generated per year from the rearing barns. The principal means for disposing this waste is through application of the litter on to farm land. Although this practice can provide beneficial nutrients to the crops, there are many areas where the nutrients may be in excess and may be migrating into the groundwater and surface water. It is believed that excess nutrients in surface waters are a contributing factor in the recent outbreaks of *Pfiesteria*. During the summer and fall of 1997, several tidal rivers and creeks experienced fish kills and human health disorders as a result of *Pfiesteria*. This has prompted an effort to look at other options for poultry litter disposal.

Previous studies have documented that it is feasible to use poultry litter as an alternate fuel source. Muir 2 in 1984, conducted several tests and found that poultry litter burned very readily in a furnace. He documented the energy content of the litter to be in the range of 4,500 to 6,400 BTU/lb. This is compared to approximately 4,600 BTU/lb for wood chips. Also, in Europe, the burning of poultry litter and other livestock wastes is quite common. The 1992 Incineration Conference cited a paper entitled, "Poultry Litter as a Fuel In the UK - A Review," by S.P. Dagnall. This paper describes the operation of several poultry litter combustors in England which are presently operating with satisfactory results. The company that owns and operates these plants also has a plant under construction in England with plans for additional units in other European countries.

II. SCOPE OF PROPOSAL

The scope of this proposal consists of installing and operating, for a period of one year, a 25,000 to 35,000 lbs/hour sized boiler combustor unit that will burn poultry litter as the primary fuel. This combustor will be a full scale unit capable of burning from 55 to 75 tons of poultry litter per day. From information compiled by the MD Department of Natural Resources, it is estimated that approximately 300,000 tons of litter are produced each year in Maryland with at least 150,000 tons of excess 3 litter available within a 25 mile radius of the proposed facility location. It is also estimated that the neighboring states of Virginia and Delaware generate quantities of poultry wastes greater than that of Maryland. Therefore, the type of combustor that will be installed will be selected based on its efficiency for burning poultry litter and its adaptability for use at other locations. If it is determined that

burning poultry litter is feasible, then the technology and procedures developed from this project could be applied at other locations.

The combustor unit will be installed at the Eastern Correctional Institution (ECI) Cogeneration Plant. The Cogeneration plant is owned by the Maryland Department of Public Safety and Correctional Services and operated by the Maryland Environmental Service. At the present time, the facility burns wood chips to produce steam and electricity for the prison complex. The proposed unit will burn poultry litter to produce low pressure steam for the prison. During the first year of operation, regular monitoring of the unit will be conducted to determine the BTU content of the fuel, characterization of the emissions, and quantities and composition of the ash. Previous studies of poultry litter ash have determined it may be used as a phosphorus supplement (Muir, et. al., 1990) 4 in chicken feed or the ash can be used as a valuable additive in commercial fertilizers for use outside of the poultry industry.

At the conclusion of one year of operation, a report will be prepared which discusses the monitoring results and other observations noted during operation of the unit. The report will also discuss any problems encountered, make recommendations for improvements, and provide a summary discussion as to the feasibility of using chicken litter as a fuel.

III. ENVIRONMENTAL AND ECONOMIC BENEFITS

There are several significant environmental and economic benefits realized by burning poultry litter. First, it may provide an inexpensive option for the poultry grower to dispose of the litter. The material can be merely hauled to ECI for burning. Second, by burning the poultry litter, it eliminates the possibility that the nutrients in the litter will be released to groundwater and surface water. Also, with respect to air pollution, it is possible that burning poultry litter may actually release less pollutants to the atmosphere than land application or composting the material. This assumes that a certain quantity of energy must be supplied to the prison for a given day to meet its demands, and to supply this energy, a quantity of fuel will be combusted which emits pollutants to the air. Likewise, to meet the market demands for poultry, the chicken growers will generate a specified amount of litter which must be disposed. If this litter is biodegraded via land application or composting, these processes release pollutants to the air. Therefore, if the litter is burned it is not available for biodegradation which saves an equivalent amount of wood chips from burning, thereby freeing this resource from combustion. Please note that a precise analysis of the net gain or loss of atmospheric pollutants has not been conducted. This discussion was added to merely illustrate that it may be possible to have a net reduction of some environmental pollutants. The proper emission control equipment will be installed on the combustor to reduce emissions to meet all regulatory requirements. Burning of the litter also prevents the propagation of disease which may occur when the material is land spread or composted.

IV. COSTS

It is estimated that 75 percent of the funds required for this project will go toward the actual purchase and installation of the boiler, litter handling and feed equipment, and emissions control equipment. It is estimated that approximately 25 percent of the funding will be applied toward operations, maintenance, and monitoring of the system for one year. The estimated cost for the project as proposed is \$2,000,000.

V. FUNDING

Although we feel that the project as proposed will provide valuable information, there may be justification to conduct additional work beyond the first year. Modifications to the combustor and/or emission control equipment may be made which would also necessitate accurate monitoring of the operations to document the results. In order to fund the additional work, discussions have been initiated with other federal agencies (Dept. of Energy, Dept. of Agriculture) and State of Maryland agencies to provide additional funding for this project. Unfortunately, the deadline for submission of this proposal did not allow for obtaining any firm commitments from these agencies. If additional funding is obtained, it will be used to fund modifications and operating costs for subsequent years.

VI. SCHEDULE

The Maryland Environmental Service is prepared to move forward as quickly as possible to purchase and install this combustor unit. It is anticipated that the construction phase will take approximately five months. After one month of start-up and adjusting the combustion controls and settings, the unit will be operated for a period of one year. A report describing the operation of the combustor unit will be prepared and disseminated prior to the end of the first year. If additional funding beyond the \$2,000,000 has been obtained, input from the Technical Advisory Committee, Delmarva, Power & Light, and others will be obtained to determine what modifications and operational changes should be made for continuing the project beyond the first year

VII. PRINCIPAL INVESTIGATORS

The Maryland Environmental Service will provide a qualified operations staff along with engineers and other technical staff to ensure proper operations and monitoring of the unit during the first year. It is anticipated that a Technical Advisory Committee will be established with members from the State Departments of Agriculture, Environment, Energy, and Natural Resources. In addition, the Delmarva Power & Light has agreed to participate and provide technical oversight and advisory services. Their participation will ensure that the unit chosen for installation will be compatible and suitable for use at other possible locations.

Appendix 17:

Conclusions submitted by Dr. Russell B. Brinsfield

Nitrogen

- The ratio of N leached to N in runoff for Coastal Plain cropland is approximately 5:1 without cover crops.
- Achieving a 40% reduction in field losses depends primarily on reducing nitrate leaching.
- Even when corn yield goals are met using all recommended BMP's and a nutrient management plan, nitrate leaching losses can be approximately 20-30 lbs/ac/yr and nitrate-N concentrations often exceeded 10 mg/l.
- Cereal grain cover crops can reduce nitrate leaching losses in Coastal Plain cropland by at least 60% following both corn and soybeans.

Phosphorus

- Traditional erosion control practices can be highly effective for reducing edge-of-field soil losses.
- However, these practices will not result in a 40% reduction in edge-of-field losses from most Coastal Plain cropland.
- Practices that concentrate P in the top of the soil profile will increase dissolved P concentrations in surface runoff.
- Soil and runoff P levels respond very slowly to reduced P application rates.
- For a given management system, edge-of-field P losses can vary significantly depending on precipitation patterns.

Recommendations

- Legislatively fund a comprehensive long-term cover crop program.
 - Reduce eutrophication by limiting N.
 - Develop a strategy that prevents further increases in soil phosphorus levels where adequate levels for optimum crop production exist.
 - Balancing P on a field-by-field basis.
 - Exporting poultry litter
 - Develop a long-term program which enhances the substitution of P in animal wastes for inorganic P imported into the Chesapeake Bay watershed.
 - Reassess recommendations to account for dissolved P.
-

Appendix 18:

(TEXT UNAVAILABLE)

Appendix 19:

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Appendix 20:

(TEXT UNAVAILABLE)

Appendix 21:

October 24, 1997

Dr. Donald Scavia
NOAA Coastal Ocean Office
Suite 9608
1315 East-West Highway
Silver Spring, MD 20910

Dear Don,

Thank you for providing Maryland with the opportunity to review the federal document "National Harmful Algal Bloom Research and Monitoring: An Initial Focus on *Pfiesteria*, Fish Lesions, Fish Kills and Public Health". You and your colleagues have done an excellent job of capturing all of the major efforts that are required to respond to our recent problems related to *Pfiesteria*-like organisms.

The comments below represent a review by the interested Maryland state agencies and input to date from the Governor's Citizen *Pfiesteria* Action Commission ("*Pfiesteria* Commission"). The Commission will be issuing its final report in the next two weeks and it will contain a number of recommendations relating to monitoring and research. Therefore, we may have additional information to add in the near future and we would be pleased to continue to work with you and the other federal agencies on this plan as it evolves.

The implementation of this strategy is also of great interest to Maryland. We have directed considerable resources to this problem already but will be very dependant upon future federal support for both research and monitoring. As I'm sure you know, and as we have learned through our experiences this year, the implementation of this strategy will be costly. We urge that in addition to the dollars allocated to scientific work by the various federal agencies, that substantial support be provided extramurally to build upon existing mechanisms such as state monitoring programs and peer-reviewed research programs. These mechanisms are in place and have worked well in the past to respond efficiently and rapidly to new developments.

As you refine your document, please consider the following recommendations:

1. As you point out in this document, both research and monitoring are important components of the response. Because of the different nature of these activities, we suggest that you present and prioritize these as two distinct categories. For example, the research efforts will likely be collaborative and regional, if not national. The monitoring, however, will be state-specific, as we have responded in the State of Maryland with both rapid-response and comprehensive evaluations of affected regions. The monitoring and research are also intended, for the most part, to address different issues. By distinguishing these functions in your document, we assure that the top priorities in each will be highlighted. Of course, we also recognize that there are important linkages between the research and monitoring, such as research aimed at improving the field identification of cells and toxins and the identification of factors associated with *Pfiesteria* outbreaks.
2. There are clearly many research needs and a number of these can and should proceed as soon as possible. Your first two objectives are ones that we would highlight as priorities -- the identification of the toxins involved and the development

of assays for the rapid detection of both these toxins (in environment and humans) and the organisms (in environment). It would be helpful to see additional detail under "required new effort" for Objective 2 that speaks to the rapid identification of cells, whether by cell surface recognition, nucleic acids, etc.

3. Objective 3, especially the human effects, is certainly an area of great concern to Maryland. This may need to be updated as we understand there are a number of efforts currently underway by CDC, NIEHS, and the affected states.
4. Objective 4 is also of great interest to Maryland. We believe that progress in this area will come from a combination of controlled laboratory experiments and carefully evaluated assessments of field conditions where outbreaks occur. The latter approach has been part of our objectives for the environmental monitoring programs in affected areas of Maryland. We believe this section needs to be focused on a few of the most promising techniques. As currently written, a long list of ongoing programs are included, some of which may not be very promising to meet this objective. For example, the idea of using sediment cores to identify the historical record of *Pfiesteria* was recently discussed by a technical group (including Dr. Burkholder) assembled by our *Pfiesteria* Commission and it was concluded that this is not now possible. The associated effort to reconstruct past environmental conditions in sufficient detail to establish the relationships with *Pfiesteria* abundance also seems dubious.
5. Some of the major needs for research being identified by our *Pfiesteria* Commission relate to the science and economics of managing animal wastes. These include composting, feed composition, ability of soils to hold phosphorus and the most effective application of BMPs. We would suggest that Objective 5 be adjusted somewhat to accommodate these types of research needs. Another observation is that some of the items currently in Objective 5 that relate to specific regulatory program seem out of place in the context of research needs.
6. We would agree that elements of Objective 6 are "mandatory" and this should be at the top of the list in the monitoring category. Other aspects of monitoring relating to more comprehensive and long-term assessments of affected areas are mentioned in a number of the previous objectives and may need to be consolidated if you decide to adopt our suggestion of creating separate monitoring and research categories.
7. We strongly support Objectives 7 and 8 which are closely related and could be combined with appropriate recognition of various subcategories of information. This need was also highlighted in the recent Governor's Summit on *Pfiesteria*. Maryland has developed information for our web sites and we would like to expand this in conjunction with our federal partners. We are also expediting the computerization of new scientific data collected in affected areas so that other may have access to it. We have already had numerous requests for these data, including federal agencies.
8. On page 2, paragraph 3, there is language that "public health and safety teams were mobilized ... and health-threatening conditions". Our seafood safety people believe that there is no evidence that the *Pfiesteria*-like organisms pose a health threat to seafood and that this language should be modified to reflect more the educational aspects of what they did during our outbreaks this year to assure consumers about seafood safety.

We in Maryland see this situation as an excellent opportunity to explore new and productive avenues of cooperation between state and federal governments on a difficult environmental issue of great concern to all of us. We look forward to working with you and you colleagues in the months and years ahead.

Sincerely,

Robert Magnien, Chair, Maryland Lower Eastern Shore Study Team

Copies: Honorable Harry Hughes, Chair, Maryland's *Pfiesteria* Commission
Joseph Bryce, Maryland Governor's Office
Dr. John Toll, Maryland *Pfiesteria* Commission
John Griffin, Secretary, Maryland Department of Natural Resources
Jane Nishida, Secretary, Maryland Department of the Environment
Martin Wasserman, Secretary, Maryland Department of Health and Mental Hygiene
Lewis Riley, Secretary, Maryland Department of Agriculture

Appendix 22:

Comments submitted by Delegate Ronald A. Guns

The time-frames for having the State enroll every farmer in a nutrient management plan by the year 2000, as well as having the plans fully and demonstrably implemented by 2002, are not realistic. The expectations for the government and the private sector to shift the demand for chicken manure presently used by the farming community to a non-farming use is near impossible. The scientific link between toxic *Pfiesteria* outbreaks in Maryland and nutrient over-enrichment of the lower Eastern Shore tributaries is at this time highly questionable. The devastation that the farming community suffered during the drought followed so rapidly by new state requirements for new, untried management strategies may economically devastate the farm community beyond repair. A more prudent time frame for the implementation of nutrient management plans for phosphorus must be considered. In addition to these issues, I have serious reservations with the requirements that best management practiced be employed in the design and construction of all new on-site sewage disposal systems.
