# Watershed Management Plan for Lake Bosomtwe

## 1.0 INTRODUCTION

Lake Bosomtwe is a valuable and beautiful natural resource that is enjoyed by watershed residents, as well as tourists. It supports many recreational activities, fishing and swimming and many more. All of these uses depend on maintaining the aesthetic quality of the lake, which is impacted negatively by human activity throughout the watershed.

Friends of the Earth, Ghana recognizing the need to prevent further degradation of the lake and to improve quality of the watershed, acknowledged that there was a need to bring together all stakeholders to agree on a strategic plan of actions that requires the cooperation of all the communities and their citizens. The stakeholders will use three approaches to accomplish its goals: gauging public opinion, educational approach and scientific approach. Through these efforts, there will be gained a greater understanding of the complexities of the Lake Bosomtwe watershed and the effect of human activity on it. Implementation of best management practices and model regulations will be encouraged. The Education, data collection, and implementation will create, in essence, a watershed management plan for the Lake Bosomtwe watershed.

The Lake Bosomtwe Biodiversity Conservation project which was conceived and executed as an environmental restoration project, aimed at improving the quality of life of the local people through conservation and sustainable management of biodiversity, reforestation of degraded forest lands using indigenous tree species and implementation of community forest management, training and capacity building, environmental awareness creation and education programmes on sustainable resources management has unearthed certain important issues which necessitated the need to have Lake Bosomtwe watershed management plan. The findings and lessons learnt from the biodiversity conversation project implementation as well as the recommendations are to be consolidated and expanded in the watershed management plan.

The Lake Bosomtwe Watershed Management Plan is an **action plan** containing the suggested management actions developed by Friends of the Earth, Ghana on steps that should be taken to protect Lake Bosomtwe and its watershed. It documents on-going lake management efforts, and serves as a guide for future development and environmental initiatives in the watershed.

Thus this document is as a comprehensive plan of action or road map to protect Bosomtwe Lake well into the future.

### 1.1 The Aim and Goal of the of Lake Bosomtwe Watershed Management Plan

The Lake Bosomtwe Watershed Management Plan study called for an in-depth description and analysis to determine the state of the watershed, an education and awareness program to educate local residents and to stimulate their interest in protecting the resource, development of coalitions for cooperation and participation in projects, and development of a plan of work relevant to the watershed and its residents to achieve the following goal:

- To improve environmental quality of Bosomtwe Lake watershed
- To protect the quality of natural resources in the Bosomtwe Lake Watershed
- To improve the low quality of life enjoyed by residents of the Bosomtwe Lake Watershed
- To improve water-dependent recreational opportunities
- To retain and attract business, improving local economic development opportunities
- To consider economic, social and other incentives for watershed protection
- Institutionalise environmental protection measures in the lake catchment area
- Develop and manage a sustainable fishing in the lake that will contribute to a reduction of poverty in the area
- Establishment of a sustainable biodiversity conservation programme

## 2.0 LAKE BOSOMTWE WATERSHED INFORMATION

Lake Bosomtwe was formed by a falling meteriite about 1.6 million years ago. Lake Bosomtwe is situated about 32 km south east of Kumasi, the capital of the Ashanti Region, Ghana and occupies a meteorite impact crater that was formed. The formation of the crater by an extraterrestrial body makes Lake Bosomtwe a unique meteorite crater heritage site in West Africa.

The area has a rich geological and biodiversity information and is also endowed with historical and cultural information. These are all very educative to a visitor to the site, and they can be harnessed to provide the grounds for sustainable community-based ecotourism.

The formation of the crater by the meteorite impact has rendered the landscape very weak with shattered, fractured and faulted rocks dominating in the area. Weak zones are therefore prominent thus making the area susceptible to landslides and massive erosion that can cause a rapid siltation of the lake with disastrous consequences for the aquatic life. The lake could even dry up as a result.

### 2.1 Local economies

The communities living in the watershed have to cope with a very low standard of living. Their livelihoods depend mainly on fishing and subsistence farming. The farming practices adopted and the over dependence on fishing are having negative impacts on both the land resources and the lake. Agricultural activities such as slash and burn and shifting cultivation with very short fallow periods have resulted in land degradation. Illegal tree felling is threatening to destroy the last spots of rain forest in the area. The fish stock in the lake has been continuously decreasing since the last decades due to over fishing, destruction of reed zones and poor fishing methods such as the scooping of fingerlings and the use of small-sized nets.

### 2.2 Natural environment

The Lake Bosomtwe being formed by a falling meteorite was discovered by rock analysis in 1965 in the United States of America.

Fossils of many animals including elephants, lion, tigers, black cobra, pythons, and many more were also found along the river banks indicating that these animals once inhabited the area around the lake.

The lake is about 90 metres deep and has a diameter of 10.5 kilometres. Two rivers and groundwater keep the water volume of the lake constant. The lake is surrounded by a serene atmosphere.

The area has a rich geological and biodiversity information and is also endowed with historical and cultural information. These are all very educative to a visitor to the site, and they can be harnessed to provide the grounds for sustainable community-based ecotourism.

The lake has a rich biological diversity, including fish that is the main source of animal protein for the adjacent communities. The lake is also of cultural significance to the Ashanti people who constitute about 30% of Ghana's population. The Ashantis believe that the lake is the abode of their gods.

There are 24 villages, with a total population of 11,800 people (the average size of a village is 500 people) along the 32km shoreline of Lake Bosomtwe. The main occupation of the people is fishing; shifting cultivation and farming are also undertaken in the catchment area and the main crops cultivated are maize, cassava, cocoyam, yam, and plantain.

## 3.0 NEED FOR THE LAKE BOSOMTWE WATERSHED MANAGEMENT PLAN

Biodiversity conservation in the Lake Bosomtwe basin has been identified as a priority in the Ghana National Biodiversity Action Plan, Ghana National Biodiversity Country Study, and the National Environmental Action Plan. There is therefore the strong need to protect this beautiful natural landscape for generations to come.

### 3.1 Local economies

The residents in the watershed depend mainly on fishing and subsistence farming for living. However, the farming practices adopted and the over dependence on fishing are having negative impacts on both the land and the lake. Agricultural practices such as slash and burn and shifting cultivation with very short fallow periods have resulted in land degradation. The illegal tree felling is also threatening to destroy the last spots of rain forest in the area. The negative impacts of farming methods as well as the mode of fishing pose a problem and has to be mitigated.

### 3.2 Decrease in Fish Stock

The fishing methods adopted by the residents have a negative effect on the fish population and as such the fish stock since the last decades in the lake has been continuously decreasing. This practices stern from over fishing, destruction of reed zones and poor fishing methods such as the scooping of fingerlings and the use of small-sized nets. The downward trend in the fish population will have to be halted through the watershed plan.

### 3.3 Hydrology

Lake Bosomtwe is about 90 metres deep and has a diameter of 10.5 kilometres and there are two rivers and groundwater which keeps the water volume of the lake constant. Thus if any project is located within the watershed of Lake Bosomtwe, the project will definitely impact on the hydrology of the area. The resultant effect would be the impingement on the natural drainage and flow rates and paths of these water bodies. The impacts of project implementation on the hydrology of the area will have to be looked at.

### 3.4 Erosion and Subsequent Siltation of the lake

As a result of the way the lake was formed by the meteorite, the impact of the meteorite has rendered the landscape very weak with shattered, fractured and faulted rocks dominating in the area. Weak zones are therefore prominent thus making the area susceptible to landslides and massive erosion. The area is therefore fragile and the problem of erosion and landslide can cause a rapid siltation of the lake with disastrous consequences for the aquatic life. The lake could even dry up as a result. Erosion and landslide potential will be addressed in the watershed plan.

## 4.0 ASSESSMENT OF THE NATURAL, ECONOMIC AND SOCIAL FEATURES OF LAKE BOSOMTWE WATERSHED.

### 4.1 Fauna and Flora

The project site combines a forest ecosystem with a wetland ecosystem, with a very rich biodiversity of trees, shrubs and herbaceous vegetation, birds, mammals, reptiles, amphibians and butterflies. The area falls within the peripheral semi evergreen forest and the Guineo-Congolian regional centre of endemism. It is characterized by *Afzelia africana, Cola gigantea, Hildegaradia barteri, Mansonia altissima, Morus mesozygia, Nesogordonia papaverifera* and *Pterygota macrocarpa.*

The forests throughout this area are a mosaic of moist semi-deciduous and evergreen type and characterized by a multi-layered structure. Taylor (1952) and Mooney (1959) described the vegetation of Bosomtwe as *Antiaris – Chlorophora* Association. The vegetation is dominated by *Antiaris toxicaria* (bark cloth tree) locally known as *kyenkyen* and *Milicia (Chlorophora) excelsa*, locally known as *odum*. Members of the *Marantaceae* and *Zingiberaceae* are common, but most species are woody trees.

Small woody trees like O*lax subscorpioidea, Bequaertiodendron oblanceolatum, Memecylon aylmeri* are common in the shaded under storey. Common large trees species are *Antiaris toxicaria, Ceiba pentandra, Chrosophyllum perpulchum* and *Triplochiton scleroxylon.* These forests also contain endemic forest species like O*lyra latifolia* and L*eptaspis cochloeata*. *Belanites wilsoniana* is a less common large tree species.

There is one major forest reserve and several sacred groves in the project area which could provide genetic resources for species of conservation interest such as several species of *Rubiaccae.* These cover a combined surface of more than 110 ha. The management of these sacred groves is governed by local taboos. These taboos draw their strength from religious beliefs or certain events which are thought to have taken place in the past and which have in a way made an impact on the lives of the people in the locality and encouraged them to conserve the plant resources.

### 4.2 Global Biodiversity Significance of the Lake Bosomtwe

#### 4.2.1 Aquatic biodiversity

The lake Bosomtwe is rich in aquatic biodiversity of national and global significance. Because the lake has no outlet, it has a high degree of endemism among the flora and fauna. The limited taxonomic work that has been undertaken in the lake points to a high degree of richness among the fish species, particularly in the *Cichlidae family*. The most important species described to date is an endemic fish, *Tilapia busumanna*. The fish species include sarotheroden *Galilaeus multifasciatus*, *Tilapia busumana*, *T. discolour*, and *T. zilli*. The other known fish of importance is the catfish of genus *Claria*.

#### 4.2.2 Terrestrial biodiversity

The forests in the catchment areas of Lake Bosomtwe harbors a variety of fauna that are recognized nationally and /or globally as endangered. These species include palm squirrel (*Epixerus ebii*), giant pangolin (*Manis [phataginus] gigantea*), tree pangolin (*M. tricuspis*), long-tailed pangolin (*M. tetradactyla*), bosman's potto (*Perodicticus potto*), dwarf galago (*Galagoides demidoff*), diana monkey (*Cercopithecus diana*), black and white colobus (*colobus [procolbus] polykomos*), African civet (*Viverra civetta*), two-spotted palm civet (*Nandinia binotata*), forest genet (*Genetta pardina*), yellow-backed duiker (*Cephalophus jentinki*) and bare-headed rock fowl (*Piscathartes gymnocephalus*).

Important flora in the catchment area include commercial timber species that are nationally or globally endangered or threatened. These species include *Khaya grandifoliola*, *Khaya senegalensis*, *Triplochiton screlexylon*, *Terminalia superba*, *Terminalia ivorensis*, *Bombax buonopozense* and *Ceiba pentandra*.

The catchment area also harbors flora species that are important biodiversity for agriculture and traditional medical practice that are endangered or threatened in West Africa. Examples of these species are listed in Table 2. Among these are over 30 plant species of medicinal values found around Lake Bosomtwe.

### 4.3 Threats to Biodiversity Conservation

The aquatic and terrestrial biodiversity in the Lake Bosomtwe basin is important from the local, national, and global perspective. Factors including the lack of updated information; the weakening of traditional resource systems (taboos, sacred groves regulations, etc); habitat degradation; and

increased harvest of biodiversity resources, particularly in the fisheries sector serve as threat to the biodiversity conservation.

### 4.3.1 Lack of up to date information

There is very little information about the status and trends of the biological diversity in the Lake Bosomtwe basin. Friends of the Earth-Ghana has undertaken, in collaboration with the local communities, preliminary surveys of the forest vegetation in the catchment area. These surveys have helped to identify a number of plants of conservation importance, including endangered commercial timber species, wild relatives of agricultural crops, and medicinal plants.

Very little is known also about the aquatic flora and fauna. Some fish species have been described, including the endemic fish, *T. busumanna*, but some experts believe that other endemic flora and fauna may occur in the lake because of its unique physical and chemical characteristics, largely influenced by the fact that the lake has no outlet.

### 4.3.2 Weakening of traditional resource management systems

The people living around the lake have for centuries had a traditional system of authority headed by chiefs that oversees religious activities, regulation of local natural resources, and other aspects of the life in the communities.

The traditional natural resource management regimes in communities around the lake include a network of sacred groves in the forest areas that are strictly protected because of their religious and cultural significance. There are several sacred groves with an average size of 4 hectares and many of them coincide with ecologically sensitive areas in the catchment areas, including the banks of streams associated with the lake. Local taboos, based on religious beliefs, have prevented encroachment into the sacred groves for centuries.

The lake itself is considered to be sacred because of the belief that it is the abode of the gods. As a result, no motorized boat is allowed on the lake because of the belief that the sound of the engine would disturb the gods; only the traditional method of fishing is permitted on the lake. The traditional fishing craft comprises of single wood plank measuring about 3 metres long and 0.5 metres wide, "powered" with small calabash paddles. The traditional authorities have been successful in maintaining this taboo. Apart from the religious significance of this fishing method, it has also helped to limit fishing effort. However, the influence of western religions has begun to erode some people's perception of those taboos and regulations. As a result, encroachment into the sacred groves by shifting cultivation is increasingly becoming a problem. Furthermore, pressure is growing on the traditional authorities to allow motorized boats on the lake and more efficient fish harvesting gear.

### 4.3.3 Habitat degradation

The integrity of both aquatic and terrestrial habitats in the Lake Bosomtwe basin is being undermined by human-induced activities. The lake is facing localized pollution from the dumping of domestic waste. Sedimentation is also threatening the lake; larger areas of the watershed of associated streams are being denuded by shifting cultivation, thereby increasing soil erosion.

The forest in the catchment area is also threatened by bush fires that are often triggered by shifting cultivators or hunters. About 90% of the original forest cover in the watershed have been lost. The

most critical areas that urgently need improved management are the forests along the banks of streams that are connected to the lake to minimize the impacts of sedimentation on water quality and species diversity.

### 4.3.4 Increased harvesting of biodiversity

Fishing is the main occupation for people in the Lake Bosomtwe area. The continued enforcement of traditional restrictions on fishing methods has helped to avoid overfishing. Limited catch statistics available appear to indicate that harvest levels are below the maximum sustainable yield (MSY). However, harvest may quickly exceed the MSY if the traditional management regime collapses.

The forests in the catchment area are an important source of firewood which accounts for about 80% of the energy needs of the people. It is estimated that the annual per capita consumption of firewood in the Lake Bosomtwe area is 0.83 m3. As the population increases, demand for firewood is rising with adverse impacts on forest flora and fauna.

## 5.0 POLLUTION SOURCES REMEDIATION ACTION PLAN

The Lake Bosomtwe Watershed management plan projects various scenarios into the future, to predict the most likely outcomes, and to plan for them. Actual and potential sources of pollution have been broken down into different categories and their mitigation strategies outlined. These categories provide a convenient way of identifying sources and remediation techniques for the various sources of pollution. Each category is described, a list of prioritized action items is identified, and an agent with primary responsibility is assigned. The order in which the individual Pollution Sources are listed is intended as a rough prioritization.

### 5.1 Soil degradation

Soil degradation comprises of loss of productive soils and reduced capacity of soils to support economically important uses. Degraded soils reduce fertility and productivity. They also render some area unfit for any vegetative cover and decrease the quality and availability of some water resources by reducing infiltration and runoff water, contributing to erosion, and failing to support vegetation cover. The primary causes include the following:

- Removal of vegetative cover
- Removal of top soil during land clearing and mechanised soil removals, resulting in soil compaction, decrease in infiltration rate and increase in run off.
- Removal of natural nutrients in the soil due to vegetation removal,
- Mining and strip mining practices with no land reclamation
- Bush burning

### 5.1.1 Pollution Prevention Actions

- Inactment of Active Environment & Social management policies especially the policy on nature conservation
- Restriction on indiscriminate land clearing and practices.

### 5.2 Deforestation

Deforestation results from the following human activities:

- Bush burning or clearing
- Mining activities

- Fuelwood
- Uncontrolled exploitation of forest resources
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**5.2.1 Pollution Prevention Actions**

- Intensification of afforestation programmes
- Ensuring sustainable harvesting of forest resources

**5.3 Soil erosion**

Lack of adequate soil conservation practices by any activity concerns usually lead to soil degradation and erosion, resulting in land that is unsuitable for other activities. Erosion of exposed area and lands can be attributed greatly to storm water runoff. Construction activities normally involve the removal of vegetation and topsoil leaving the land bare. This makes such arrears susceptible to gully and sheet erosion. The most vulnerable areas are soils with loose cohesion and bonding agents.

**5.3.1 Pollution Prevention Actions**

- Active watershed land and soil conservation practices
- Prohibition of mining practices in the catchment area
- Management and reclamation of disturbed areas
- Restrictions of quatters and restriction of development in the land use and
- Increase revegetation and afforestation to in crease groundwater recharge and reduce surface runoff.

**5.4 Wildlife and Fishes**

Activities in the catchment area will give rise to erosion hazards with attendant adverse effects of erosion and sedimentation. Soil sedimentation has far reaching implications and multiple effects than just the deposition of soils. These include abrasive and mechanical damage to the gills of fishes; smothering of benthic organisms and fish egg in receiving waters and plants on land; lowering of dissolved oxygen in waters, through bacterial breakdown of organic matter contained in the soils, introduction of toxic materials adhering to soil particles into waterways and reduction in materials adhering to soil particles into waterways and reduction in materials that function as fertilizers for plant growth.

Undesirable sedimentation of Lake Bosomtwe can occur especially during the rainy season. The effects of sedimentation could therefore make stream biota very vulnerable.

**5.4.1 Pollution Prevention Actions**

1. Seed fish, if necessary, to maximise fisheries productivity.
2. Prevention of sediment loads from reaching the river which can cause injury to the gills of the fishes and destroy breeding grounds as well as destroy zooplanktons on which fishes feed.
3. Poor fishing methods such as the scooping of fingerlings and the use of small-sized nets should be stopped.

**5.5 Mining**

Precipitation on sand and gravel mines contributes to runoff and groundwater recharge. The operation of mining activities will enhance erosion and subsequent sedimentation of the lake.

### 5.5.1 Goals

To minimize water pollution such as sediment runoffs and groundwater contamination originating from active or inactive mines in the Lake Watershed

### 5.5.2 Pollution Prevention Actions (prioritized)

1. No mining should be allowed in the watershed. If permitted, these mines have the potential to pollute surface and groundwater
2. Share information on mines prohibition with regulatory officials (Minerals commission and Mines Department) so that they do not give the mining companies permits to operate

## 5.6 Nutrients

External sources of nutrients into the lake include fertilizers and, in addition to external nutrient sources, under certain conditions (anoxia in hypolimnetic waters) phosphorus is liberated into the water column from the large amounts stored in the bottom sediments. The sediments are a historic record of past land uses responsible for these high level of nutrients. Internal loading of nutrients from the bottom sediments can be significant in Lake Bosomtwe.

### 5.6.1 Goal

To reduce inputs of nutrients, especially phosphorus, from a variety of sources (sediment, wastewater, agriculture, erosion, etc.) to Lake Bosomtwe.

### 5.6.2 Pollution Prevention Actions (prioritized)

1. It is recommended to develop a Generalized Watershed Loading Function (GWLF) watershed model to project nutrient loading from both internal and external sources
2. It is recommended to control excessive algae blooms using an alum treatment of bottom sediments.
3. Develop Macrophyte Management Plan according to DEC guidelines considering all forms macrophyte management
4. Manage excessive macrophytes with weed harvesting until the MMP is completed.
5. Expand the tributary sampling program that will assess the actual contribution of streams and direct drainage areas to the lake's overall nutrient budget under baseline and storm conditions
6. Investigate the condition of the private wastewater (septic) treatment systems in the watershed and their role as a source of nutrients.
7. Evaluate nutrient sources from highways, shoreline and stream banks
8. Educate residents on a "lake-friendly lawn" program to reduce nutrient input to the lake and perform survey of resident practices
9. Investigate potential point sources of nutrient discharge
10. Encourage farmers to participate in Agricultural Environment Management (AEM) programs

### 5.6.3 Importance / Feasibility

1. Generalized Watershed Loading Function (GWLF) loading model will provide preliminary answers on how much phosphorus loading originates in the watershed vs. in-lake sources.
2. According to current research sealing phosphorus-rich nutrients is possible and is commonly done.
3. Existing program to be enhanced and consider shoreline pickup program

4. Real runoff data, including flow measurements, sediment and nutrient loading will calibrate the GWLF model and improve targeting of remedial efforts.
5. A survey of septic system owners to determine what kind of action, educational, remedial and/or regulatory, is required
6. The magnitude of nutrient loading from highways, shoreline and streambanks is unknown and needs to be quantified.
7. Participation in AEM is best achieved by farmers talking to one another.

### 5.7 Onsite Wastewater Systems (Septic)

The resort near the lake has a sewer system installed and there may be leakage from this aging sewer system. In addition the various community have numerous septic systems within the watershed. Malfunctioning septic systems can deliver pathogens (disease-causing organisms) and nutrients (nitrates and phosphorus) to wells in this watershed water.

#### 5.7.1 Pollution Prevention Actions (prioritized)

1. Develop a uniform and cooperative approach to septic system regulation and inspection in the watershed
2. Develop a schedule of septic system inspections for those systems within 200 feet of a lake or stream
3. Educate septic system owners and promote regular septic system maintenance
4. Arrange more frequent inspections of septic facilities

### 5.8 Forestry

Common problems are poor harvest planning and improper harvest. Steep slopes, inappropriate stream crossings, disturbed erodeable soils and intense harvesting activities can cause significant damage. Weather conditions play a major role in the water quality impacts associated with harvesting. Significant soil degradation can occur during wet conditions and heavy loads can severely damage roads. Harvest practices are extremely variable.

#### 5.8.1 Goals:

To reduce the impacts of forest harvesting activities in the Bosomtwe Lake Watershed

#### 5.8.2 Pollution Prevention Actions (prioritized)

1. Consider banning Timber Harvesting in the catchment area
2. Provide technical and financial assistance to forest owners

### 5.9 Roadbanks and Ditches

There are public roads in the Bosomtwe lake Watershed. Improper design, construction and maintenance of bridges, culverts, ditches and banks can cause major water quality problems, chiefly through increased erosion and sedimentation. Proper erosion and sediment control on highway projects are necessary, since they are a major source of sediments delivered to streams that empty into the lake. Sometimes poorly built and suffering from lack of maintenance, contribute to sediment and nutrient problems in nearby streams. Because of steeper topography roads normally cause greater problems. Construction standards for roads are to be followed so as they will continue to cause water quality problems.

### 5.9.1 Goal:

To reduce the delivery of sediments, nutrients, and salt originating from road construction and maintenance to the Bosomtwe lake Watershed

### 5.9.2 Pollution Prevention Actions (prioritized)

1. Encourage increased use of training in erosion control for highway officials (e.g. Highway Authority Roads Program)
2. Include erosion and sediment control in all highway construction and maintenance Projects in the catchment area
3. Use re-vegetation measures, such as mulching and hydro-seeding of roadside banks and ditches
4. Use structural measures, if necessary, to control sediments from stormwater
5. Establish and enforce site and construction standards for roads

## 5.10 Development

The quantity and quality of storm water can be adversely affected by land development activities. Construction activities typically alter or remove vegetation, re-direct drainage and add impervious surfaces, such as roads and roofs. This directs more water runoff into streams. Lack of planning can have lasting detrimental effects within the watershed.

Developments can become an environmental problem by generating increased runoff and erosi on. The beauty and amenities of the Bosomtwe lake Watershed will continue to attract developers. Large scale development requires proper planning and active enforcement.

### 5.10.1 Goals:

To minimize the sediment and nutrient inputs to Bosomtwe lake from de veloping and developed land

### 5.10.2 Pollution Prevention Actions:

1. Address development within the watershed by requiring appropriate building standards
2. Provide education for officials on erosion control of storm water and management options
3. Watershed communities should work together to identify environmentally sensitive and undeveloped lands requiring protection
4. Provide consistent, uniform enforcement of existing land use regulations.

## 5.11 Recreational Use

The water quality of the lake can be affected by pollution originating from its recreational use, chiefly motorboats. Because many of these boats are equipped with two-cycle engines, as much as 25% of their unburned fuel mixture could be vented un-combusted into the lake.

### 5.11.1 Goals:

To encourage recreational activity and tourism while minimizing the environmental impacts of recreational uses on water quality

### 5.11.2 Pollution Prevention Actions (prioritized)

1. Discourage the use of fuel boats
2. Promote increased enforcement of existing boating regulations

3. Examine boat speed regulations, especially near-shore, to diminish shoreline disturbance
4. Determine impact of prop wash on bottom sediments of Bosomtwe lake, especially if re-suspended sediments are phosphorus sources

### 5.12 Agriculture

Types of pollution coming from agriculture include sediments, nutrients from fertilizers and animal waste. These can contaminate both ground and surface water. Transport of these pollutants occurs through movement of eroded soil particles with attached pollutants or pollutants dissolved in runoff. Agricultural use in the Bosomtwe lake Watershed is much lower. Tilled land could be a major source of sediment and nutrients, but this is common in the watershed.

#### 5.12.1 Goal:

To reduce inputs of nutrients and sediment from agricultural sources and to preserve the agricultural use of lands in the Bosomtwe lake Watershed

#### 5.12.2 Pollution Prevention Actions (prioritized)

1. Assure that the farmers are participating in programs that use the principles of Agricultural Environmental Management. There are a variety of cost-sharing options to assist farmers in trying new technology, using conservation practices and converting to sustainable operations. Use "Lake Friendly Farmer" signs to publicize participation.
2. Create a survey and database of farmers in the watershed for contact
3. Cooperate with Friends of the Earth on programs to acquire development rights or whole properties and to ensure future agricultural uses

#### 5.12.3 Importance / Feasibility

1. Requires public relations efforts by the pertinent officials, Ministry of Agriculture
2. Requires outreach to farmers in the watershed by government.

### 5.13 Pesticides

Some pesticides persist for long periods of time and may collect in soils, sediments or in tissues of plants and animals. Proximity of pesticide use to water increases risk, so setbacks from lake should be maintained. Soluble pesticides are more likely to contaminate groundwater. Less soluble pesticides are more likely to attach themselves to soil particles, and as the soil erodes, the pesticides travels with it. Pesticides come from residential and agricultural sources. Residential use has minimal control since no training is required to purchase and apply most home and garden pesticides. Proper disposal of unwanted pesticides is necessary to prevent environmental damage.

#### 5.13.1 Goal:

To reduce pesticide input from agricultural and household sources to the water resources in the Bosomtwe lake Watershed

#### 5.13.2 Pollution Prevention Actions (prioritized)

1. Promote the use of Integrated Pest Management (IPM) for agriculture, homeowners, and institutions to target appropriate pest species, choose proper pesticides, and apply chemicals safely
2. Institute periodic testing for pesticides as part of the stream sampling

3. Promote use of hazardous waste clean-up day, which does not exists in Lake Bosomtwe water shed County, for safe disposal pesticides and other toxic materials.
4. Encourage watershed farmers to use the Agricultural Environmental Management ( AEM) program that offers technical and financial assistance to farmers working to utilize pesticides properly.

**5.14 Spills**

Hydrocarbons, mostly gasoline, diesel fuel, hydraulic fluid represent 35-50% of all spills reported in the Ghana. Though Spills are not always remediated as soon as it is notified, there is a need to increase spill prevention efforts and improve local response in the watershed. Spills have not been reported in the watershed. This does not rule out the possibility of occurrence. Should this accidents happen, their frequency and impact can be reduced through targeted educational efforts and improved clean-up procedures.

**5.14 Goals:**

To reduce the effect of spills in the Bosomtwe lake Watershed and to improve the effectiveness of spill reporting and response

**5.14.1 Pollution Prevention Actions (prioritized)**

1. Inventory small fuel tanks in the watershed.
2. Compile information on chemical storage in the watershed.
3. Inventory underground storage tanks in flood zones (such as home heating oil).
4. Make information on chemical storage in the watershed available to the residents of the communities.
5. Educate owners of small fuel tanks on who to call and what to do if they have a leak.
6. Educate owners of underground storage tanks in flood zones on the danger of tank rupture

**5.15 Dumps and Inactive Hazardous Waste Sites**

The waste from the communities need to be disposed off and as such there may be small private dumps and accumulations of household debris in the gullies of the watershed which, though never regulated, should be cleaned up.

**5.15.1 Goals:**

To minimize the impacts of inactive dumps on the water quality in the watershed and to remove threats to public health

**5.15.2 Pollution Prevention Actions (prioritized):**

1. Survey locations, dates of operation, types of material deposited and vulnerability to water resources
2. Investigate leachate, if present, through an intensive engineering study and Develop an engineering study for proper closure public education program could explain the issues related to dumps
3. Conduct water quality tests in their vicinity as part of the stream monitoring program
4. Organize cleanup campaigns with media involvement campaigns.
5. Encourage town cleanup days.
6. Put up signs to discourage dumping.

7. Communicate illegal dumping problems to the public and how to anonymously report dumping activities.
8. Examine roadside dumping law and implementation system. Determine if Friends of the Earth should enact such a law.

**5.15.3 Importance / Feasibility**

1. May require specialized consultant assistance
2. Technically difficult and may be expensive
3. Technically difficult and would require an engineer experienced in landfill closures

**5.16 Exotic, Introduced and Invasive Species Management**

**5.16.1 Goal:**

Address the problem of exotic, introduced and invasive species in the watershed.

**5.15.2 Suggested Actions:**

1. Initiate a regular inventory and monitoring program for exotic, introduced and invasive species in the lake and watershed.
2. Short term objectives: Implementation is feasible and/or should be done in the next 1 to 3 years.
3. Utilize expertise to monitor and control invasive species before they become established.
4. Other objectives: Implementation depends on future resources or identification of additional concerns.
5. Investigate the variety of habitats around the lake for species diversity and assess the potential effect that might occur if damaged in any way.

## 6.0 PRIORITIZED PLAN

Creating a five-year action plan is a reasonable beginning point for a project of significant scale and unknown duration. Many projects are more feasible if their costs are spread over a five-year term. Some actions can be further divided into steps to attain a large or distant goal.

In the action plan over 70 action items have been designated as the means of remedying or avoiding the major sources of pollution. The pollution sources have been listed in the document, from the most to the least serious. Within each of the categories the action items to remedy/avoid each pollution source have been placed in an order of overall efficacy, generally without regard to cost. The order in which tasks are to be undertaken should be determined by the Friends of the Earth in conjunction with the agency responsible for performing the task.

It is recommended that all of the action items identified in this document should be considered because some can be accomplished through volunteer efforts, some have minimal costs, some are purely administrative, and some should begin as soon as possible to pave the way for future tasks.

### 6.1 The list of action items considered most significant

The list of action items considered most significant are:

1. Use GWLF or other watershed model to predict loading to lake
2. Curtail internal loading of phosphorus with an alum treatment of the lake bottom

3. Develop Macrophyte Management Plan according to DEC guidelines considering all forms macrophyte management
4. Manage excessive macrophytes with weed harvesting until the MMP is completed.
5. Expand the tributary sampling program to comprehensively assess inputs to the lake
6. Develop and adopt a uniform and cooperative approach to septic system regulation in the watershed
7. Develop a regularly scheduled system of septic system inspections for systems within 200 feet of the lake or major streams
8. Educate septic system owners and promote regular septic system maintenance
9. Encourage town to pass a Timber Harvesting Regulation
10. Promote participation in existing forest stewardship programs
11. Provide technical assistance to forest owners
12. Promote the ban of forest harvest by loggers
13. Promote increased training in erosion control for highway departments
14. Include erosion and sediment control planning in all high way projects
15. Use re-vegetation such as mulching and hydro-seeding of roadside banks and ditches
16. Adopt land use regulations aimed at reducing peak flows in streams
17. Survey and identify most severe areas of streambank and shoreline erosion
18. Restore severely eroding stream banks and shorelines
19. Review municipal land use regulations for adequacy of water quality protection
20. Address lake-front congestion and further shoreline growth through land use regulation
21. Educate municipal officials on erosion control
22. Discourage use of fuel pollution boats

The above are of the action items are need to implement the Lake Bosomtwe Watershed Plan.

## 7.0 IMPLEMENTING STRATEGY AND SCHEDULE

### 7.1 Gauging Public Opinion

More needs to be done to gather and process information about the management of Bosomtwe Lake and its watershed. Surveys of public opinion have to be carried out to assess the interested public needs to be presented with these findings and asked to provide their fresh opinions on further actions.

Public hearings associated with this Plan will be used to gauge and record public opinion on current issues relating to Bosomtwe Lake Watershed Management.

### 7.2 Educational Approach

Many years of concentrated efforts have been spent to protect Bosomtwe Lake and improve its watershed. Many of these efforts concentrated on the necessary role of education in the process. Indeed, education is the motivating force for all sorts of social improvements including environmental protection. Educational efforts have been aimed at citizens and governmental officials. It should be clear from the list of the accomplishments of the Friends of the Earth Bosomtwe Lake Biodiversity Conservation that they have been involved in a long term public education program, first to draw the public's attention to Bosomtwe Lake problems, then to engage the public in seeking solutions.

### 7.3 Scientific Approach

Watershed management efforts must have a solid scientific basis, including the analysis of water quality problems, selection of remedial actions, and analysis and evaluation of results. Before actions are recommended or taken, a scientific analysis of the problems must be performed. Solutions must be tailored to target problems as specifically as possible and to avoid unintended consequences. Comprehensive analysis is needed in complex systems, such as lakes and watersheds. Sufficient data and an accurate picture of the interrelationship of various factors must be researched.

The Bosomtwe Lake Watershed has been intensively studied for at least three decades, but information gaps exist. Scientific studies have to be intensified in certain areas of interest: sediments, internal and external nutrient loading, water chemistry, the impacts of various management options, land use and cover and plankton.

## 8.0 PARTNERSHIPS

The management of a complex ecosystem like a watershed or lake it is necessary to foster a cooperative partnership approach. No single entity manages Bosomtwe Lake or watershed for its numerous stakeholders. The lake itself is subject to several forms of regulations and jurisdictions. Thus, for the sake of good management, it is necessary to foster cooperation, participation, communication, and, to the extent possible, uniform regulations. Management of Bosomtwe Lake and its watershed will require the efforts of many levels of government, agencies, organizations, groups, and citizens working together in partnership. Effective partnerships are based on good information and educational efforts. Cooperation requires that the parties have a knowledge of why, how, when and where to cooperate, which can only be gained from shared information and communication. Mutual trust is necessary to make partnerships work, and trust can only be earned.

### 8.1 Support and Leadership

There could be no Bosomtwe Lake Watershed Management Plan without the support of community, regional and the government. In the plan put forward for the Bosomtwe Lake Watershed management governments must stepped forward to exercise their powers to regulate land use and perform other functions for the improved health, safety and general welfare of their citizens. As in the case of the other Lakes, it makes sense to speak of Bosomtwe Lake as an “economic engine” of the area. Recreation and tourism contribute substantially to the local economy, and the tax base is significantly affected by the presence and condition of Bosomtwe Lake. Self-interest requires that the watershed communities take action to protect the source of business and tax revenues.

Donor support in the form of funding is tremendously important to the short and long term implementation of the Bosomtwe Lake Watershed Management Plan. A question always arises in the minds of distant funding sources: Are the locals doing enough? The answer is yes and they have to be provided with financial support to the project.

### 8.2 Staffing

The watershed management plan is a compilation of technical information to guide future actions. The collection of tasks has various characteristics: stand-alone, sequential, immediate, long term, technical, educational, planning, discrete and continuing. In reviewing the list of actions, the project sponsors must decide the best means to accomplish them. Friends of the Earth employees, trained technicians and knowledgeable consultants will complete the tasks. Other tasks could be

accomplished by a well-trained employee, with some cost-savings to the organization. In some cases, volunteers may be able to accomplish tasks if they are sufficiently trained or organized by a staff person. If the Bosomtwe Lake Watershed Management Plan is to be carried out in a timely manner, it is clear from the list of tasks that it cannot be accomplished solely on a volunteer basis. A part-time employee acting as a Watershed Manager to work with the Bosomtwe Lake Watershed Task Force may be a viable option.

## 9.0 MONITORING

A final step in implementing a watershed management plan is assuring the quality of the actions by setting benchmarks to monitor success/failure. It is recommended that the Bosomtwe Lake Watershed Management Plan establish a "trophic target". With it, the Friends of the Earth will be able to chart the progress of Bosomtwe Lake Watershed management toward a better trophic state. Monitoring progress is important for measuring the effectiveness of programs, selecting new directions, and ensuring accountability to the public. If goals are not being met, current priorities will have to be adjusted. Benchmarks set for reductions in the priority pollutants are measurable steps on the way to the goal of improving the quality of Bosomtwe Lake's water. Yearly reviews by the participating communities in the Bosomtwe Lake Watershed will be used in conjunction with reports from the monitoring program to ensure that public expenditures are having the proper effect. The Bosomtwe Lake Watershed Management Plan should be reviewed annually and amended as necessary.

**Annexes**

**SELECTION REPORT**

*Abrodwum Dedicated Forest*
The area was inspected on June 29, 2002; the chief sent a native to facilitate the objective of the operation.

*Stocking:-* The forest recorded a very good stock of timber and non-timber species. Dominant species was found to be *Pterygota macrocarpa* (*Kyere)*

*Topography:* - The area is very hilly with a deep gully created by erosion which served as a path to the forest.

*Vegetation:* - The forest is semi deciduous with a closed upper canopy and partly open lower canopy. The under storey trees were densely populated and lot of shed leaves on the forest floor.

*Ownership:* - Aboaso Stool Land.

*History:* - There were farms on the outskirt of the forest. It served as a source of tree for constructing canoes for fishing.

*Recommendation*: - The area is suitable for the intended purpose since it is in tact and not prone to serious human activities due to the hilly nature.

*Details of Species Enumerated,*

| SPECIES | **D I A M E T R E R A N G E (cm)** | | | | | |
|---|---|---|---|---|---|---|
| | Below 10 | 10 – 20 | 20 –30 | 30 - 40 | 40 – 50+ | ***TOTAL*** |
| Akye | 4 | 2 | - | - | - | 6 |
| Danta | - | - | 2 | 1 | - | 3 |
| Sinuro | - | 2 | 3 | 3 | - | 8 |
| Kyere | 2 | 1 | 5 | 6 | 4 | 18 |
| Watapuo | 2 | 2 | 1 | 1 | - | 6 |
| Wawa | - | - | - | 2 | 3 | 5 |
| Onyina | 2 | 3 | - | - | - | 5 |
| Okure | 1 | 1 | - | - | - | 2 |
| Efobrodedwo | - | - | - | 1 | - | 1 |
| Papie | - | 3 | 2 | 1 | - | 6 |
| Okure | 2 | 1 | - | - | - | 3 |
| Tanuro | 2 | 2 | 1 | - | - | 5 |
| **GRAND TOTAL** | 15 | 17 | 14 | 15 | 7 | **78** |

**Abono Dedicated Forest**

A one day field inspection was carried out on the 11th June 2002 aimed at knowing the boundaries and the state of the forest to facilitate the objectives of management. The operation accompanied by five (5) natives delegated by the chief, took us to about 1/3 of the total area of the forest. Below are the details of the inspection.

*Stocking:-* The area had a good record of young timber and non-timber species with Kyere (P*terygota macrocarpa*) being predominant.

*Topography*: The parcel of forest was situated on a hilly terrain with a very deep and long gully, created by erosion from upstairs down the valley.

*Vegetation*: Semi deciduous with open lower canopy and closed upper canopy.

*Ownership:* Abono Stool Land.

*History*: - The area shares boundary with Adwafo Community and was alleged to be in dispute.

*Recommendation:* The area is generally suitable for conservation since no farming or illegal chain saw activities could be carried out due to the nature of topography.

*Details of Species Enumerated*

| ***SPECIES*** | **D I A M E T R E R A N G E (cm)** | | | | | |
|---|---|---|---|---|---|---|
| | | Below 10 | 10 –20 | 20 - 30 | 30 – 40 | ***Total*** |
| Sinuro | | - | 2 | 8 | 3 | 13 |
| Onyina | | - | 3 | 2 | 3 | 8 |
| Watapuo | | - | 2 | - | - | 2 |
| Tanuro | | 3 | - | - | - | 3 |
| Kyere | | 2 | 2 | 4 | 4 | 12 |
| Tie-Tie | | 6 | - | - | - | 6 |
| Okure | | 3 | 1 | - | - | 4 |
| Wawa | | - | - | - | 2 | 2 |
| **GRAND TOTAL** | | 14 | 10 | 14 | 12 | 50 |