CITY OF LAKE VIEW URBAN ISSUES PLAN

Black Hawk Lake: Urban Issues

The City of Lake View went through an extensive process to update the City's Comprehensive Plan in 2009 – 10. This plan identified priority issues to drive the development of Lake View into the future. The top priority identified in the Comp Plan is the protection of Black Hawk Lake. Specifically, the Number One priority to be implemented was to "Promote the use of "green solutions" to protect water quality of Black Hawk Lake."

The City of Lake View proposes several projects to protect Black Hawk Lake that fall under the classification of public education or construction projects.

Years 1 through 5

In the Years One through Five, the City proposes to:

- Develop our Lake Protection Association.
- Obtain 100% utilization of phosphorous-free fertilizers on yards.
- Undertake a process to provide detailed maps of storm sewers and drainage tiles flowing into Black Hawk Lake.
- Install a rain garden on the City Hall property.
- Place markers on intakes reminding folks not to dump into the intake as the water runs to the lake.
- Undertake an awareness campaign encouraging residents to keep their gutters clean so that no debris & leaves flow to lake.
- Install shoreline armoring on areas adjacent to Crescent Beach.
- Install engineering solutions for storm sewers outletting into the lake.
- Promote the installation of residential rain gardens.
- Promote the use of rain barrels and provide rain barrels for volunteer participants.
- Implement an "Environmental Protection Zone" covering areas near water bodies.

<u>Lake Protection Association:</u> Within the past few months, Black Hawk Lake has been developing a fledgling Lake Protection Association (LPA). This group will be the "voice of Black Hawk Lake," advocating on behalf of the lake, educating the public about the lake project, and encouraging environmentally-friendly activities around the lake. The LPA was loosely organized under the direction of Emily Busch, Lake View's marketing consultant. The LPA seeks funding to keep Emily on board as a contracted part-time staff to work with the LPA, government agencies, and our watershed coordinator to further the lake restoration project and keep the public well informed of the project.

Requested funds: Contract position at $1,000 per month for two years = $24,000.
Local Match: $12,000 paid to marketing consultant for 2011.

"100% Phosphorous-Free:" The City of Lake View proposes to partner with the Black Hawk Lake Protection Association to encourage the voluntary use of phosphorous-free fertilizers. This public education will be done through the press and through mailings. Also, a $5.00 voucher will be provided to each residence to be used toward the purchase of phosphorous-free fertilizer at local retailers.

Requested funds: Semi-annual print ads in the Lake View Resort for five years: $2,000.
Annual brochure mailing to all Lake View residences for five years: $2,000.
$5.00 voucher for the purchase of phosphorous-free fertilizer. Two vouchers per residence for one year. It is estimated that 500 residences will participate = $5,000.

Private match: Remainder of the cost of the fertilizer is $30.00 per residence. Total private match = $15,000

Storm Sewer & Drain Tile Mapping: The City of Lake View does not have adequate maps of the public storm sewer system or the public or private drain tiles in the area. The City proposes to use the services of a consultant to assist City staff in researching records to determine sewer and tile locations and to conduct field work to map the storm sewer and drainage tile system. This field work includes running cameras through the tiles to determine tile location and condition.

Requested funds: Consulting firm: $10,000.
Local match: 25% soft match for staff time.

City Hall Rain Garden: The City proposed to install a Rain Garden on the City Hall property. This would be a pilot project to explain how a rain garden works and to show construction techniques. The City had planned to install the Rain Garden as part of their 2009 Streetscape Project, but this project was not completed due to funding constraints.

Requested funds: Construct Rain Garden: $5,000 (Engineers estimate from Snyder & Assoc.)
Local match: 20% soft match for staff time & equipment usage.

Intake Marking: The City proposes to educate the public about the hazardous situations that can arise when materials are dumped down storm sewer intakes. A permanent metal plaque will be attached to each intake which drains to Black Hawk Lake stating something like "No Dumping – Drains to Lake."

Requested funds: $ 1,000
Local match: 25% soft match for staff time.

Awareness to Keep the Gutters Clean: Using newspaper articles, pieces in the City newsletter, and through the City web site and the use of social media, homeowners will be reminded of the need to keep the street gutters clean so that no debris & leaves flow to lake.

Requested funds = 0; In-kind City staff labor.

Shoreline Armoring: The City owns and operates Crescent Beach, a public swimming beach in the Town Bay portion of Black Hawk Lake. Over the years, the sandy beach has eroded and the shoreline adjacent to the beach on both sides has also eroded. The erosion of the lands adjacent to the beach can be mitigated with the installation of more native stone shoreline armoring. The City proposes to add more armoring for 100' on the east side of the beach and 100' on the west side of the beach.

Requested funds: 200' of shoreline armoring @ $55 / ft. = $ 11,000

Storm Sewer Outlets: There are successful examples of engineering solutions to storm water problems. Upon examination of the known outlets of public storm sewers into the lake, there are at least two sites where it would be feasible to install an engineered solution, such as a bio-reactor, at the outlet of the storm sewer. This bio-reactor or other screening device catches many impurities before they arrive in the lake.

Much more research is needed on the various types of engineering solutions to storm water management problems.

Estimated Cost: Engineering solutions for two storm sewer outlets: $75,000 each = $150,000.

Requested funds: $ 120,000
Local match: $ 30,000

Residential rain gardens: The City will encourage the installation of small rain gardens on residential properties, particularly on lakeshore lots. The City seeks funding to provide a 50% cost share to install one residential rain garden per year. It is estimated that the 50% cost share will be $1,000 per project

Requested funds: 50% cost share: $1,000 X 5 projects = $5,000
Private match: 50%

Residential Rain Barrels: The City will encourage the use of residential rain barrels to collect and harvest rain water for use in their yards and gardens. Harvesting rain water not only reduces the amount of municipal water pumped from the ground, it also reduces the amount of run-off that will eventually end up in Black Hawk Lake. The cost of a rain barrel and stand is estimated at $75.00. The City proposes to provide a rebate of $50.00 for any residence installing a rain barrel.

Requested funds: Cost of $50.00 rebates for 100 rain barrels: $5,000
Private match: Remainder of the cost of the rain barrel & stand for 100 barrels: $2,500

"Environmental Protection Zone." The City's recently completed Comp Plan recommends the implementation of an Environmental Protection Zone for all areas within ¼ mile from a water body. Goals and regulations for this Zone have not yet been established, but the concept behind this Zone will be to encourage environmentally-friendly actions to benefit the lake, and also to institute regulations prohibiting certain actions which have negative environmental impacts. The City will need professional assistance from engineers or planners to formulate and implement regulations putting into place this proposed Environmental Protection Zone. The cost of the consultant firm is estimated to be $12,000.

Requested funds: $10,000.
Cash match from City: $2,000
Soft match: $3,000 for staff time.

New Developments

The Comp Plan also states that: Any urban development around the lake will require green solutions or low impact development (LID) methodologies. The green solutions or LID refer to urban development methodologies that will result in the least impact on the lake and the environment. Examples of these LID methodologies may include:

- Addressing drainage and water impoundment.
- Encouraging use of pervious pavement / pavers.

Drainage and Water Impoundment: The City will establish standards for the storm water management within the conservation zone around the lake for new site developments. Water will be detained on site with the goal of slowing flow to the lake, allowing detention time for the water, and time for sediment to settle out. We will utilize bioswales, or retention berms. An example currently under construction is a retention basis west of the Glacier Bay restaurant. A retention basin was required to slow the flow of water to the lake and provide for detention time prior to flowing into the storm sewer and thus into the lake.

Run-off from parking lots is of particular concern. During the Site Plan evaluation process, developers need to show that they are slowing run-off from the parking lot. This can be done by channeling the drainage from the lot to a retention area.

It is anticipated that there will be at least three new commercial development projects within the next five years. The City seeks funding to assist the developers with storm water management / detention by participating in a cost-share for required stormwater detention facilities. The proposed cost share is 50% and the estimated cost of a retention structure is $4,000.

Requested funds: 50% cost share: $2,000 X 3 projects = $6,000
Private match: 50%

Pervious Pavement: Using pervious pavement or pavers has been proven effective in reducing the run-off from parking lots and other hard surfaces. The City will encourage the use of pervious pavement for new development. It is estimated that pervious pavement costs two to three times as much as conventional asphalt. The City seeks funding to provide a 50% cost share to install parking lots and sidewalks using pervious pavement.

Requested funds: $30,000 – Estimate.
Private match: 50%

Future - Years 6 through 10

The City will identify areas where BMP's can be implemented or structures could be built. The City proposes funding for the installation of:

Impoundment structures: There are many acres of tilled farmland within one-quarter mile of Black Hawk Lake. There are at least two sites within this farmland that may be suitable for the development of permanent ponds.

Also, within the City's General Land Use Plan there are at least three 10 to 20 acre sites which are identified for future residential development. These sites will be developed utilizing low impact development (LID) methodologies, including the installation of waterways and ponds.

The City seeks funding to assist with the installation of three ponds in the lands around Black Hawk Lake.

Requested funds: Three ponds @ $30,000 each = $90,000.

Residential rain gardens: The City will encourage the installation of small rain gardens on residential properties, particularly on lakeshore lots. The City seeks funding to provide a 50% cost share to install up to 25 more residential rain gardens. It is estimated that the 50% cost share will be $1,000 per project

Cost of 50% cost share: $1,000 X 25 projects = $25,000
Private match: 50%

TOTAL COST FOR THIS URBAN WATER QUALITY PLAN:

Years 1 - 5	Requested Grant Funds	Local Match
Lake Protection Association: Contract position for $1,000 per month for two years.	$24,000	$ 12,000
"100% Phosphorous-Free" Campaign	$9,000	$ 15,000
Storm Sewer & Drain Tile Mapping	$10,000	Soft - $ 2,500
City Hall Rain Garden	$5,000	Soft - $1,000
Intake Marking	$1,000	Soft - $ 250
Awareness to Keep the Gutters Clean.	$ 0	
Shoreline Armoring: 200' of shoreline armoring @ $55 / ft	$ 11,000	0
Storm Sewer Outlet – engineered solutions	$ 120,000	$30,000
Residential rain gardens	$ 5,000	$ 5,000
Residential Rain Barrels: 100 incentives at $50 each for rain barrels	$5,000	$ 2,500
"Environmental Protection Zone"	$10,000	$ 2,000 Soft - $3,000
New Developments: Drainage and Water Impoundment 50% cost share: $2,000 X 3 projects	$6,000	$ 6,000
New Developments: Pervious Pavement. 50% cost share	$30,000	$ 30,000
Total Cost of Years 1 – 5	$ 236,000	$ 109,250

Future Years 6 - 10		
Impoundment structures	$ 90,000	0
Residential rain gardens	$ 25,000	$ 25,000
Total Cost of Future Work: Years 5 – 10	$ 115,000	$ 25,000

TOTAL COSTS	$ 351,000	$ 134,250

*** Hard costs to the City are:

Marketing Contract	$ 8,000 to City and $4,000 to Community Club
Storm Sewer outlets	$ 30,000
"Environmental Protection Zone"	$ 2,000

APPENDIX B

IDNR Fisheries In-Lake Management and Restoration Plan

Introduction

Black Hawk Lake supports a long tradition of sport fishing, waterfowl hunting, swimming, and recreational boating. Marginal sport fishing still exists, waterfowl hunting can be good at times, and large numbers of recreational boaters still use the lake. However, the degrading water quality continues to impact these uses. Black Hawk Lake is the focal point of the city of Lake View, which is supported by tourism that is created by the lake. Strong local support for restoring the lake, coupled with a multi-agency task force, shows a promising future for Black Hawk Lake.

Black Hawk Lake is listed as an impaired waterbody due to algae, turbidity, and bacteria as required by section 303(d) of the Clean Water Act. After a statewide ranking of significant publicly owned lakes in need of restoration, Black Hawk Lake was ranked in the top 35. In order to improve water quality around the state, a recent push for lake restoration activities has included Black Hawk Lake. Two major studies that investigated the issues affecting Black Hawk Lake and possible solutions were completed within the last year. The information gathered in these studies provided working documents that can be used to identify key solutions for removing Black Hawk Lake from the impaired waters list.

The Diagnostic Feasibility (DF) study conducted by Iowa State University and the Total Maximum Daily Load (TMDL) study conducted by the Iowa DNR Watershed Improvement Section discussed a number of management alternatives for in-lake work to supplement and enhance the improvements to water quality achieved through work done in the watershed. The logical progression of improvements to the overall watershed and lake ecosystem would begin upstream in the watershed progressing downstream and ultimately to the lake. Therefore, it would be appropriate to discuss in-lake management alternatives in the same manner.

Black Hawk Lake can be broken into two components, the inlet (Figure 3) and the main basin (Figure 4). The inlet area receives water from Carnarvon Creek, which then flows into the main basin. Although both are considered to be part of Black Hawk Lake, and should be managed as such, the two basins are currently separated by a fish barrier located on South State Road near the entrance to the Ice House Point portion of Black Hawk State Park (Figure 5).

It should be noted that the various management alternatives presented are merely options for improving the lake. Many of the options discussed in this document require further investigation to assess the feasibility and costs associated with such practices. In some instances, a suite of scenarios are presented for certain management alternatives so that different levels of costs and benefits can be considered. Additionally, many of these practices should not be considered until notable improvements in the watershed have been made. For instance, it would be premature to conduct dredging before careful steps have been taken to reduce the input of sediment from the watershed. After a description of the management options and associated benefits are presented, a timeline for management activities is discussed as a three phase approach.

Narrative of Management Strategies

Inlet Area

The inlet portion of the lake is the first part of Black Hawk Lake to receive the main flow of water from the watershed. As a result, it degrades at a faster rate than the main lake basin as it is the first to intercept the bulk of the nutrients and sediments. Before significant anthropogenic disturbances in the watershed severely reduced the functionality of the inlet area, it naturally served as a sediment detention basin for Black Hawk Lake. The DF study and the TMDL study have identified the inlet portion of the lake as a key component in restoring the entire lake ecosystem to its natural function.

Aquatic Vegetation Management

Emergent vegetation and other aquatic macrophytes are an essential part of a natural, healthy aquatic ecosystem. Aquatic plant life competes with algae by taking up nutrients, provides habitat for fish and wildlife, reduces wave energy from wind action, and helps keep bottom sediments in place through complex root systems. Many aquatic plants, such as cattail and bulrush, rely on periods of drought for seeds and turions to germinate. After drought periods, plants become inundated and eventually die off and another drought is required to carry on the cycle. Due to the improved drainage of Iowa's agriculture fields through tile systems and the sheer size of the watershed to Black Hawk Lake, the inlet area rarely dries up long enough to allow plants to reestablish. Pumping water out of the inlet and moving it to the main lake basin is a means to replicate drought conditions, even in years with average precipitation. The effects of pumping the inlet dry can be two-fold. Mud flat conditions will allow aquatic plants to reestablish and will also eliminate rough fish inhabiting the inlet area. The common carp are instinctively drawn to shallow water areas during the spring to spawn. The inlet area serves as prime spawning habitat for carp, and although there is currently a fish barrier in place, it is undersized and fish can move into the inlet during high flows. As carp take advantage of the prime spawning habitat provided by the inlet area, their offspring flourish in the absence of predator species. Young of the year carp spawned in the inlet can then migrate through the fish barrier (due to their small size) and enter the main lake basin. Periodically and temporarily draining the inlet will eliminate resident carp allowing reestablished vegetation to remain unperturbed by rough fish. The volume of the inlet is currently 257 acre feet, which equates to 83,743,707 gallons of water. With no influx of water to the inlet, a 5,000 gallon per minute pump would dewater the inlet in about 11.5 days (279 hours). Additionally, the elimination of carp from the inlet area will reduce the overall reproductive potential of the carp population in the entire lake system. The proposed location for a pump station is at the inlet bridge, which is easily accessible and electricity is readily available, next to the existing fish barrier (Figure 3). Stop log structures would need to be installed so that water from the main lake basin does not back flow into the inlet area during pumping. A platform on which to install the pump would need to be constructed on the inlet because there is no room on or next to the roadway (Figure 5).

Hydraulic Dredging

Dredging in targeted areas could create settling basins and intercept sediment before it reaches the main basin of the lake. In addition, vegetated shallow areas could slow down water forcing sediment to drop out while simultaneously taking up nutrients and competing with algae. For the purposes of discussing management in the inlet area, the water body can be divided into three zones (Figure 3). Dredging in zone one would deepen the area that intercepts water from Carnarvon Creek and would act as a primary settling basin. Dredging zone two would act as a secondary settling basin and provide a path for water to flow to the pump during draw down. Zone one and two would be connected via a narrow channel created by dredging. The purpose of the channel is to provide connectivity from the deep water area of zone one to zone two so that the inlet can effectively be dewatered. A byproduct of the deepening in these areas is better boat access and navigation for duck hunters from the boat ramp out to some of the most popular duck hunting locations (which would remain intact) in the inlet. The TMDL stated that longer residence time of water in the inlet would help to settle out sediments and improve water quality in the main lake basin.

Many alternatives to increase residence time were discussed, including the construction of underwater berms to direct flow between the island and Merehoff's point, out into the east portion (zone three), and back to the grade. While this would undoubtedly increase residence time of water, this would create underwater obstructions to boat traffic, albeit there is little boat traffic in the inlet. Moreover, it would make dewatering the inlet difficult by creating blockages of direct flow to the pump during draw downs. Rather than constructing underwater berms and other structures to alter flow patterns, the establishment of a diverse community of aquatic vegetation would slow down water and increase residence time. Additionally, increasing the volume of the inlet would increase the residence time. Because the majority of the flow moves through the grade at the inlet bridge, dredging zone three would do little to intercept sediment from Carnarvon Creek. Although improving water quality is the primary goal of this project, fish and wildlife habitat diversity are important factors to consider. The aforementioned management plan for the inlet area would provide such diversity. Zone one and zone two would provide deep water habitat, surrounded by emergent vegetation, with submergent vegetation for diving ducks. Zone three would be left as is providing shallow wetland habitat for puddle ducks, rails, muskrats, and other marshland animals. The primary recreational use of the inlet is duck hunting and the proposed management activities would work to enhance it. Duck hunters would benefit from the increased depth so that boats can easily access more of the inlet. The improved habitat and increased vegetation would attract more waterfowl.

The maximum depth of the inlet area is currently 3.7 feet, as calculated by the most recent bathymetric maps produced by the Iowa DNR. The inlet area has an average depth of 1.6 feet with an area of 162 acres resulting in a water volume of 257 acre feet. The DF study states that increasing the average depth of the inlet area to 3 feet could reduce phosphorus input to the lake by 65%. To increase the average depth to 3 ft from the current average depth, an estimated 381,958 yd^3 of sediment needs to be removed. The cost estimates for dredging operations range from $3.75-$4.25 per yd^3 (Iowa DNR 2008). To achieve the removal of 381,958 yd^3 of silt, zone one and zone two (27.7 acres total) would need to be deepened to an average depth of 11.1 feet (Figure 3). At an average of $4.00 per cubic yard of silt, it would cost $1,527,940. If cost prohibits such activities or parent soils are not deeper than 11.1 feet, dredging to a lesser degree could still provide benefits to water quality. Deepening zone one and zone two to an average depth of 8.0 feet would result in the removal of 241,273 yd^3 of sediment at a cost of $965,092. Deepening zone one and zone two to an average depth of 6.0 feet would result in the removal of 151,912 yd^3 of sediment at a cost of $607,608. Under any scenario, zone one should never be made deeper than zone two so that water can flow to the pump at the inlet bridge. Because a hydraulic dredge would be the most feasible method of dredging, a spoil site would be needed. Hydraulic dredges utilize a cutter head to break up sediment on the lake bottom and a pump to suck the sediment laden water and move it to a containment site. Therefore a containment site would need to be constructed to allow silt to settle out and return clean water to the lake. Based on the DF study, the cost of land acquisition would be approximately $452,000 (~84 acres) and the cost to construct the containment site would be approximately $500,000.

Rough Fish Exclusion

The DF and TMDL studies both indicated that rough fish are a contributor to the water quality problems in Black Hawk Lake. Furthermore, the TMDL study suggested that in years with little precipitation, common carp contribute greatly to phosphorus loading via internal resuspension of bottom substrates. Numerous studies have shown that carp in large natural lakes utilize connected shallow water habitat to spawn.

Fish Barrier Improvement

Carp in the main basin of Black Hawk Lake congregate near the grade in an attempt to access the inlet area to spawn during the spring (Figure 3). The existing grade structure separating the inlet area from the main basin currently excludes adult carp under normal flows. However, the fish barrier can be overtopped and water can flow around the ends of the barrier during high flows allowing fish passage. Consequently, the high flow events typically occur during spring when carp are attempting to move into the inlet area. The grade can become plugged with vegetation during high flows and cause water to back up on landowners up stream. Fisheries personnel must manually rotate the gates on the grade structure to clean them off. This poses a hazard to personnel as they must position themselves in between the structure, where there is a swift current, to turn the gates. Turning the gates also provides a window of opportunity for carp to pass from the main basin of the lake into the inlet area negating the purpose of the fish barrier. The water quality in the main basin, as well as the sport fishery, could be improved if a more effective fish barrier were in place. A larger fish barrier, one that is taller and wider, would help to block fish passage during high flow events, yet pass enough water to avoid inundating upstream landowners. Hydraulic gates, as opposed to manually operated gates, would allow for safe cleaning when vegetation accumulates. A larger barrier would most likely require a small dike to be built from the road so that the barrier can be built away from the bridge. The existing barrier was not allowed to be tied into the bridge; therefore, a dike system would move the new fish barrier slightly south of the bridge allowing a bigger barrier to be built (Figure 5). The construction of dikes and a new fish barrier would allow fishery managers to easily trap carp for removal and this topic is discussed later in the document. Electric barriers are commonly used in combination with other fish exclusion devices. Placed immediately downstream of a physical barrier, the electric barrier adds another line of defense. When the gates on the physical barrier need to be cleaned, the electric barrier keeps fish from passing through the openings. As fish enter the electric field trying to move into the inlet area, they become stunned and the flow pushes them back out into the main lake basin before they can reach the physical barrier.

East Culvert

There is a 24 inch steel culvert on the east end of the inlet area that allows flow to the main lake basin (Figure 3). Originally, there was a fish barrier over the end of the culvert, but ice heave destroyed it and there is no longer any structure blocking fish movement. The amount of water that the culvert passes pales in comparison to that of the grade area at the inlet bridge. Therefore, plugging the 24 inch culvert would block fish passage while having little to no effect on the passage of water from the inlet area to the main basin.

<u>Main Lake Basin</u>

Many water quality improvements can be accomplished by working within the lake itself. Winter aeration, shoreline armoring, rough fish management, and hydraulic dredging can work to improve the water quality of the lake, and in turn, the sport fishery. Shoreline armoring can be conducted at any time throughout the project, and the sooner it is done, the better. Rough fish management should not begin until a proper fish barrier is in place. Dredging should not take place until watershed improvements have been made. Upgrading the winter aeration system should not occur until dredging is completed unless another method of winter aeration, one that does not require extensive piping throughout the Town Bay, is developed.

Winter Aeration

Black Hawk Lake is a shallow lake (mean depth 5.97 feet), and as a result, is at risk of periodic winter fish kills. Winter fish kills rarely kill all of the fish in a lake. However, winter fish kills tend to kill more sport fish, which tend to be more intolerant of low dissolved oxygen, and the rough fish survive. The rough fish that survive flourish in the void left by the fish that died and water quality suffers. There have been many documented winter fish kills throughout the history of Black Hawk Lake, but since winter aeration was installed in the late 1970s there have been no significant winter fish kills. The current aeration system originally consisted of 16 helixors that diffused air into the water and is powered by two pumps (Figure 4). Due to constant maintenance and safety issues (helixors extended ~4 feet up from the bottom) the helixors were removed and holes were drilled into the pipes to allow large air bubbles to keep ice from forming at the surface. The lake now depends on winter aeration through the air water interface that is created from the turbulence and warmer hypolimnetic water brought to the surface. The aeration system continues to operate during the winter time, but repairs need to be made to some pipes and some pipes need to be reset. The aeration system is located in the Town Bay portion of the lake. The Town Bay area is a no-wake zone, and consequently, large numbers of recreational boats anchor there. Some of the pipes that are part of the aeration system have been overturned and resituated by boat anchors hooking onto them. At the very least, the pipes from the aeration system need to be pulled up, inspected, repaired, and properly reset. Another option that is being investigated is a method of aeration that does not require as extensive of a pipe system out in the lake. Aeration could be achieved through forcing ambient air or oxygen into solution and pumping the super-saturated water into the lake. A considerably shorter set of pipes could be used and kept closer to shore to avoid interference with boat anchors. This type of aeration would also eliminate the need to keep open water in the town bay. By letting the Town Bay freeze over during the winter time, the safety hazard of open water during ice-up conditions would be avoided and anglers could also utilize that area of the lake to ice fish. Furthermore, eliminating open water during the coldest months of year would cause waterfowl to migrate south, which could reduce the amount of fecal matter deposited directly into the lake. The town of Lake View would also benefit because they could hold community functions on the ice there, such as ice skating and the Arctic Open golf tournament, as they historically did. Furthermore, aeration through pumping in supersaturated water could help reduce potential summer fish kill situations. Black Hawk Lake has historically experienced summer fish kills and a significant one occurred in 1999. A severe algal bloom followed by a series of hot, calm days led to a mass algae die-off and a subsequent sag in dissolved oxygen levels. The aeration system in place could not be turned on as it would have upset the stratification in the Town Bay causing already hypoxic water from the hypolimnion to mix with the epilimnion. The proposed aeration system would oxygenate the water near the bottom first and then spread throughout. To effectively prevent a summer kill situation, one would have to recognize the signs that lead to summer kill situations and be proactive and turn on aeration before it is actually needed. Additionally, running an oxygen infusion type aeration system during the summer would not interfere with boat traffic because everything would occur below the surface of the water. More research needs to be done to look into the feasibility of such an operation. If this type of aeration proves to be a cost effective, reliable method of aeration then this system should be installed.

Shoreline Armoring

Siltation is one of the major factors causing Iowa's natural lakes to degrade. Although much of the sediment that enters the lake comes from the watershed, significant amounts of silt can be deposited into the lake from eroding shorelines. Trees and other rooted terrestrial vegetation can help hold shoreline soils in place, but hard armoring, usually in the form of native field stone, can provide lasting protection. Over the years the majority of Black Hawk Lake's shoreline has been armored using native field stone to line the banks. The burden of armoring the shoreline usually lies upon the property owner as it is in their best interest to protect their lakefront property. There are some areas of the shoreline on Black Hawk Lake that are not protected by hard armoring and they are located on sovereign land. One area that has been identified in need of hard armoring is Denison Beach, located on the north shore of Black Hawk Lake. Denison Beach is a high use public area that is part of Black Hawk State Park. It is located on a point that extends into the lake making it more susceptible to erosion from wind and wave action. The shoreline at Denison Beach has receded and trees have been lost due to erosion. Approximately 400 feet of shoreline would need to be armored to protect this area from degrading any further. Rock armoring can easily be placed from shore in the Denison Beach area. Cottonwood Point is a unique feature in Black Hawk Lake that remains undeveloped and is sovereign land (Figure 4). It is a narrow land mass located on the south shore and extends into the lake to the northeast. Wind and wave action has broken through one small portion of Cottonwood Point and steps should be taken to prevent further degradation. Approximately 920 feet of shoreline on the lower portion of Cottonwood Point and approximately 1,400 feet along the main point have been identified as areas in need of hard armoring. Preserving this feature will reduce the amount of sediment deposited from the eroding shoreline, provide fish and wildlife habitat diversity, and help protect surrounding shoreline areas by providing a windbreak and reducing wave action. In addition, Cottonwood Point serves as one of the primary duck hunting locations on Black Hawk Lake. Hard armoring would most likely need to be placed with equipment operating on the ice or by barge. Ice House Point is another high use area that is part of Black Hawk State Park and is located in the town bay area of Black Hawk Lake. Most of the shoreline around this point has some level of hard armoring, but there are some areas in need of repair. Additional stone needs to be placed in certain locations to bolster protection. Stone on Ice House Point could be placed from shore.

Hydraulic Dredging

Hydraulic dredging is commonly used to reverse the effects of years of sediment deposition in Iowa's natural lakes and slow down succession. While the maximum depth of the lake is currently around 15 feet, it is estimated that Black Hawk Lake historically had areas over 30 feet deep. Agricultural practices have caused much sediment to deposit in the lake over the last 150 years. Hydraulic dredging is the only feasible method for removing the nutrient laden silt that has filled in Black Hawk Lake. Done properly and in the right locations, dredging can help to improve water quality as well. Limnologists at Iowa State University suggest that dredging a lake to an average depth that reaches or exceeds 10 feet can reduce sediment and nutrient resuspension from wind action and have positive effects on water quality. Dredging Black Hawk Lake to a mean depth of 10 feet would require the removal of approximately 5 million yd^3 of sediment and a containment site of around 320 acres. If a land acquisition associated with a containment site were to occur within the watershed, runoff and sediment loss on that parcel of land could be controlled; thus, reducing phosphorus and sediment inputs into the lake. Obviously the costs associated with the removal of this much sediment are quite high, but a worthy goal none the less. Although it may not be feasible to dredge the lake to an average depth of 10 feet, any increase in average depth would help to reduce sediment resuspension from wind and boat traffic to some degree. Deepening the lake and working towards a bathymetry similar to historical conditions would also improve the sport fishery in the lake. Deepening the lake would increase the water volume, which in turn would help to reduce oxygen sags and fish kill situations during the winter time, especially in the east portion of the main basin. Increasing the water volume of the lake would also help to dilute the nutrients that are brought into the lake. Hydraulic dredging inherently leaves behind deep cuts, mounds, and other features on the lake bottom. These features provide more habitat diversity for sport fish populations, as well as locations for anglers to target fish. Dredging Black Hawk Lake's main basin to mean depth of 10 feet should be pursued if presented with the opportunity. If money or resources are not available to dredge to that extent, improvements from dredging can still be made by targeting certain areas (Figure 4). The Town Bay area of Black Hawk Lake serves as a winter refuge for fish. Deepening the Town Bay area would increase the carrying capacity by increasing the water volume providing a more effective winter refuge. Depths currently range from 6 to 9 feet throughout most of the Town Bay. Deepening the Town Bay area to a depth of 15 feet would almost double the water volume and allow more fish to take advantage of the aeration system. The majority of the east end of the lake, which is the largest portion of Black Hawk Lake, is 6 feet deep. As a result, the east end portion of the lake frequently experiences oxygen sags during the winter time. There is a 7 foot trench running southwest to northeast, which then doglegs straight west. This trench was created by a dredge in the mid 1990s to provide fish with a path to the Town Bay area during winter. Removing four feet of sediment from the 6 foot contour and three feet of sediment from the 7 foot contour would provide a depth of 10 feet throughout the majority of the east end of the lake. The majority of the middle segment of Black Hawk Lake is 8 feet deep. These depths were created by hydraulic dredging in the mid 1990s. Deeping this area to 10 feet by removing two feet of silt would allow for a 10 foot deep passage for fish migrating from the east end to the town bay during the winter. The middle segment and the east end of Black Hawk Lake receive almost all of the wake-speed boat traffic and wind action. Thus, deepening these areas could reduce sediment and nutrient resuspension.

Rough Fish Management

Black Hawk Lake contains a diverse warmwater fish community, including a number of rough fish species. Bigmouth buffalo and common carp are among the most abundant species in the lake. Bigmouth buffalo filter feed and compete with young of the year desirable sport fish for zooplankton as a food source. Zooplankton feeds on phytoplankton (algae) and can help to control algae. Excessive phytoplankton increases water turbidity, which blocks sunlight that aquatic macrophytes need to grow. The effect of filter feeding on zooplankton is augmented by the sheer number and size of the bigmouth buffalo in the lake. Common carp feed along the bottom of the lake and stir up sediments as they feed and move around. Their feeding action uproots aquatic vegetation and the silt they stir up blocks light penetration making it difficult for aquatic macrophytes to grow. Additionally, the nutrient laden sediment that is resuspended promotes algae growth. As with bigmouth buffalo, the effects of common carp are augmented by their high abundance in the lake system. Both bigmouth buffalo and common carp can thrive in the poor water conditions they create, whereas desirable sport fish populations deteriorate. The majority of recreational anglers do not prefer to keep and consume bigmouth buffalo or common carp, and the resource goes underutilized. Steps must be taken to reduce or eliminate rough fish populations, namely common carp, so that water quality can improve.

In Black Hawk Lake we are faced with three methods, some which can be used in combination, for reducing common carp and other rough fish numbers. The first is the installation of a fish barrier to block off common carp spawning habitat as discussed earlier. The second is the mechanical removal of rough fish for which there are two options. Falt Fisheries currently has a contract for commercial harvest of rough fish from Black Hawk Lake. Although they do remove thousands of pounds of rough fish each year, it does little to impact the entire population. Lake restoration efforts at Lost Island Lake and Clear Lake have included an incentivized program that encourages commercial fishers to remove large quantities of rough fish from the lake. Under this program, commercial fishers receive bonuses as they remove target levels of rough fish. The goal of this program is not to eradicate rough fish completely, as that would be nearly impossible, but to reduce their population to a manageable size. Over the coming years this program will be evaluated and more knowledge will be gained as to its positive impacts. If this program were to be applied to Black Hawk Lake a study would need to be done to estimate the abundance and biomass of rough fish in the lake. After a population and biomass estimate is obtained, target levels of fish removed would be set. The installation of an effective fish barrier to the inlet area is a necessity prior to a fish removal program. Another method of mechanical fish removal is through a fish trap. We are presented with an opportunity to remove carp when they congregate at the inlet grade during the spring. Constructing a dike on the inlet side of the grade would allow for an area where the carp can be trapped (Figure 5). Gates on the dike would allow flow into the lake attracting fish into a small portion of the inlet. Once carp have accumulated in the area, stop logs can be placed in front of the gates on the dike and underneath the bridge. Water can then be pumped out of the small basin in which the carp are trapped and the fish can be removed. Depending on the size of the basin, it could possibly be pumped down in a matter of hours. This could be done for numerous consecutive days each spring to continually reduce the carp population. Constructing a dike would also provide a location to install the pump that is needed to draw down the inlet for vegetation management, a location to build a larger fish barrier, and a location for an electrical barrier housing.

The other option for reducing carp numbers is chemical renovation. The chemical rotenone is an effective tool for eliminating fish, but it is not selective towards specific species. Therefore, a chemical renovation would kill all fish in the lake and anglers would experience an absence of recreational fishing for two to three years after restocking of sport fish. Black Hawk Lake was chemically renovated in 1979, but common carp were able to seek refuge in upstream wetland areas where chemical could not be applied. Rotenone is spread by boat through the propwash and chemical cannot effectively be spread in areas that are shallow and highly vegetated because boats cannot operate in those areas. A chemical renovation of Black Hawk Lake would only be effective under two scenarios. The first, and most ideal, is a chemical renovation under drought conditions. With extremely low water levels common carp would not be able to seek refuge in shallow vegetated areas because they would be high and dry. Low water levels would also allow fishery managers to take advantage of the decreased water volume through significant cost savings in the amount of chemical needed to carry out the renovation. One cannot predict a drought, but having plans in place for a chemical renovation would allow fishery managers to respond quickly if presented with such an opportunity. The other scenario for a chemical renovation, albeit a difficult one to achieve, is a phased approach starting from upstream to downstream. Planned draw downs in the state marsh complex have the potential to eliminate carp from those areas. Fish barriers installed on the outlet structures of those marshes could then keep the carp from re-entering the system. Dewatering the inlet area would follow to eliminate carp in this portion of the lake. A fish barrier located at the inlet bridge would keep carp from re-entering the inlet area. A chemical renovation could then be carried out in the main lake basin where rotenone could be effectively applied throughout the entire system. It is important to note that under either scenario, all water bodies within the watershed would need to receive chemical treatments, including Carnarvon Creek. Additionally, any chemical renovation should occur prior to dredging to take advantage of the reduced water volume to lower chemical costs and provide for a more thorough application. Before any type of rough fish management is initiated, whether it be commercial harvest or chemical renovation, it is imperative that an effective fish barrier be put in place to keep fish from entering the inlet area from the main lake basin. Following a chemical renovation, a diverse sport fishery would be established through stocking. A healthy, balanced sport fishery would provide for recreational angling and increased tourism to the local community. Predator fish, such as walleye and northern pike, would help to control rough fish in the case of a reintroduction of carp or buffalo.

Black Hawk Lake Restoration Phased Approach

The timeline associated with potential management alternatives for in-lake restoration activities can be broken into a three phase approach. Many of these management activities may occur in concert with watershed improvement activities and others must be appropriately timed to ensure maximum effectiveness. Rough cost estimates for different management scenarios are provided in table form in attached appendices.

Phase I

Many of the in-lake restoration activities can be effective in improving water quality before watershed improvement is complete. In other words, these in-lake improvements would not suffer from sediment and nutrient inputs from the watershed before those inputs are controlled. Phase I activities should take place within the next one to five years.

Shoreline armoring can stabilize banks and reduce sediment input from shoreline erosion. The key areas identified on Denison Beach, Cottonwood Point, and Ice House Point should be armored with native field stone as soon as funding, engineering, and construction would allow. Denison Beach has a shoreline length of approximately 400 feet, which would cost $22,000 ($55 per foot of shoreline) to armor. The total length of shoreline in need of armoring on Cottonwood Point is 2,320 feet and would cost $127,600 to armor. Ice House Point has existing shoreline armoring, but much (~50%) of it is in need of repair or needs to be bolstered. Ice House Point has a shoreline of 2,752 feet. To armor half of this shoreline it would cost $75,680.

Inlet dredging should occur after progress in the watershed has been made and before any dredging in the main lake basin occurs (Figure 3). Dredging zone one and zone two in the inlet to an average depth of 11.1 feet will help to reduce phosphorus input to the main lake basin by 65%, according to the DF Study conducted by ISU. The required funds for this project would be approximately $1,527,832 for hydraulic dredging. An additional $952,000 would be needed for land acquisition ($452,000) and construction ($500,000) for a containment site for the spoil.

Dewatering the inlet should occur as soon as possible, but would be better served after targeted dredging occurs in the inlet. Dewatering the inlet would help to reestablish aquatic vegetation and begin acting as a filter. A pump (5,000 gpm) would be needed to accomplish a draw down of the inlet. A base on which to install the pump would also need to be constructed on the inlet side of the grade (Figure 5). The cost of a 5,000 gpm electrical pump is approximately $137,000.

The fish barrier should be improved during the first phase of the restoration project. Because the existing fish barrier is no longer effective and nutrient and sediment inputs have no impact on the fish barrier, an improved physical fish barrier should be installed as soon as feasible (Figure 5). A larger fish barrier would need to be constructed away from the bridge so as not to interfere or compromise the integrity of the bridge structure. A dike on the inlet side of the existing fish barrier would provide a base for the pump station and a location for a larger fish barrier, which in turn would provide an area to trap carp during the spring. The gates from the existing fish barrier can be removed and the concrete base with stop log channels could be left in place. Therefore, the existing concrete structure of the fish barrier would not have to be removed and money would be saved. A dike built to encompass an area approximately 10,000 ft^2 would have a wider fish barrier incorporated into it. The dike would be built to the same elevation as the road (1226.0). The new fish barrier would allow more water to pass through than the existing one, even as vegetation accumulated on the barrier. Stop log bays would also be incorporated into the new fish barrier. As carp move into the area within the dike during the spring stop logs would be placed in the new fish barrier and the existing fish barrier and a pump would draw down the water in the small area trapping the rough fish. The cost of fill to construct a dike that is 20 feet wide on top (extending approximately 120 feet into the inlet) and encompassing an area of 10,000 ft^2 would cost approximately $5,096. Additional costs in the placement of fill would be associated with the construction of such a dike system. Approximately 300 feet of shoreline (outside of the dike) would need to be protected by hard armoring at a cost of $16,500.

Phase II

As watershed improvements are made over the initial 5 years, more work in the main lake basin should continue. The majority of the work that would occur during Phase II in the main lake basin would be sediment removal and the continuation of rough fish management. Phase II activities should take place 6 to 10 years after the entire restoration project is initiated.

Dredging in the main lake basin will remove nutrient rich sediment, provide more fish habitat, and increase water volume to decrease the chances of a winter fish kill. Three portions of the lake have been identified as areas that, if dredged, could improve the lake and the fishery (Figure 4). Although ISU limnologists suggest that dredging a lake to an average depth of 10 feet would help to avoid sediment resuspension from wind and wave action, funds to undertake such a project may not be available at this time. Dredging to an intermediate average depth could allow for water quality and fishery improvements at a lower cost. Dredging the west basin (Town Bay), in an area with a 200 foot buffer from the shoreline, to an average depth of 15 feet would increase the carrying capacity of the winter refuge that fish utilize. With a 200 foot buffer from shore in the west basin, there are 28 acres of water at an average depth of 8.73 feet. To reach an average depth of 15 feet in this area 283,178 yd^3 of sediment would need to be removed. This would cost $1,132,713 at an average cost of $4.00 per yd^3. The east basin of the lake is subject to wind action and receives the bulk of the boat traffic. The east basin of the lake is also the first place to go anoxic during the winter. Deepening the east basin of the lake, in an area within a 600 foot buffer from shore and excluding the Sac Beach portion, to an average depth of 10 feet would increase the water volume and its ability to hold oxygen. A 600 foot buffer is proposed to avoid dredging where rock piles are located. The Sac Beach area is littered with rock making dredging very difficult and should be avoided. With a 600 foot buffer from shore in the east basin and excluding the Sac Beach area, there are 216 acres at an average depth of 6.83 feet. To reach an average depth of 10 feet in this area 1,104,453 yd^3 of sediment would need to be removed. This would cost $4,417,813 at an average cost of $4.00 per yd^3. The middle basin of the lake serves as a pathway for fish to migrate to the winter refuge (west basin) from the largest portion of the lake (east basin). Dredging the east basin in an area within a 400 foot buffer from shore would provide connectivity from the east basin to the west basin. A 400 foot buffer was chosen because it closely follows the old dredge cuts from the mid 1990s. With a 400 foot buffer from shore in the middle basin, there are 105 acres at an average depth of 7.65 feet. To reach an average depth of 10 feet in this area 398,008 yd^3 of sediment would need to be removed. This would cost $1,592,031 at an average cost of $4.00 per yd^3. The total cost of dredging all of these areas to the proposed average depths is $7,142,557 and would result in the removal of 1,785,639 yd^3 of sediment. A spoil site would be needed to capture the sediment from the dredging and return water to the lake. An estimated 114 acres at 12 to 14 feet deep would be needed to contain the 1,785,639 yd^3. Acquisition of 114 acres would cost an estimated $613,428 based on an average land price of $5,380 (estimated current land value from DF Study). Cost of construction of the containment site would vary depending on land topography.

The pipes associated with the aeration system in the west basin must be removed before dredging begins in the west basin. Once dredging is completed in the west basin, the aeration system should be replaced. Dredging should occur first in the east basin and then in the middle basin before the dredging occurs in the west basin. This will provide the lake with more water volume and a decreased chance of a winter fish kill if, for any unforeseen reason, dredging of the west basin could not be completed within one open water season and the aeration system replaced.

Rough fish management would continue throughout Phase II of the project as needed. This would require personnel hours and pump operation. The cost of this would vary depending on the intensity of the rough fish management.

Periodic draw downs of the inlet would occur to manage aquatic vegetation as needed. The cost to run the pump would vary depending on the frequency of drawdowns, precipitation, and carp re-infestation.

Phase III

While improvements in the watershed persist, work in the main lake could continue. Ongoing dredging in the main lake would continue to increase the water volume, provide more fish habitat, prevent winter fish kills, prevent sediment resuspension, and help dilute nutrients. Maintaining a healthy and diverse aquatic vegetated community in the inlet area will require constant attention. Phase III activities should take place 11 to 30 years after the entire restoration project is initiated.

Removing more sediment from the main lake basin to reach an average depth of 10 feet would markedly reduce the amount of sediment resuspension from wind and wave action. A total of 3,112.3 acre feet (5,020,140 yd^3) of sediment would need to be removed to reach an average depth of 10 feet in Black Hawk Lake. If the removal of sediment proposed in Phase II (1,785,639 yd^3 or 1,107 acre feet) was accomplished, then an additional 2,005 acre feet (or 3,234,549 yd^3) of sediment would need to be removed to achieve an average depth of 10 feet throughout Black Hawk lake's main basin. This would require an additional $12,938,196 for dredging and an additional $1,108,280 for land acquisition for a spoil site (206 acres). Additional cost would be associated with the construction of the containment site and would vary depending on land topography.

Rough fish management would continue throughout Phase III of the project as needed. This would require man hours and pump operation. The cost of this would vary depending on the intensity of the rough fish management.

Periodic draw downs of the inlet would occur to manage aquatic vegetation as needed. The cost to run the pump would vary depending on the frequency of draw downs, precipitation, and carp re-infestation.

Considerations

The timeline of proposed management activities and the costs associated with them are estimates. The actual work that will be accomplished and the time in which it is accomplished will depend largely on available funds, interagency cooperation, local involvement, and the feasibility of certain management alternatives. Plans should be put in place to evaluate the effectiveness of certain management strategies, and those strategies can change based on those evaluations.

Appendix I.—Cost estimates associated with various in-lake management strategies for the Black Hawk Lake restoration project.

Item	Quantity	Unit	Unit Cost	Extension
Dredging:				
Inlet				
Option 1 (3 ft. av. depth)	381,958	Cubic yard	$4.00	$1,527,832.00
Option 2	241,273	Cubic yard	$4.00	$956,092.00
Option 3	151,912	Cubic yard	$4.00	$607,648.00
Containment site (~4 ft deep)	84	Acre	$5,405	$454,020.00
Containment site construction	—	—	—	$500,000.00
Main Lake				
Intermediate goal	1,785,639	Cubic yard	$4.00	$7,142,556.00
Containment site (12 ft deep)	112	Acre	$5,405.00	$605,360.00
Final goal	3,234,017	Cubic yard	$4.00	$12,936,068.00
Containment site (12 ft deep)	208	Acre	$5,405.00	$1,124,240.00
Total dredging (10 ft. av. depth)	5,019,656	Cubic yard	$4.00	$20,078,624.00
Total containment site	320	Acre	$5,405.00	$1,729,600.00
Containment site construction	—	—	—	$750,000.00
Aeration system	—	—	—	$300,000.00
Shoreline Armoring				
Cottonwood Point	2,320	Linear Feet	$55.00	$127,600.00
Denison Beach	400	Linear Feet	$55.00	$22,000.00
Ice House Point	1,376	Linear Feet	$55.00	$75,680.00
Dike Fill (for barrier & pump station)	1,699	Cubic Yard	$3.00	$5,097.00
Fish Barrier				
Physical	1	—	$150,000.00	$150,000.00
Electrical	1	—	$175,000.00	$173,000.00
Electrical Barrier Housing	1	—	$30,000.00	$30,000.00
Pump Station (5,000 GPM)	1	—	$137,000.00	$137,000.00

Appendix II.—Estimated costs associated with the option of a chemical renovation in the main lake basin and inlet under varying water levels.

Volume (acre-ft)	Gallons	Unit Cost	Total Cost
Main Lake Basin			
4487.5 (at crest)	7,314.95	$55	$402,322.25
3727.5 (1 ft low)	6,075.83	$55	$334,170.65
Inlet			
257 (at crest)	418.91	$55	$23,040.05

Appendix III.—Explanation of cost estimates associated with and justification for various management strategies.

Dredging: The cost of dredging is estimated to be between $3.75 and $4.25 per cubic yard of sediment as suggested in the ISU DF Study. This produces an average cost of $4.00 per cubic yard.

600 Foot Dredge Buffer in East Basin: This avoids the existing rock piles and other areas of with a hard bottom in this portion of the lake.

400 Foot Dredge Buffer in Middle Basin: This closely follows the old dredge cuts and also avoids existing rock piles off of Lake Wood Point and Shotgun Hill.

200 Foot Dredge Buffer in West Basin: This closely follows the 6 foot contour line, avoids the sand beach and handicapped accessible dock, and avoids the rock pile off of Crescent Park.

Containment Site: The cost of land acquisition is based on the current average price of land at $5,405 per acre as suggested in the ISU DF Study.

Containment Site Construction: Taken from ISU DF Study. However, it should be noted that containment site construction can vary widely depending on topography of containment site area.

Shoreline Armoring: The cost of material and placement is estimated to be $55 based on estimates from the NRCS.

Dike System for Fish Barrier: The size of the actual dike system would need to be investigated. An area of 10,000 ft^2 within the dike system was arbitrarily chosen, but thought to be of a size that would be conducive to fish removal.

Fill Material: The estimated $3 per cubic yard of fill is derived from cost estimates for the Little Storm Lake Restoration Project.

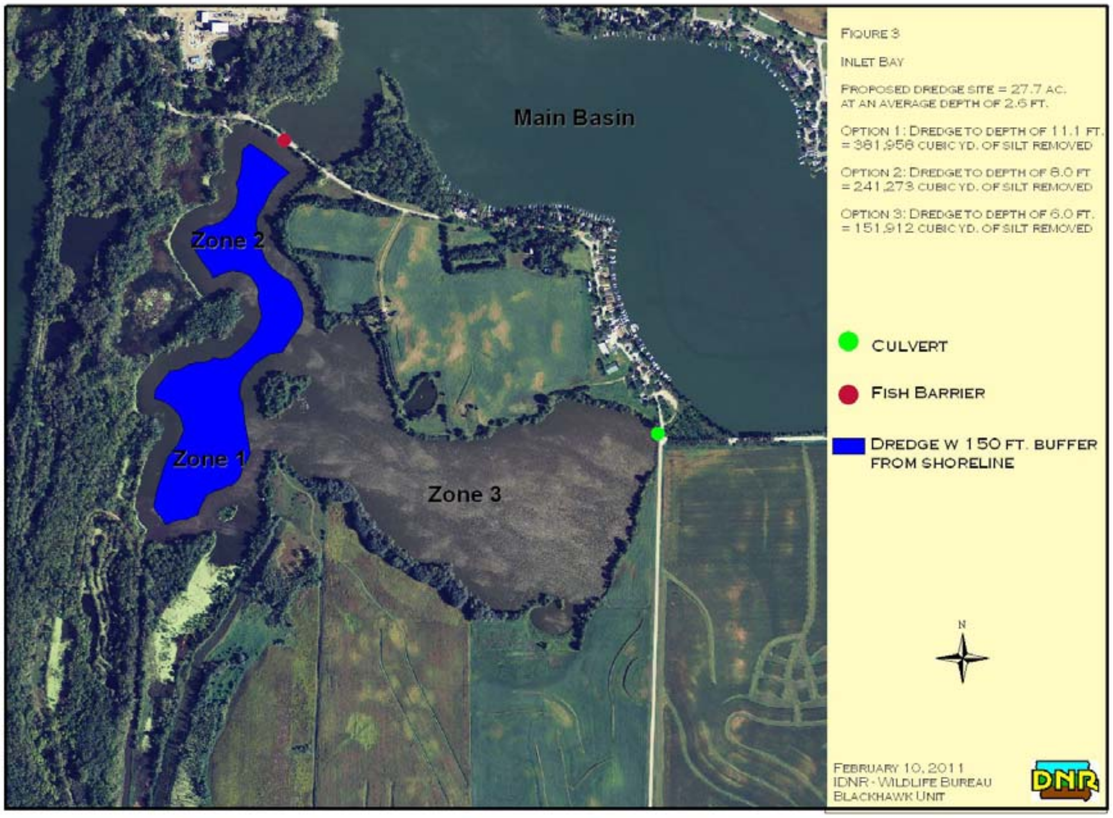
Physical Barrier: Estimated from previously constructed fish barriers and suggested by the ISU DF Study.

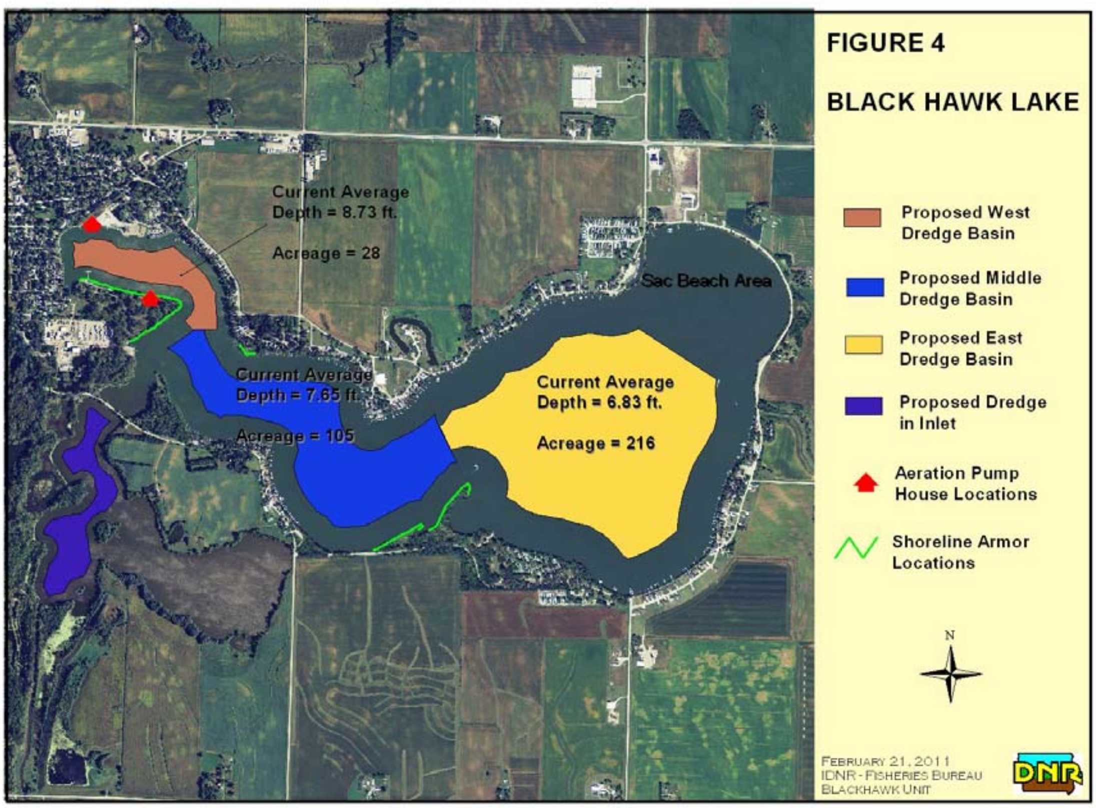
Electrical Barrier: Estimated from a quote provided by Smith-Root, Inc. for an electrical barrier to be installed at Lost Island at a cost of $148,000 (including two pulsators). An additional $25,000 was added to the estimate for the Black Hawk Lake project to account for an additional pulsator due to the wider opening at Black Hawk Lake's inlet.

Electrical Barrier Housing: Estimated from a quote provided by Smith-Root, Inc. for the Lost Island Lake project.

Pump Station: Derived from cost estimate of a 5,000 gpm pump to be installed at Little Storm Lake.

Aeration System: Estimated from other cost estimates on aeration systems at other natural lakes.


Main Basin
Zone 2
Zone 1
Zone 3
FIGURE 3
INLET BAY
PROPOSED DREDGE SITE = 27.7 AC.
AT AN AVERAGE DEPTH OF 2.6 FT.
OPTION 1: DREDGE TO DEPTH OF 11.1 FT.
= 381,958 CUBIC YD. OF SILT REMOVED
OPTION 2: DREDGE TO DEPTH OF 8.0 FT
= 241,273 CUBIC YD. OF SILT REMOVED
OPTION 3: DREDGE TO DEPTH OF 6.0 FT.
= 151,912 CUBIC YD. OF SILT REMOVED
CULVERT
FISH BARRIER
DREDGE W 150 FT. BUFFER FROM SHORELINE
N
FEBRUARY 10, 2011
IDNR - WILDLIFE BUREAU
BLACKHAWK UNIT
DNR


Current Average Depth = 8.73 ft.
Acreage = 28
Sac Beach Area
Current Average Depth = 7.65 ft.
Acreage = 105
Current Average Depth = 6.83 ft.
Acreage = 216
FIGURE 4
BLACK HAWK LAKE
Proposed West Dredge Basin
Proposed Middle Dredge Basin
Proposed East Dredge Basin
Proposed Dredge in Inlet
Aeration Pump House Locations
Shoreline Armor Locations
N
FEBRUARY 21, 2011
IDNR - FISHERIES BUREAU
BLACKHAWK UNIT
DNR

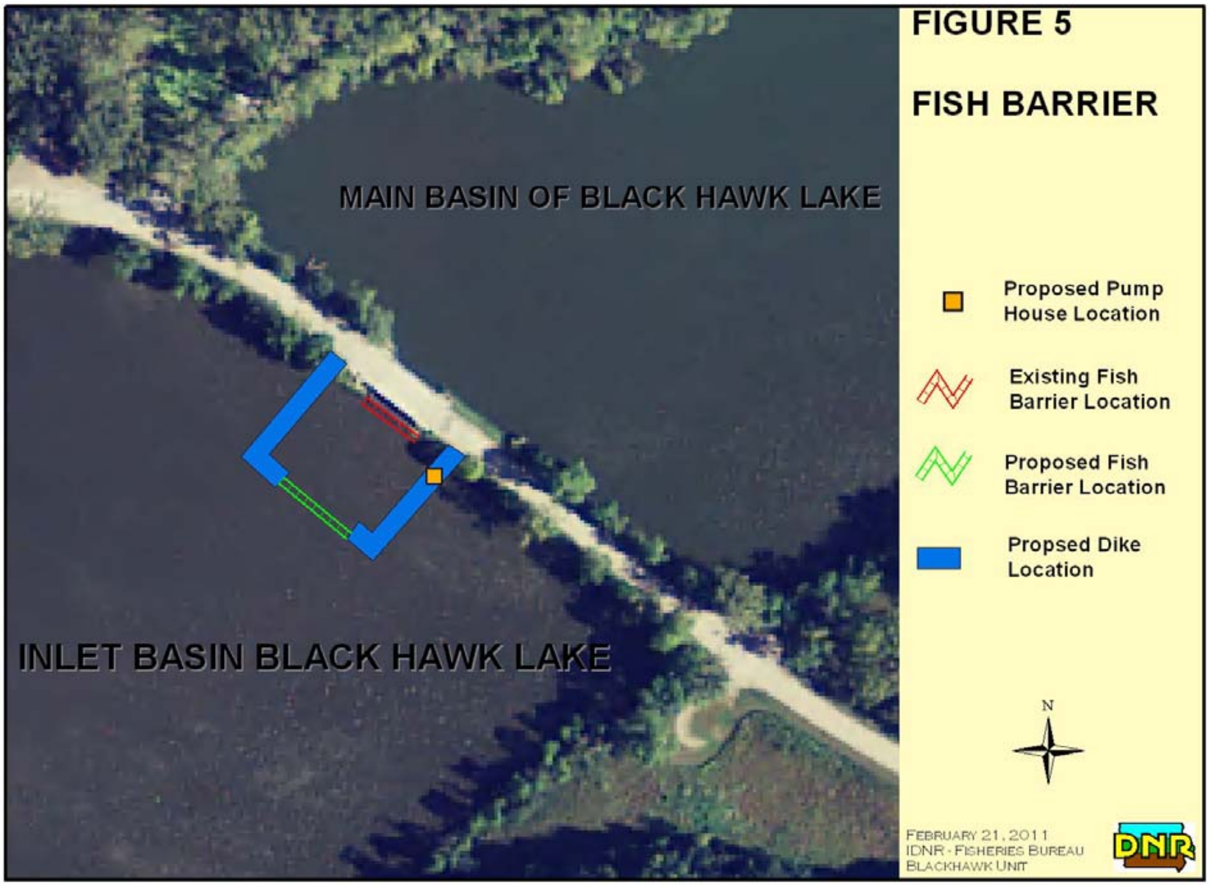


FIGURE 5
FISH BARRIER
MAIN BASIN OF BLACK HAWK LAKE
INLET BASIN BLACK HAWK LAKE
Proposed Pump House Location
Existing Fish Barrier Location
Proposed Fish Barrier Location
Propsed Dike Location
N
FEBRUARY 21, 2011
IDNR - FISHERIES BUREAU
BLACKHAWK UNIT
DNR

Water Quality Benefits Derived through Appropriate Management of the Black Hawk Marsh Wildlife Management Area, Sac County

I. Background

The Black Hawk Marsh Wildlife Management Area (Black Hawk Marsh WMA) is a publically owned 1,153-acre wetland/prairie complex located adjacent to the south shore of the 923-acre Black Hawk Lake in central Sac County, Iowa (figure 1). The Black Hawk Marsh WMA contains a variety of land forms, including upland prairie, wetland, timber, creek bottom, gravel pits, wildlife food plots, and hay fields. Two wetlands within the complex are of significance: the 173-acre State Marsh was constructed in 1994 using $193,400 in state Migratory Waterfowl Stamp dollars and the 45-acre DU Marsh was constructed in 1996 by Ducks Unlimited, Inc. (DU) using their program funds. Both basins have water control structures to allow for periodic water level manipulations and both are managed for wildlife habitat, public recreation, and water quality improvements. Another major hydrological feature of the landscape is Carnarvon Creek, which drains water from a large (13,155-acre) and intensively cultivated watershed southwest of Black Hawk Lake. Upon entering the Black Hawk Marsh WMA, Carnarvon Creek flows through DU Marsh and State Marsh before releasing water into Black Hawk Lake (figure 2).

Black Hawk Marsh consists of 12 state-owned Wildlife Management Areas (WMA) totaling 1,053 acres and one federally owned 100-acre Waterfowl Production Area (WPA). All tracts were purchased between 1928 and 1993. WMAs were purchased with state general fund and Fish and Wildlife Trust Fund dollars. Trust Fund dollars originate from the sale of hunting, fishing and trapping licenses and are used to leverage additional federal Sport Fish and Wildlife Restoration funds which originate from a federal excise tax placed on hunting and angling equipment. WPAs are acquired using dollars gained from the sale of federal Migratory Waterfowl Stamps. Federally owned WPAs are managed by the Iowa Department of Natural Resources (IDNR) through an agreement with the U.S. Fish and Wildlife Service (FWS).

Public land within the Black Hawk Marsh WMA is managed using the same funding sources that were used to purchase them as well as outside private funds from various conservation partners. The primary management goals of the Black Hawk Marsh WMA and most other WMAs and WPAs in Iowa are to provide the habitat needed for resident and migrant wildlife species to fulfill their life cycle and to provide appropriate wildlife-related recreation opportunities (hunting, fishing, trapping, bird-watching, etc.). As such, management objectives include developing and managing native wetland/prairie complexes, establishing food plots and woody cover plantings, and providing sufficient public access and opportunity.

II. Landscape Management and Water Quality

Another increasingly important function of proper habitat management on public and private is improved water quality. Native perennial vegetation established on upland areas enhances water quality by holding soil and chemicals on upland areas. Healthy wetlands, which include robust stands of emergent (cattails, bulrush, etc.) submergent (pondweeds, chara, etc.), and floating leaf (duck weeds, etc.), purify water in several ways: these plants use up nutrients that would otherwise be available to grow algae; their roots hold bottom sediments in place while other parts of the plant break wave energy and protect shorelines; and their structure provides escape cover for the minute invertebrates (fresh water shrimp, daphnia, etc.) that graze heavily on algae (a healthy population of daphnia will filter the entire volume of water in a lake 4 times a day). Proper wetland management involves using water control structures to try to replicate the natural wet/dry cycles (that seldom occurs due to an extremely altered hydrology) that are needed to keep wetlands healthy. It is through a natural drought or the man-induced drawdown that wetlands are rid of carp, black bullheads, fathead minnows, and other problem fish (which root up beneficial aquatic plants, resuspend bottom sediments, recycle nutrients, and overgraze beneficial invertebrates), are able to have bottom sediments compacted, and are able to have beneficial aquatic plants germinate. Upon return of the natural wet season or the management action to refill the wetland, these wetlands become extremely productive systems typified by clean water, diverse and abundant vegetation, heavy wildlife use, and increased recreational opportunity. IDNR wetland managers consider a number of ecological and socio-political factors to manipulate water levels within a basin, including: the existing ecological condition of the basin (water quality, plant communities, problem fish populations, wildlife and human use, etc.); probability of slowing the return of problem fish to the basin through the construction and maintenance of strategically placed fish barriers; watershed size and basin morphology; juxtaposition of other wetlands; upstream and downstream drainage issues and limitations; political concerns, human-use concerns, etc.).

III. Management of the Black Hawk Marsh WMA relative to wildlife use, public recreation, and water quality

With the renewed interest of improving the health of Black Hawk Lake and the potential commitment of local, state, and federal dollars to achieve this goal, the IDNR and others recognize that more intensive conservation work in Black Hawk Lake's watershed (including private and public lands) will result in improved water quality in Black Hawk Lake. The recently completed ISU Black Hawk Lake Diagnostic Feasibility Study (2010) identifies many of the watershed improvements needed to make and sustain water quality improvements in Black Hawk Lake and its watershed. The IDNR strongly supports this comprehensive watershed effort and the IDNR – Wildlife Bureau would like to partner in this clean-water initiative by increasing management efforts on land it manages in the watershed (Black Hawk Marsh WMA).

A. Wetland Management

In the past, IDNR staff has attempted to manage State and DU Marsh in as healthy of a condition as possible. However, excessive amounts of sediment and nutrient-laden water originating from the large and intensively cultivated watershed and chronic rough fish re-infestations have made this difficult. Successful draw downs were infrequent, and once obtained, short-lived.

As part of the immediate effort to improve water quality in the Black Hawk watershed (and to adhere to our primary goal of providing optimal wildlife habitat and public recreational opportunities) the IDNR –

Wildlife will increase management actions on State and DU Marshes by attempting to increase the frequency of draw downs and exploring opportunities to install effective fish barriers. IDNR and others are hopeful that on-going and future watershed treatments will result in more effective management of downstream basins.

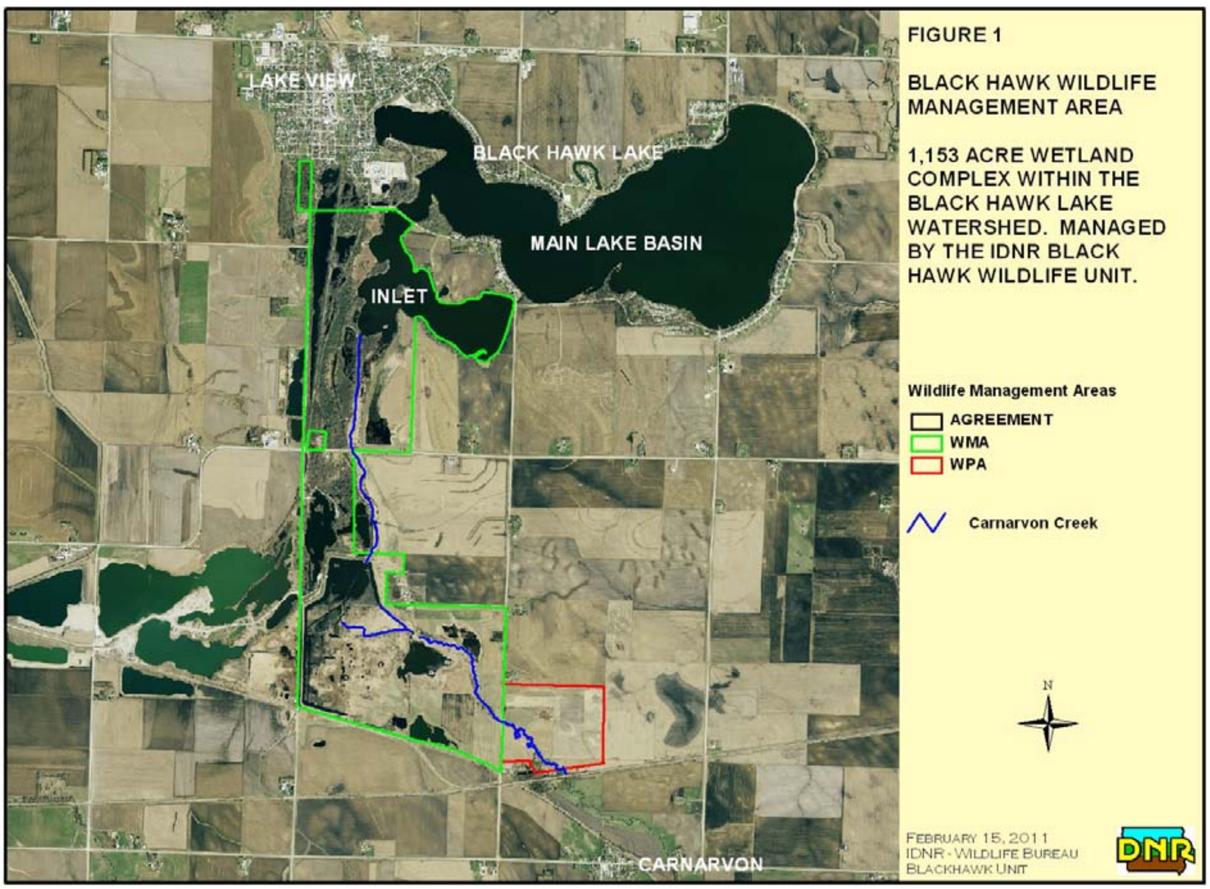
During fall 2010 staff initiated draw downs on State and DU Marsh by temporarily removing the stop logs from the respective water control structures. The hope is that the watershed will experience a relatively dry year thereby allowing the basins to dry so that rough fish will be eliminated, bottom sediments consolidated and beneficial aquatic plants re-established. The basins will be kept as dry as possible through spring 2012. During late spring 2012, water will be allowed to slowly rehydrate the basin. Throughout summer 2012, managers will attempt through intensive water level manipulations to keep about 2/3 of the new plant growth above water (i.e. allow only 1' of water on a 3' tall plant). During fall 2012, plants will senesce and water levels in both basins will be allowed to return to full pool. Again, success of all phases of the drawdown is dependent on the amount and timing of snowmelt and precipitation runoff released from a large and intensively cultivated watershed. Following a successful "2-year" drawdown (i.e. that described above), IDNR staff may use periodic winter draw downs (i.e. partially de-water the basin during the winter months to set back problem fish populations) thereby preserving the vegetation and invertebrate populations obtained during the 2-year draw down. Managers may also annually remove some yet-to-be-determined amount of water in late winter so as to provide spring runoff/snowmelt storage in the basins. During spring/summer 2011, IDNR staff will gather topographical survey and design information needed to investigate the feasibility of installing effective (or somewhat effective) fish barriers on marsh outlets. Excessive water levels downstream of basin outlet structures and potential for damage and/or blockage caused by floating large woody debris will cause fish barrier failure, so the probability of high water events must be weighed against the cost and maintenance requirements of the fish barrier.

In the long-term, the IDNR will consider more effective water control and fish barrier structures on a multitude of public basins in the Black Hawk Lake watershed, realizing that each basin in those watersheds contributes to water quality in Black Hawk Lake and has the potential to provide critical habitat for wildlife and recreation opportunities for the public.

B. Upland Management

IDNR-Wildlife will assess all upland management practices on the land it manages in the Black Hawk Lake Watershed so as to meet wildlife habitat goals, provide public recreation opportunities, and enhance water quality on those public lands and waters. At present, the state's entire management responsibility is the 1,153-acre Black Hawk Marsh WMA, which consists of 10% (119 acres) agriculture fields. Of these, 74% (88 acres) are in hay and 26% (31 acres) in row crop. These lands are cooperatively farmed with local producers with the producer keeping a share of the crop and the state's share being used to manage the WMA. Crop fields are strategically placed and rotated to provide optimum wildlife habitat, public recreation, as a means to convert former ag land to wetland/prairie complexes, and as a means to reduce depredation on neighboring private lands. Managers will re-assess all croplands, especially with regards to placement near aquatic systems, to ensure water quality is not being compromised. Those lands being identified as potentially harmful to water quality will be seeded to perpetual native vegetation. Other non-remnant prairie areas may need to be converted from grass to ag land to meet the wildlife and public use needs of the WMA.

The IDNR also offers to be involved in private land management within the watershed. IDNR has well qualified Private Lands Biologists and Technicians who are eager to work with other agency staff and private landowners to implement the Best Management Practices identified in the ISU Black Hawk Lake Diagnostic Feasibility Study (2010). IDNR is hopeful that though sustainable funding, the state will someday have the funds needed to implement voluntary perpetual conservation easements in the Black Hawk watershed and other targeted landscapes in Iowa. Finally, IDNR-Wildlife is interested in talking to those landowners who may be interested in voluntarily selling property to the state. For additional information on how the IDNR can partner to improve the ecological health of the Black Hawk Watershed, please contact The Black Hawk Wildlife biologist at 712-657-2639.



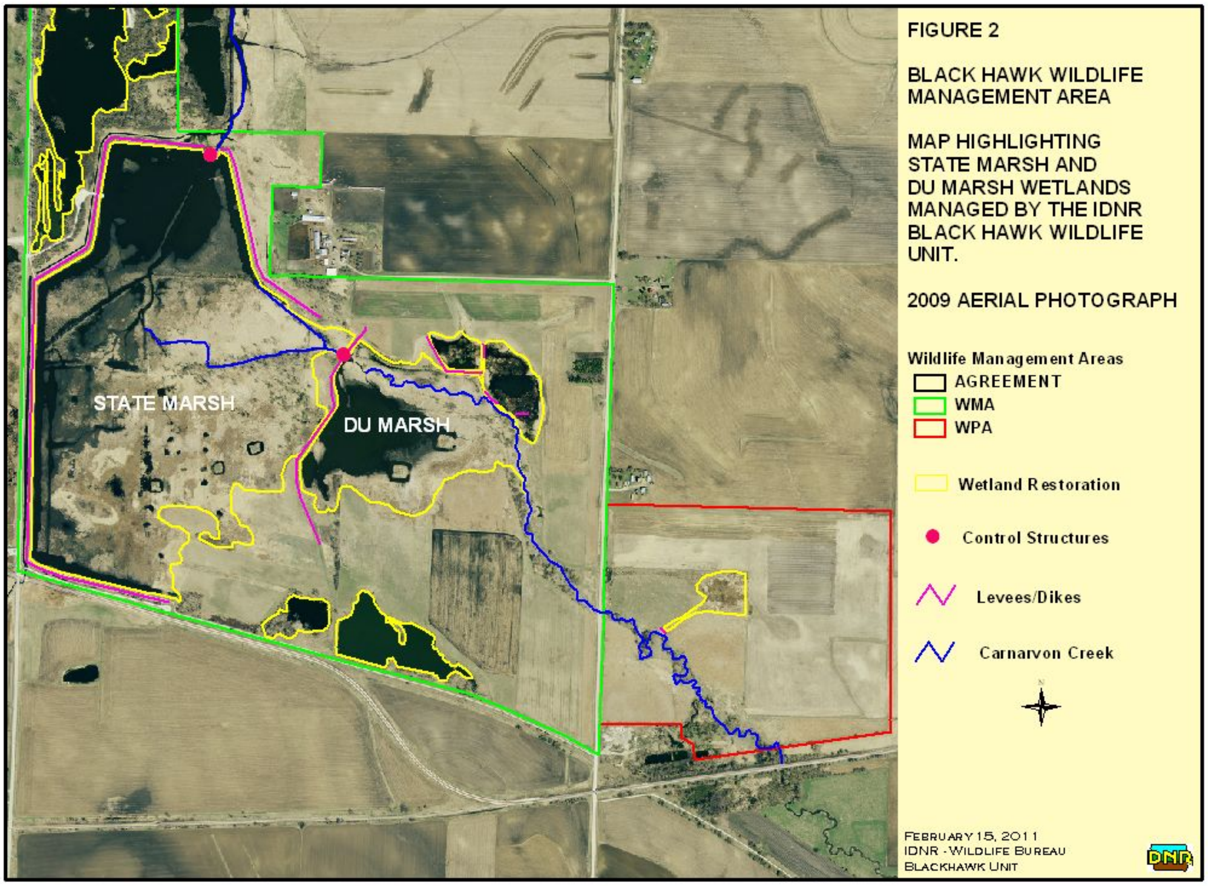


FIGURE 2
BLACK HAWK WILDLIFE MANAGEMENT AREA
MAP HIGHLIGHTING STATE MARSH AND DU MARSH WETLANDS MANAGED BY THE IDNR BLACK HAWK WILDLIFE UNIT.
2009 AERIAL PHOTOGRAPH
Wildlife Management Areas
AGREEMENT
WMA
WPA
Wetland Restoration
Control Structures
Levees/Dikes
Carnarvon Creek
STATE MARSH
DU MARSH
FEBRUARY 15, 2011
IDNR - WILDLIFE BUREAU
BLACKHAWK UNIT
DNR