City of Moberly's

Sugar Creek Lake

Source Water Protection Plan

April 2004

Introduction & Purpose

Sugar Creek Lake serves the City of Moberly as the source of its drinking water. Anticipated tightening of regulations governing finished water quality as well as projected population increases for the City make it prudent to plan for longevity of the lake's water quality and quantity.

The first attempt to address resource issues concerning the lake and its watershed was undertaken at a public meeting in May of 2000. (The watershed is defined as the area of land from which water flows to recharge the lake.) City and State officials, as well as private citizens attended this meeting that was endorsed by the City Council, and hosted by the local soil district and NRCS (Natural Resource Conservation Service). The purpose was not only to identify resource issues concerning Sugar Creek Lake and its watershed, but also to begin the process to develop a plan to address these issues. There were 30 problems and questions identified at this meeting (Appendix 1). Seven of these were published with the local media (Table 1). A steering committee was formed from meeting attendees that volunteered to gather information and address some of the concerns raised at this initial meeting (Table 2).

One purpose of this document will be to present a concise summary of the information that has been collected to date. Another will be to lay out a plan of action that will address the unanswered concerns raised at this meeting to insure the lake's longevity as the primary source of potable water for the citizens and industry in and around the City of Moberly.

Table 1: Top Seven Resource Issues
1. Lack of information and misconceptions of origins of problems.
2. Identify costs tied to the solutions and source of payment.
3. Properly inventory watershed.
4. Septic effluent
5. Quality of fishery/fish management.
6. Development of housing, industry, etc. in watershed and around watershed.
7. Water quality.

Table 2. Names of the original Steering Committee members	
Committee Member	*Affiliation*
Mary West	City of Moberly, Director of Utilities
Frank Fillo	Lake Property Resident

Watershed Background

General Information

Sugar Creek Lake and its watershed are located in north central Missouri in northeast Randolph County. The upper end of the watershed is along the eastern edge of the Grand Divide. Streams to the west of the divide flow to the Missouri River, those to the east flow to the Mississippi River.

The entire watershed area covers just over 7,000 acres beginning on the north edge of Moberly extending north nearly five miles to the south edge of Cairo. State Highways 63 and 24 are near the east and south boundaries, respectively. County highways DD and I, likewise, are near the west and north boundaries (Figure 1, *Expanded View of Watershed County within Missouri*).

Sugar Creek Lake itself covers 322 acres. The City of Moberly owns the lake and 269 surrounding acres.

Land Use

There are a wide variety of land-use types with the lake's watershed due to it being so near and including a small portion of land within the City limits (Table 3, Figure 2). The bulk of the land, however, is rural with just over 40% being used for agricultural production (e.g. crops, pasture, hay etc.).

In order of predominance, approximately 24 percent of watershed lands are cropland, 24 percent forested land, 22 percent grass and hay land, 10 percent pasture and 20 percent other land (water, homes, light industrial, roads, etc). The land under agricultural production is largely unterraced cropland. Though the specific amount of land planted to any given crop changes from year to year, approximately half will be in soybeans, 30% in corn and 20% in wheat (J. Kirchhoff U.S.D.A., pers. com.) A significant amount of land formerly under agricultural production, nearly 400 acres, is set aside in the Conservation Reserve Program (CRP).

Within the watershed of Sugar Creek Lake there is currently an Agricultural Nonpoint Source Special Area Land Treatment grant (AgNPS SALT) available for improving production and reducing erosion on agricultural lands. Over 480,000 dollars will be available through the year 2009 for cost-sharing practices.

Table 3. Inventory of land-use types within the watershed of Sugar Creek Lake.

General Category	Land Use	%	Acreage
Cropland (24%, 1713 A)	Cropland, unterraced	18.6	1313.0
	Cropland, terraced	5.66	399.6
Forest (24%, 1707 A)	Forest	24.16	1706.7
Grass (22%, 1588 A)	Grass	9.1	643.7
	Hay	7.3	513.8
	CRP	5.55	392.3
	Grass Waterway	0.54	38.1
Pasture (10%, 719 A)	Pasture	10.2	718.5
Water (7%, 518 A)	Sugar Creek Lake	4.57	322.9
	Clay Pits	1.74	122.6
	Lakes and Ponds	1.02	72.23
	Streams / Stream Beds	0.00	0.15
Other (13%, 771 A)	Low Density Residential	2.96	209.1
	Roads	1.4	97.41
	Brush	1.32	93.1
	Other Commercial	1.04	73.4
	Other Industrial	0.85	60.0
	Farm Machinery Lots / Outbuildings	0.83	58.3
	Airports	0.71	50.3
	Road / Railroad Right-of-Way	0.71	50.0
	Tree Line	0.44	31.1
	Parking	0.34	24.0
	Transmission Line Cut	0.15	10.4
	Railroad Beds	0.13	9.11
	Cemeteries	0.12	8.15
	Mobile Home Park	0.10	7.22
	Automotive Related	0.10	7.15
	Variable Shore Area	0.08	5.82
	Orchards, Groves, Vineyards	0.08	5.51
	Storage Lot	0.07	5.05
	Dumping/Burning Sites	0.06	4.52
	Parks	0.06	4.31
	Sewage Treatment Plants	0.03	1.78
	Barren/Rock Outcrop	0.02	1.50
	Commercial Storage	0.02	1.29
	Medium Density Residential	0.01	0.96
	Feedlots	0.01	0.95
	Equipment Lot	0.01	0.47
	Sawmill	0.01	0.47
	Office Buildings	0.00	0.28
	Storage and Treatment Lagoons	0.00	0.03
	TOTAL ACREAGE	**100%**	**7065.25**

Soils
Soil types range from the Gosport-Gorin association on moderate to steep slopes closer to the lake, to the nearly level to gently sloping Mexico-Leonard-Putnam association in the upper end of the watershed along highways 63 and 24. There is also a small area of generally steeply sloped Bethesda-Schuline association surrounding an old clay mining area just above the lake's eastern arm.

In general, the soils on steeper slopes are well drained whereas those on moderately sloped to level areas are poorly drained. Permeability of the soil (infiltration of water) is very slow on all the soil types. This makes the potential for soil erosion in steeper areas or seasonal wetness on more level areas very high.

Soils are classified as deep or moderately deep silt-loams with different slopes, productivity and clay content (Randolph Co. Soil Survey, 1989).

- *Calwoods Silt Loam*, 2 to 5 percent slopes, eroded. A somewhat poorly drained soil on the tops of low ridges in the uplands. Individual areas are long and narrow from 15 to 100 acres in size. Natural fertility is medium, and most areas are used for hay, pasture or for cultivated crops. Shrink-swell potential is high. A seasonal perched water table is common. Due to the wetness and very slow permeability this soil is generally unsuited to septic system absorption fields.
- *Gorin Silt Loam*, 5 to 9 percent slopes, eroded. A somewhat poorly drained sol is on convex ridgetops and foot slopes in the uplands. Individual areas are long and narrow and range from 15 to 65 acres in size. Natural fertility is low, and most areas are used for hay, pasture or timber. Shrink-swell potential is high. A seasonal perched water table is common. Due to the wetness and very slow permeability this soil is generally unsuited to septic system absorption fields.
- *Gosport Silt Loam*, 14 to 30 percent, eroded. Most common soil surrounding the lake itself. A moderately deep, well-drained soil on side slopes in the uplands. Individual areas are irregular in shape and range from 30 to several hundred acres in size. Natural fertility is low, and the weathered bedrock at a depth of 20 to 40 inches limits rooting. Most areas are used for woodland or pasture. Shrink-swell potential is high. Due to limitations of slope and depth to bedrock this soil is generally unsuited to septic system absorption fields.
- *Keswick Silt Loam*, 5 to 20 percent slopes, eroded. A moderately well drained soil on ridgetops, side slopes and convex side slopes in the uplands. Individual areas are irregular in shape and range from 25 to 300 acres in size. Natural fertility is medium, and most areas are used for hay, pasture, cultivated crops or timber. Shrink-swell potential is high. A seasonal perched water table is common. Due to the wetness and slope this soil is generally unsuited to septic system absorption fields.

Leonard Silt Loam, 2 to 6 percent slopes, eroded. A poorly drained soil is on concave side slopes and at the head of drainageways in the uplands. Individual areas are irregular in shape and range from 15 to 100 acres in size. A seasonal perched water table is common. Natural fertility is medium, and most areas are used for cultivated crops or hay and pasture. Shrink-swell potential is high. A seasonal perched water table is common. Due to the wetness and very slow permeability this soil is generally unsuited to septic system absorption fields.

- *Mexico Silt Loam*, 1 to 4 percent slopes. A somewhat poorly drained soil on broad ridgetops and side slopes in the uplands. Individual areas are irregular in shape and range from 75 to 1,000 acres in size. Natural fertility is medium, and most areas are used for cultivated crops or hay and pasture. Shrink-swell potential is high. A seasonal perched water table is common. And due to the wetness and very slow permeability this soil is generally unsuited to septic system absorption fields.
- *Putnam Silt Loam*. A nearly level, poorly drained soil is on broad upland divides. Individual areas are irregular in shape and range from 25 to about 400 acres in size. Natural fertility is medium, and most areas are used for cultivated crops or hay and pasture. Shrink-swell potential is high. A seasonal perched water table is common. Due to the wetness and very slow permeability this soil is generally unsuited to septic system absorption fields.
- *Bethesda Shaly Silt Loam*, 20 to 70 percent slopes. A well-drained soil occurring in areas of mine spoil at sites of past surface mines. Soil acidity can be high. This land generally supports poor-quality timber and shrubs.

Land Features

Streams

Streams within the watershed are small, and might be called ditches by those unfamiliar with their classification. All these streams are first and second order tributaries to Spring Creek. All are intermittent and cease to flow during dry weather. Spring Creek becomes a named stream below the lake.

Wells

There are no known active wells within the lake's watershed.

Ponds

There are approximately 50 ponds within the lake's watershed, most under one acre in size. These ponds are used for livestock watering as well as recreational uses like fishing and nature viewing.

Quarries

Just above the lake's eastern arm there is an area of past stone quarrying called Cooksies Quarry. Within this area are 7 to 8 ponds that are the result of the quarrying activities. The bulk of the property is City-owned. Soil erosion from this area into the lake, though unquantified, is not thought to be significant.

Water Quality

General

"Water quality" can imply everything from muddy water to toxins and bacterial pollutants to fishery- and recreation-related issues. Sugar Creek Lake was built in 1921 and has been the subject of both water quality and recreational use studies for some time. For the purpose of bringing to light recent water quality concerns, we will review only those studies done since the 80's, beginning with the most recent.

Sugar Creek Lake has been a part of the *Lakes of Missouri Volunteer Program* (LMVP) since the year 2000. This program's goal is to provide baseline water quality data that will both gauge a lake's relative health and show if the lake's water quality is being negatively impacted by human influences in the watershed.

For the purposes of the LMVP monitoring, water quality refers to five parameters that either directly measure or are an indicator of the lake's productivity. The more productive the lake, the more likely plant blooms are to occur and negatively impact water quality for both drinking water and recreation (Thorpe et. al. 2002).

On a scale of 1 to 4, where "1" is least productive and "4" is over productive, Sugar Creek lake has been a consistent "3". This is the most common case for lakes in north Missouri, and has been the case at Sugar Creek Lake since at least 1989 (Figure 3). Volunteers Frank Fillo and Lynn Fair are the monitoring team for Sugar Creek Lake. For questions regarding their data, go to the website www.lmvp.org or call 1-800-895-2260.

A concern addressed through the nineties was seasonally high levels of Atrazine and other pesticides used in crop production. Because this issue was and continues to be of concern Statewide, monitoring was done as part of a regional study (Mark Twain Water Quality Initiative) and Statewide monitoring program (Missouri Atrazine Voluntary Monitoring Program). As was true for other lakes with agricultural land in their watersheds, levels of atrazine were seasonally high in Sugar Creek Lake (Figure 4, graph showing both studies data over an annual period).

Beginning in the early 1980's, Moberly's finished water was occasionally found to have elevated levels of trihalomethanes (THM's). This chemical is a carcinogen. It forms from the combination of naturally occurring organic compounds (e.g. predominantly from the presence or breakdown of single-celled plants called algae) and chlorine. Chlorine is added as a disinfectant to the finished water. A study to address this issue was done by the environmental firm CH_2M Hill. It was initiated by the City and was completed in 1987. It resulted in implementation of several operational changes in the water treatment process which brought the level of THM's to acceptable levels (CH_2M Hill 1987).

At the writing of this document, trihalomethanes along with haloacetic acids (HAA's) continue to be a concern for the finished water, and can be at high levels when the total organic content of the lake water is high. HAA's are also disinfection by-products that are carcinogenic. Recent changes to the disinfection procedure have resulted in both levels of THM's and HAA's being well below the new, lower action level (that level at which the EPA has determined it becomes a detriment to consumers). With ever increasingly stringent regulations, this issue will continue to be at the top of the City's list of water-quality concerns.

Drinking Water

The City purifies water from the lake that provides for the needs of 13,741 residents and 472 businesses within the corporate boundaries of Moberly. During an average month, between 35 and 42 million gallons of water are used. Of this amount between 25% and 30% is use for commercial or business use.

Though there are no outside areas currently served by Sugar Creek Lake, it serves as an emergency supply for the Moberly Area Correctional Center and the Thomas Hill Water Supply District. The Thomas Hill district supplies water to an estimated population of 8,383 from 3,353 active service connections. Of the 15.6 million gallons distributed per month, the prison uses 12 million (E. Baker, DNR pers. comm.)

With the recent completion of improvements to southbound U.S. Highway 63, the City of Moberly is anticipating some population growth. This growth is predicted to be both residential and business related. Current daily water use is around 1.5-1.6 million gallons per day (MGD). The lake's maximum capacity is 2.2 MGD (10-year-old study in Mary's office), which is a limit to population growth.

(1) Customers Served/Service Connections √
(2) Maximum capacity of lake and plant...
(3) Projected Growth √
(4) Raw Water
(5) Finished Water

Septic effluent

The impact to the lake's water quality due to failing and inadequate on-site sewage treatment systems for rural residences in the watershed has yet to be determined. The cumulative effects of such septic systems, classified as a non-point source of pollution, can be as serious as major source inputs such as substandard municipal treatment plants (Miller and Jantrania. 2000). Primary pollutants include disease causing microorganisms and plant nutrients, including nitrogen and phosphorus.

Fishing and Lake Recreation

The fishery resource of Sugar Creek Lake draws anglers from within and outside Missouri. It serves the community as a significant recreational resource, and is seen as one of many community benefits by new businesses when they consider moving or expanding to the Moberly area.

Up until 2001 a City Ranger enforced lake's fishing and boating regulations. After he retired, the City decided to leave that position vacant. Since that time, there have been several meetings with the Department of Conservation to enlist the lake in the State's cooperative "Community Assistance Program". This 25-year cooperative venture provides the City with improved lake access facilities, professional fishery management and law enforcement services, while providing the public with free fishing access. At this time, the details of this cooperative agreement are still being worked out.

The fishery itself is typical of warm water impoundments in north Missouri. Fish present include largemouth bass, bluegill and green sunfish, black and white crappie, channel catfish, gizzard shad, and common carp. Recent introductions of walleye have experienced unknown success, though survival is suspected to be quite limited (F. Filo, pers. comm.).

Recent electrofishing sampling done by the Department of Conservation found bass of all sizes, many small sunfish and crappie species, and an over-abundance of gizzard shad and carp. The presence of gizzard shad is largely responsible for the small size of the panfish. If a cooperative agreement is entered into, MDC biologists will provide periodic sampling, analysis of the data and regulations and needed action to address fish population imbalances.

Addressing Concerns

Enough Water for Future Growth?

Goal: Insure that there will be enough water to meet the City of Moberly's needs for population and business growth for the next 200 years.

Objective 1: Determine the rate of loss of lake volume due to sedimentation by 2007.

Strategy 1:
By 2006, initiate an engineering study to determine the loss of lake volume since the last study done in 19XX. This will allow a recent rate of loss to be calculated, as well as set a baseline.

Objective 2:
Halt or greatly reduce the rate of loss of lake volume due to sedimentation by 2010.

Strategy 2a:
Work diligently with NRCS officials to encourage landowner participation in the AgNPS S.A.L.T. Program. These management practices will greatly reduce soil erosion from watershed lands currently under agricultural production, and subsequently slow lake volume reduction. Implementation will also reduce seasonal herbicide and nutrient content of the lake's water. Cost-share on these is limited to stated amounts each year beginning in 2004 (Figure 5). It would be a shame if any of these monies were unused. These practices include:

1) Permanent Vegetative Cover Establishment (DSL-1)
2) Permanent Vegetative Cover Improvement (DSL-2)
3) Terrace Systems (DSL-4)
4) Terrace Systems with Tile (DSL-44)
5) Diversions (DSL-5)
6) Permanent Vegetative Cover - Critical Areas (DSL-11)
7) No-Till Systems (DSL-15)
8) Filter Strip (DSL-20)
9) Forest Plantation (DFR-4)
10) Woodland Protection through Livestock Exclusion (DFR-5)
11) Water Impoundment Reservoir (DWC-1)
12) Sediment Retention, Erosion or Water Control Structure (DWP-1)
13) Sod Waterways (DWP-3)
14) Permanent Vegetative Cover Enhancement (DSP-2)
15) Planned Grazing System (DSP-3)
16) Planned Grazing System with Pond (DSP-33)
17) Field Border (N386)
18) Nutrient Management (N590)
19) Pest Management (N595)

20) Riparian Forest Buffer (N391)
21) Use Exclusion (N472)
22) Well Decommissioning (N351)
23) Waste Utilization (N633)

Figure 4. Monies available for cost-sharing practices on watershed lands through the S.A.L.T. program grant.

YEAR	2004	2005	2006	2007	2008	2009	2010	TOTAL
AMOUNT ($)	*42,540*	*55,000*	*70,000*	*90,000*	*90,000*	*80,000*	*60,000*	487,540

Strategy 2b:
Design and install sediment basins above each arm of the lake to trap incoming sediment-laden waters. Or perhaps build a low berm across the sediment-filled upper ends of each arm of the lake, hoping to trap incoming sediment behind these structures. These basins should be designed to allow the majority of the heavier particles to settle out before allowing water to enter the lake. This will also reduce nutrient loading and pesticide transport to the lake, as many of these compounds are adsorbed onto soil particles. Natural, emergent vegetation should be encouraged within these structures to enhance filtering ability. Emergent vegetation like cattails, rushes and water willow are well known for their ability to remove pollutants from surface waters. Funding may be available through the S.A.L.T. program.

Objective 3:
Plan for an alternative or additional water source for the City's future.

Strategy 3a:
Investigate purchasing water from the Long Branch, Thomas Hill or Clarence Cannon water supply districts.

Strategy 3b:
Investigate building another lake below Sugar Creek Lake.

Water quality, high enough to meet future standards?

Goal: Reduce levels of THM's and HAA's in the finished water so that quarterly tests are always below allowable levels.

Objective 4:
Reduce the concentration of plant nutrients in the lake in order to reduce levels of organic materials in the treated water by 2010.

Strategy 4a:
Investigate engineering solutions to slow the nutrient enrichment of the lake's waters by 2007. Look into the possibility of installing a bottom-withdrawal spillway that, unlike a surface spillway that discharges higher-quality surface waters, will discharge seasonally nutrient- and sediment-laden waters from greater depths. This will need to be done in a way that does not negatively impact downstream aquatic life. By installing this type of spillway, it is perhaps possible to slow, halt or reverse the usual trend of nutrient enrichment exhibited by man-made lakes in this region.

Strategy 4b:
Same as 2a, actively promote the enrolment of watershed lands into the AgNPS S.A.L.T. program.

Strategy 4c:
Same as 2b, design and install sediment basins above all major arms of the lake.

Objective 5:
Reduce the concentration of organic compounds in the treated water prior to disinfection.

Strategy 5a:
Purchase new carbon feeders by 2005 to more efficiently remove organics.

Objective 6:
Stop producing disinfection by-products.

Strategy 6a:
Investigate other methods of disinfection that do not create harmful by-products.