LAKE LOTAWANA WATERSHED AND LAKE MAINTENANCE STUDY UPDATE

Lake Lotawana Association

ABSTRACT

An update of previously performed watershed studies, including land uses, silt contribution to the lake, silt control measures and removal practices, silt removal permitting issues, and dam permitting.

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October 11, 2016
LLR PN 0315028.01

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10-10-16

Acknowledgements

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For his many contributions to this report.

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Executive Summary

The Lake Lotawana Watershed and Lake Maintenance Study is a comprehensive effort to provide the best available information and resources for future management of this valuable community resource that is Lake Lotawana. Key findings and recommendations of the study are:

- The Soil Conservation Service, U.S. Department of Agriculture estimated, in 1984, that 72,000 tons of sediment per year enter the lake, and that over 90% of the sediment enters the lake through the five largest coves and bays: Sunset Bay Big Rock Bay, Quantrall's Cove, Waterfall Cove, and Sunrise Bay. The current study estimates that 62,000 tons of sediment enters the lake, based on current land uses. The changes are mostly due to less farming in the watersheds upstream of the lake.
- Hydraulic dredging was estimated to be the most feasible and cost effective method of removing most of the sediment in the 1985 Black and Veatch (B&V) Study. Tabulations of costs to date and amount of sediment removed confirm the cost effectiveness of hydraulic dredging for the larger coves and bays.
- Construction of silt traps in watersheds upstream of the lake were not as cost effective as silt removal by hydraulic dredging in the B&V study. The current study revisited this issue by using an example silt trap upstream of Buffalo Cove, finding that the estimated cost for permits and construction of the silt trap, including environmental mitigation, was excessive. The feasibility of permitting the facility is also unclear since other alternatives to siltation control in the lake do exist, i.e. hydraulic dredging.
- Contract hydraulic and drag line dredging, prior to 1996, removed an estimated 210,500 cubic yards of silt, of an estimated 369,300 cubic yards required to be removed to bring the lake to the Level 3 restoration (removal of sediments to provide a minimum of 8' depth, or to original bottom, except immediately adjacent to the shoreline or seawalls). The average cost for removal was $2.47 per cubic yard. The 363,300 cubic yard estimate included dredging both Sunrise and Sunset Bays completely, which subsequently LLA decided not to pursue.
- Hydraulic dredging and mechanical excavation by the LLA between 2002 and 2015 removed an estimated 237,000 cubic yards of silt at an estimated total cost of $1,553,000 for a unit cost of $6.55 per cubic yard. The LLA has been removing silt at a rate of approximately 21,545 cubic yards per year for the years that the dredge was in operation during that period. The exact cost of in-house dredging and mechanical excavation was difficult to determine as a result of less

documentation of the internal activities of the LLA dredging program. It is highly recommended that LLA invest more effort in documenting total in house costs, including dredging, land acquisition, and silt basin maintenance, as described in the report.

- The original contractor dredging program established "benefit districts" and restored the coves and bays dredged to the Level 3 restoration state. Following the purchase of its own dredge in 2001 the LLA dredged several of the areas a second time, and some a third time to maintain the Level 3 restoration depths. This work provided an opportunity to perform an analysis of hydraulic dredging to estimate the annual dredging requirement on an ongoing basis. Estimates of annual sediment loading for each of the major coves and bays was performed, resulting in a maintenance dredging requirement of between 11,336 and 18,694 cubic yards per year. The LLA has adequate capacity with the current hydraulic dredge, purchased in 2015, to achieve these goals.
- The most significant issue with regard to dredging is long term silt management. The LLA has several silt basins constructed, and owns land on which additional facilities can be located. However, the silt basins are not uniformly located with sufficient capacity to support long term dredging of some nearby bays and coves in need of dredging. Additionally, there is inadequate property to economically remove the silt from the basins after it has been dewatered. By far the most cost efficient method of silt removal, to prepare for additional dredging, is to remove the silt by loader and track hoe and spread it adjacent to each basin. Some of the silt basins, in particular the heavily utilized Basin-3 (Big Rock Bay) and Basin-6 (Kenard) do not have adequate property adjacent to them for long term silt disposal. It is strongly recommended that the LLA vigorously pursue additional land purchases to support the long term goals of the dredging program.
- The silt basins have not been uniformly cleaned out during the program. It is recommended that the LLA clean each basin out for future operations as soon as it is practical to do so, with an engineer's oversight.
- Operation of the lake, dredging program, and silt disposal potentially require a number of permits from local, state, and federal agencies.
    - According to the United States Army Corps of Engineers (USACE) hydraulic and mechanical dredging does not require a permit provided that certain conditions are met as described in this report.

- The USACE finds that returning silt basin water to the lake is a jurisdictional activity under Nationwide Permit 16. The permit does not appear to require pre-notification to the USACE, and the LLA has not been recently pre-notifying the USACE. However, it might be in the best interest of the LLA to do so, or revisit the issue with USACE for confirmation.
- It does not appear that any of the current dredging activities are regulated by the Federal Emergency Management Agency (FEMA). However, and construction within the FEMA floodplain would be a regulated activity requiring permits from FEMA and other agencies.
- The Missouri Department of Natural Resources (MDNR) requires a Section 401 water quality permit certification for the return waters from dredging. The LLA has a current permit for this purpose valid until March 13, 2018. Recently, questions arose from MDNR regarding conditions of this permit. Representatives from LLA and Larkin Lamp Rynearson plan to meet with MDNR to clarify conditions of this permit.
- Construction or modification of silt holding basins potentially requires permits from agencies, including:
  - If the construction activities disturb over 1 acre of land then a Land Disturbance Permit from MDNR is required. This permit requires an engineered Stormwater Pollution Prevention Plan (SWPPP) be developed and implemented during construction.
  - The City of Lake Lotawana requires an Excavation Permit for any excavation where heavy equipment or trucks are required or used.
- The dam itself is regulated by the MDNR Dam Safety Division. The LLA has a current Registration Permit No. R-317, valid until August 18, 2017. The dam is currently classified as a Class II, based on the number of homes in the inundation zone downstream of the dam.

- It is highly recommended that LLA perform two ongoing tasks with regard to the dam registration:
  - Monitor development trends in Jackson County, and the incorporated areas within the dam breach inundation zone to verify that development is in accordance with the Jackson County Sni-A-Bar Inundation Overlay District. It is critical to the future of the lake community that additional commercial or residential structures not be allowed in

the inundation zone, thus jeopardizing its Class 2 rating authorized by MDNR. While this should be the responsibility of the various governing agencies, it is too important to allow development without oversight.

- Purchase and remove the seven houses currently within the overlay zone when they become available. Class 2 status limits inundated houses to no more than nine. Currently there are seven houses remaining in the dam breach inundation zone.

Introduction

Lake Lotawana is a private 480-acre lake community located in Eastern Jackson County, Missouri. It was conceived and built in the 1920's by the Lake Lotawana Development Company, following its successful creation of Lake Tapawingo, a smaller 120-acre lake development located adjacent to the City of Blue Springs, Missouri. The Lake Lotawana development consists of approximately 15.5 miles of surrounding private single lane asphalt roads; a 58 feet tall earthen dam and spillway structure (registered as a Missouri Class-2 Dam), approximately 2,000 platted first and second tier lots, various land tracts, over 150 acres of common parkway land surrounding the lake, as well as various easements and a perimeter two feet wide strip of land for the purpose of retaining the development's privacy. Figure I-1 is the original plat map for Lake Lotawana

The community is currently governed by The City of Lake Lotawana, organized under Missouri statutes as Fourth Class City, and Lake Lotawana Association, Inc. (LLA), a Chapter 355 not-or-profit corporation, made up of approximately 1,250 property owners, also referred to as "Members".

The City of Lake Lotawana (The City)

The City was first chartered under Missouri statutes in 1958 as a Fourth Class City form of government. It is governed by an elected six-member Board of Alderman and Mayor. The City boundaries originally, more or less, coincided with the Lake Lotawana subdivision development boundaries, approximately 2.3 square miles. In 2004 the City began expanding beyond the traditional Lotawana subdivision by a series of involuntary (voter approved) and voluntary annexations. This was in response to the City's citizens desire to bring the adjacent Barber and Sons Aggregates quarry under City jurisdiction; and the rapid growth of two nearby cities, Blue Springs, expanding southward and Lee's Summit from the west. Currently the City jurisdiction covers approximately 11.3 square miles, extending primarily southward Figure I-2 is the current limits of the City of Lake Lotawana.

Services provided by the City include, sewer district (primarily the Lake Lotawana subdivision), roadways not belonging to the Lake Lotawana Association, tax and fee collection, public safety policing and emergency response, animal control, zoning and building codes administration and municipal court. Public water service is provided primarily by Rural Water District 15 and to some extent District 13. Fire and life safety protection is provided by Lake Lotawana Fire Protection District and the Prairie Township Fire District.

Lake Lotawana Association (LLA)

The Association was first incorporated as a Chapter 355 organization in 1932. It is governed by a 37-member Board of Directors, including its nine-member Executive Committee comprised of the President, Vice President, Secretary, Treasurer, Sargent-of-Arms and four standing committee Chairpersons, overseeing Ways and Means, Environment Water Quality, Rules and Regulations and Roads. The Board is also supported by a variety of other voluntary committees as well as two standing Boards; Lake Improvement Board and Water Use Enforcement Board. All Member boards and committees are voluntary.

LLA has a paid management staff consisting of the Executive Director, Operations Manager, Office Manager and Water Safety Manager overseeing LLA's day to day operations. Total staff count varies up to 15, depending on seasonal employees.

LLA's governing documents include The Deed of Restrictions, Association Bylaws, Lake Use and Common Area Rules and Regulations and what is commonly referred to as the "1988 Court Order". This Court Order was a historic settlement agreement between LLA and the Lake Lotawana Development Company transferring ownership of the Lake, dam, roads and other common areas to LLA. The Order also instituted the means for LLA's Board of Directors to establish Member approved annual budget assessments to fund its operations.

The Association's principal responsibilities include: member services, ownership administration, maintenance of the lake, roads and common areas; water quality & fisheries, watercraft and boat dock registration; promulgation and enforcement of rules and regulations; water use safety patrol, compliance with governmental regulations, and finally, enforcement of the lake and common area privacy.

Figure I-1

Original Plat Map of Lake Lotawana

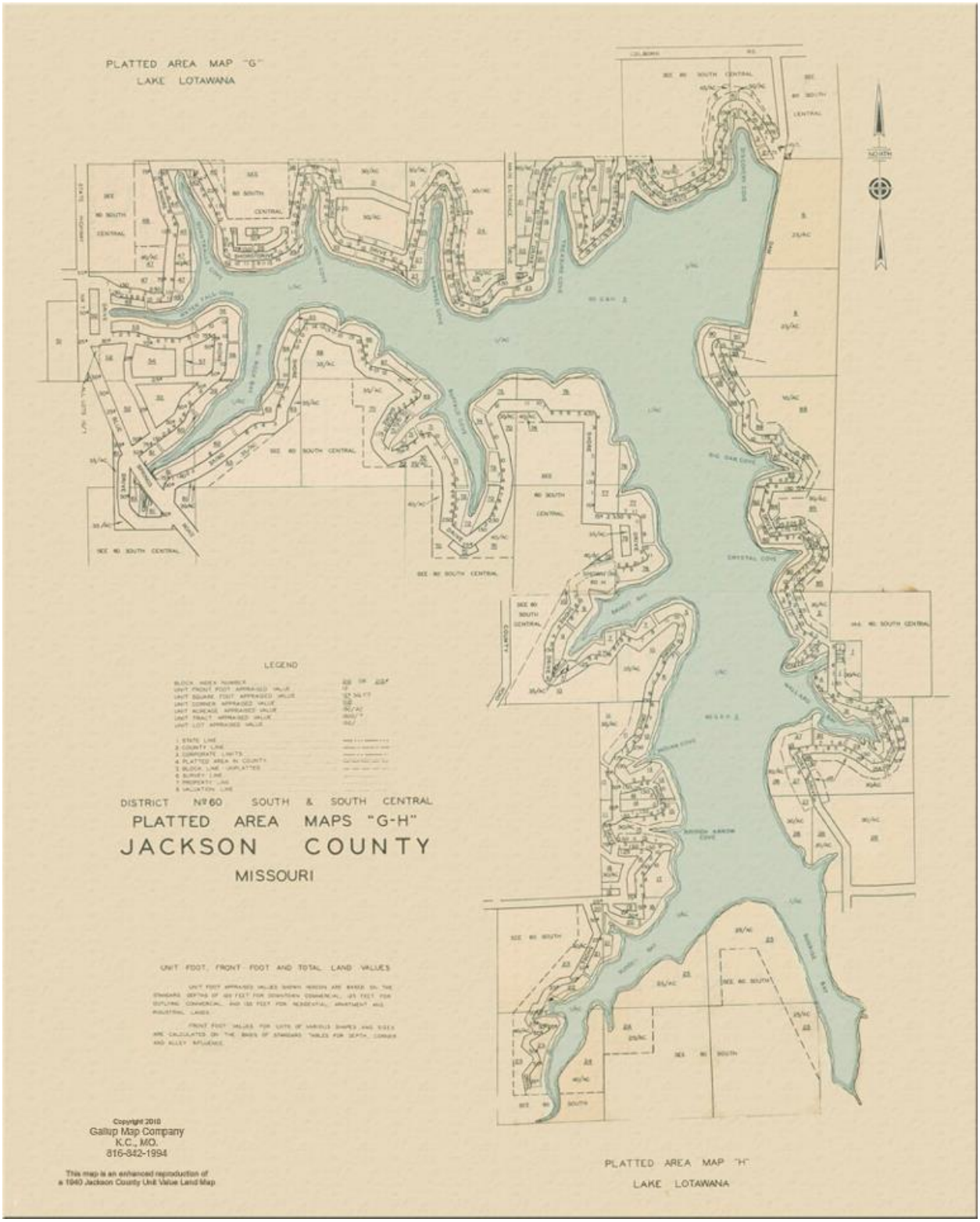
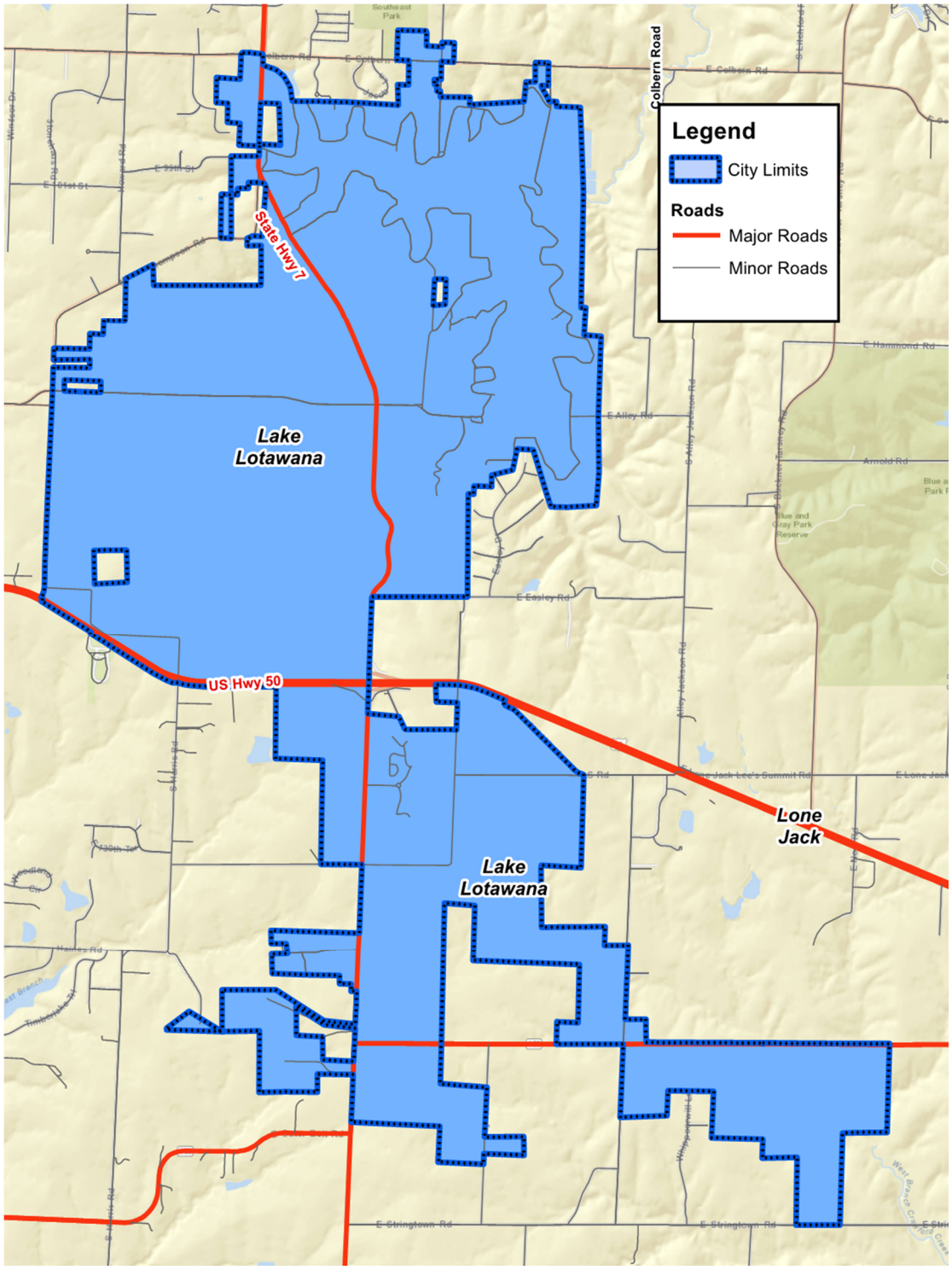


Figure I-2

City of Lake Lotawana



Chapter 1

Purpose of Chapter

Review previously completed watershed study reports by Black & Veatch (1985) and Larkin Group (1996 and 1997). Provide a summary of findings and conclusions in those reports that are relevant to the Lake Lotawana Association at this time.

Black & Veatch (1985)

Lake Lotawana was constructed in 1927 as a private lake. By the early 1980s it was clear that depth of the larger coves and bays of the lake had decreased noticeably. As a result, the Lake Lotawana Association (LLA), at the recommendation of its Lake Restoration and Maintenance Study Committee, retained Black & Veatch, Engineers-Architects (B&V), to conduct an engineering study to identify the best methods of restoring the lake and maintaining it at acceptable depths. B&V completed the study for the Lake Lotawana Association in 1985.

The 1985 study had several components:

- The study authors worked with the Soil Conservation Service, U.S. Department of Agriculture (SCS), to estimate the amount of sediment entering the lake on an annual basis.
- In 1984 the SCS made estimates of the amount of sediment existing in the coves and bays of the lake with the assistance of the members of the LLA.
- Dredging and disposal alternative were evaluated in sufficient detail to estimate probable construction costs based on best methods.
- Guidance for a dredging program was provided, including design components and required construction permits.
- Guidance was provided to obtain a dam registration permit by 1987, as required by the Missouri department of Natural Resources Dam and Reservoir Safety Program.

The B&V study provided important information to guide the LLA in further activities related to the above study components:

- The SCS estimated that about 72,000 tons of sediment per year enter the lake. Of the total 8,118 acre drainage area, the SCS did not include the drainage area above the two lakes located on the Barber quarry in the sediment estimate, as they assumed nearly 100% trap efficiency of those reservoirs. Of the remaining drainage area at the time of the study the SCS estimated that

there were 3,218 acres of cropland (not including 736 acres above the Barber ponds). Nearly 90% of the sediment was contributed by sheet and rill erosion from cropland. Over 90% of the sediment enters the lake through five coves and bays listed in order of contribution: Sunset Bay, Big Rock Bay, Quantrall's Cove, Waterfall Cove, and Sunrise Bay.

- The study determined three levels of possible restoration, depending on criteria determined in coordination with the LLA. Level 3 was ultimately selected to remove sediment to provide a minimum depth of 8 feet, or to the original lake bottom if less than 8', in all areas except immediately adjacent to the shoreline or seawalls. The estimated amount of sediment to be removed to achieve this objective was 369,300 cubic yards. In accordance with the SCS estimates it was determined that about 90 percent of the restoration amount would take place in the five coves and bays with the highest rate of delivery as noted.
- The study concluded that hydraulic dredging was the most feasible and cost effective method of removing most of the sediment. Dragline dredging was suggested in the upper areas of Sunrise and Sunset Bays where access could be obtained. The January, 1985 present-worth cost of restoration was estimated to range between $762,000 and $1,334,800, depending on the restoration level and extent of involvement by the LLA in performing the dredging. The estimated cost of maintaining the lake at the desired level ranged from $140,900 to $207,000 per year depending on whether the LLA performed the dredging or had the work completed by contracts.
- The study estimated that the restoration program could be accomplished in 6 months if a large contractor performed it, or in about 2 years if the LLA performed the dredging.
- The total dredging cost estimates included construction of disposal ponds at costs ranging from $382,000 to $523,000 depending on the restoration level. Disposal of material in the deeper portions of the lake was not recommended due to the potential for undesirable water quality changes.
- The study found that construction of upstream sedimentation basins that would capture between 50 and 90% of the sediment prior to it entering the lake was not cost effective compared to the LLA dredging the material after it enters the lake.

In 1988, as a result of a court approved legal settlement, the lake and other common areas were deeded to the LLA from the Lake Lotawana Development Company (the original developer). The LLA embarked on a program in 1989 to implement recommendations in the 1985 engineering report. The program was

structured around the formulation of “Benefit Districts” as the principal source of funding (Appendix 1). It included both hydraulic and dragline dredging, land purchases, and construction of silt disposal ponds.

Larkin Associates (1995)

In 1995 the LLA commissioned Larkin Associates consulting engineers to conduct a study with the following objectives:

- Document progress and costs to date for silt removal projects that had been completed through contract dredging.
- Survey coves that were restored to determine completed bottom elevations.
- Survey selected unrestored coves to provide current estimates of sediment accumulation.
- Investigate methods and costs for creating silt traps for some of the smaller coves and drainage areas.
- Estimate the sediment volume remaining in the lake that must be removed to achieve the “level 3” restoration as defined by the 1985 report.

The Larkin Associates engineering report was completed in 1996 (Appendix 1). The reporting of progress to date is summarized below:

- Between 1989 and 1992 the LLA completed 13 hydraulic dredging projects and they were all completed by one contractor. The dredging generally was effective at removing sediment, leaving a layer of between 4 to 12 inches behind after the completion of dredging.
- The total amount dredged was estimated at 194,800 cubic yards.
- The dredging and pumping costs ranged from a low of $1.97 per cubic yard to a high of $9.75 per cubic yard, with an average cost of $2.47 per cubic yard.
- Six silt ponds were constructed with a total storage capacity of 195,750 cubic yards. The total cost of constructing the silt basins (including land acquisition cost for two of the basis) was $235,300. The average cost of construction was $0.91 per cubic yard of storage without land acquisition included, and $1.20 per cubic yard with land acquisition costs included. All of the silt basins were essentially filled to capacity at the end of the dredging.
- The overall cost of the hydraulic dredging projects completed by the LLA between 1989 and 1992 was $3.67 per cubic yard of silt removed including the acquisition of land.
- The LLA completed 12 dragline projects during this period, generally in areas inaccessible to the hydraulic dredge, or were done in support of the hydraulic dredge project to remove debris and

rock, or to excavate virgin lake bottom material. The dragline projects removed an estimated 15,981 cubic yards of sediment from the lake. The total cost of dragline excavation and silt disposal was $66,872 for an average cost of $4.18 per cubic yard. The dragline process does not require the construction of silt basins for storage. In order to minimize hauling and disposal costs the dragline disposal sites were located on LLA property close to the excavation sites. The study recommended that disposal sites for mechanical excavation (either dragline or long stick excavator) be located within ½ mile of the excavation site.

- The LLA completed nine other dragline projects for general maintenance of silt traps located within the watershed. These projects were completed on an hourly rate basis. Information on hourly cost per cubic yard of material removed was not documented.

The Larkin surveyors completed cross section profiles in coves that were restored to determine bottom elevations in the restored state. Surveys were also conducted in selected unrestored coves to provide current estimates of sediment accumulation.

- The restored coves that were cross sectioned included Siesta, Union, Quantrill's, Big Rock Bay, Bandit Bay, and Broken Arrow cove.
- Surveys were completed for the areas identified in the 1985 report that were not yet addressed, including Sunrise Bay (dredged along the developed side of the Bay only), Mallard Bay, Crystal, Big Oak, Treasure, and Shawnee Coves. The estimate of silt to be removed in these locations, to complete the restoration program, was at least 75,750 cubic yards. In subsequent dredging operations conducted in house by the LLA, an estimated 51,000 cubic yards was removed from these locations, except that silt removal amounts are not available for Big Oak and Crystal Coves.

The study investigated methods and costs for silt traps on some of the smaller coves and drainage areas.

- As of 1996 there were several silt traps in the watershed, most of which had been dragline excavated by the LLA to improve their performance. At that time two ponds were constructed on the larger watersheds. The neighboring Carriage Oaks development constructed a pond upstream of Quantrall's cove with an estimated trap efficiency of 90%. A pond upstream of Waterfall Cove was also under restoration by dragline with an estimated trap efficiency of 45% (now nearly full of silt).
- The study estimated the required size of silt traps on the watersheds under 200 acres for both 50% and 90% trap efficiency.

- It further developed cost estimates for constructing two traps on the smaller watersheds for example purposes, one at Broken Arrow Cove and the other at Bandit Bay. At 1996 prices, the estimated cost of the Broken Arrow silt trap was $25,000, and the Bandit Bay silt trap was $35,000. Neither cost estimate included land acquisition and maintenance costs, including silt removal and disposal.
- Similar to the 1985 engineering study, this study questioned constructing silt traps on the smaller watersheds. Based on historical records of mechanical excavation, the cost to maintain the silt traps was considered potentially greater than the cost to dredge the material after it enters the lake. The study also recommended no further action, at that time, in construction of silt traps on the large watersheds; these contribute 90% of the total sediment to the lake. It was recommended that the LLA take no action regarding silt trap development until the SCS worked with Mr. Barber's property in crop and land management. The SCS noted in their 1984 report that construction of silt storage basins without applying treatment on the upland crop land to reduce sheet and rill erosion is not recommended due to the increased difficulty of operating and maintaining the basins.

Larkin Associates (1997)

The LLA commissioned Larkin Associates engineers to expand on the 1996 report and prepare an addendum to focus on the following areas:

- Identify locations for the construction of permanent silt pond disposal facilities to support future dredging projects.
- Investigate the costs associated with pumping to the defined permanent silt pond facilities.
- Define the appropriate equipment and respective costs to support future maintenance of the permanent ponds.
- Investigate methods for cleaning the existing pond facilities for reuse in future dredging projects.

During the study, LLA also asked that Larkin Associates engineers investigate the costs associated with the purchase of an IMS portable hydraulic dredge and support equipment, and evaluate its yearly operating costs.

Dredging Costs

This study estimated the costs of in house dredging. Assumptions include operating for a 15 year life span at an average of 400 hours per year. Two possible production rates, of 50 and 100 cubic yards per hour, were used for the analysis. When considering just the costs of dredge ownership, O&M costs, and silt storage pond maintenance the estimated cost was $3.46 per cubic yard of material removed at 100 cubic yards per hour. The estimate is doubled at 50 cubic yards per hour. This study did not include costs of land purchase and silt pond construction.

Silt Disposal Facilities

The 1997 study suggested potential locations for short term silt disposal facilities to complete the initial dredging at the following general locations:

- One large pond along the east arm of the lake adjacent to Sunrise and Mallard Bays. The LLA's Dredging Committee identified acreage owned by the Sportsman Club as a potential location for this disposal site.
- Another potential site is the 40 acres owned by LLA that lies directly west of Broken Arrow cove. (This later became the location of Basin-1). This pond would principally serve Sunset Bay. It was suggested that a silt disposal facility at this site be sized to accommodate 60,000 cubic yards. A second basin, Basin-5, was later constructed on this site as well.
- A smaller pond directly east of B-Block, adjacent to Big Oak and Crystal Coves, for which a preliminary design was completed in the 1996 report. A cost of $18,500 for a storage capacity of approximately 8,000 cubic yards was estimated in the 1996 report for this site. A second possible site to serve Crystal and Big Oak Coves was the LLA owned property lying directly south of the dam (formerly known as the Avise property).
- A silt disposal pond was recommended on the north side of the lake to serve Treasure and Shawnee Coves. Due to the heavily wooded nature of the area, no specific location was noted.

The study suggested potential locations for long term silt disposal facilities at the following general locations, based on the dredging equipment being considered for use at that time:

- It was suggested that the LLA concentrate on developing permanent facilities adjacent to Sunrise and Sunset Bays, Big Rock Bay and Buffalo Cove. All areas identified were on the west side of the lake, on high ground. It was recommended that the land areas should be large enough to allow for land application of the silt removed. These disposal sites would be centrally

located to allow maximum coverage of the lake with the dredging equipment operated by LLA. Permanent piping systems were recommended so that operators would only be required to connect the booster pump to the permanent piping system and attach the dredge piping to the booster pump location on the shore. It was later found that permanent piping systems were not viable and it was easier to use portable piping systems, moving them around as necessary, to support the dredging operation.

- The study recommended land application of the dried sediment by disking into the ground using conventional farm equipment, followed by restoration with a cover crop.
- The assumption in this study was that the LLA would dredge approximately 30,000 cubic yards of material per year.

Chapter 2

Watershed Concerns and Issues

The purpose of this chapter is to identify items that are deemed significant, ongoing issues and challenges that have impacts on Lake Lotawana's watershed, but are beyond the scope of this study. Due to their importance, to one degree or another, they are briefly discussed herein along with recommendations for future documentation and follow up actions by the Association. No priority has been assigned.

1) **Water Testing:** For many years, the Association and City have cooperated in the annual testing of lake water for the presence of excessive fecal E. coli counts. The purpose of the testing is to determine safe water conditions for swimming and related boating activities. Coliforms are bacteria found naturally in the environment from plant decay and fecal waste from animals and humans.
   - General coliforms exist in all bodies of water. The presence of general coliform bacteria indicates that the water has come in contact with plant or animal life. They do not present a concern at low levels. At unacceptable high levels they could include harmful pathogens.
   - Fecal coliforms, such as E. coli, typically indicates the presence of mammal or bird feces in the water.
   - Enterococcus bacteria also indicates the presence of feces from warm blooded animals in the water. Enterococcus are a type of fecal streptococci and are a valuable indicator for determining fecal contamination. Studies by the EPA have shown that enterococci can have a greater correlation with illnesses due to swimming in fresh waters than say other bacterial organisms.
   - The more closely related the animal to humans, the more likely pathogens from their feces can infect people.
   - Human feces are the biggest concern, since what infects one human could more easily infect another. This is why there are concerns from septic system leaching and/or sewer system leakage into bodies of water.

   <u>Recommendations:</u>

   a) Continue working with the City of Lotawana on the periodic testing of lake water for the presence of safe or unsafe E. coli.
   b) Seek professional guidance, by a qualified water quality expert, of the current testing procedures, methods, frequency and recommended documentation to assure safe water conditions for swimming activities.

2) **Fisheries:** Lake Lotawana has a long history of working with the Missouri Department of Conservation's Fish and Wildlife Division to determine the presence of various fish species populations and recommendations for annual fish stocking and the introduction of new species, such as Red Ear Sunfish introduced to help control Zebra Mussel larva.

Recommendations:

a) Continue the practice of working with the State's fisheries staff on an annual basis.
b) Catalog current fish species types present in the lake.
c) Document past fishery activities and all future fish shock population counts, stocking recommendations, actual fish stocked, including fish quantities, size, purchase costs, sources, and recommendations for fish habitat.
d) Create an ongoing summary table of fisheries data to capture past history and future fisheries data. While the data appears to be is available, it is not currently summarized in a concise summary table format.

3) Watershed Activities:

a) Farming: Farming operations and tillage in the Lake Lotawana watershed makes a significant contribution toward soil erosion and resulting lake siltation. Good farming practices can substantially reduce the amount of suspended silt that enters the lake, particularly with large rain events.

Recommendations:

i) Identify farm land ownership and monitor the most significant farming operations in the Lake's watershed.
ii) Continue to seek Soil Conservation Service input and cooperation on best farming practices for reducing soil erosion.
iii) Work with local farm land owners to implement best (SCS) erosion control practices.

b) Land Development: Residential and commercial development, including hard surface parking and roadways will continue to have potential negative impact on water quality due to silt laden runoff, particularly during construction phases.

Recommendations:

i) Identify and monitor development projects in the zoning and planning stages located in the Lake Lotawana watershed. Take a proactive stance early in the development of residential and commercial projects that drain to Lake Lotawana.
ii) Work with the City of Lake Lotawana and to some extent the Cities of Blue Springs and Lee's Summit and Jackson County to have in place and enforce soil erosion control measures, such as silt fencing, during construction phases to minimize off site soil runoff.

c) Barber & Sons Aggregates: The adjoining Barber quarry (approximately 450 acres) and onsite concrete and asphalt plant operations have high potential for negatively impacting Lake Lotawana's water quality. This is in addition to the Barber farming operations which entails the largest tilled crop land area located in the lake's watershed. The total Barber land area that drains to Lake Lotawana is over 2,000 acres and is principally located within the boundaries of the City of Lake Lotawana.

Several governmental agencies have specific regulatory oversite of the quarries' operations, including:

- The City of Lake Lotawana (Conditional Use Zoning Permit)
- Jackson County (Carriage Oaks Sewage Treatment Plant)
- Missouri Department of Natural Resources
  - Land Reclamation Program (Permit No 0388 – 445 Acres)
    - Missouri Mining Commission
  - Air Pollution Control Program (Permit No OP2009-028)
    - Air Conservation Commission
  - Water Protection Program (Permit No OG491203)
    - Clean Water Commission
  - Dam & Reservoir Safety Program (Permit No MO2057)
    - Dam & Reservoir Safety Council
- Federal Agencies
  - Mine Safety & Health Administration (MSHA)
  - Alcohol, Transportation and Firearms (ATF)
  - Environmental Protection Agency (EPA)

<u>Recommendations:</u>

i) The Association should work hand-in-hand with the City of Lake Lotawana to assure its citizens and Association Members that the quarry operations do not negatively affect the health, safety and well-being of citizens. This includes safe guarding the environment and property values.
ii) Become educated on the various regulatory permits under which the quarry operates. Along with the City, keep track of all related regulatory activities and documents.
iii) The City and Association should seek ways to cooperatively work with the quarries' owner and regulatory governmental agencies to assure safeguards and regulatory compliance.

d) Lotawana Sportsmen's Club: The Lotawana Sportsmen Club is located within the Lake's watershed, in close proximity to its water's edge at the East end of Sunrise Bay. The Club offers clay sport shooting with three trap ranges and two outdoor target ranges for rifle and pistol shooting. Its property lies adjacent to the Association's two-feet privacy border strip that surrounds the subdivision limits. It is located in the unincorporated area of Jackson County, just beyond the City of Lake Lotawana's jurisdiction. For entry access to the target ranges, the Club and Association have a written agreement allowing Club members to cross the two-foot strip through a locked gate and gravel drive maintained by the Club.

Potential problems arising from the Club's close proximity to Lake Lotawana include, lead contamination and spent plastic shotgun shell wades that find their way to the lake. Recent testing sponsored by the Association for the presence of lead in fish turned up negative to well below acceptable limits.

Recommendations:

i) Review and understand regulatory requirements related to the Sportsmen Club's shooting activities.
ii) Work with Sportsmen's Club leaders to prevent lead contamination and the migration of spent plastic shotgun wades into the lake.
iii) Seek professional guidance on issues related to lead contamination of lake water, recommended preventative measures and future testing.
iv) Seek professional guidance on controlling plastic wade migration to the lake during large rain events.

4) Sewage Treatment Facilities: Sewer treatment facilities located in the watershed areas of Lake Lotawana remain an important concern for assuring safe water conditions. Sewage treatment facilities located in the lake's watershed include: a waste water collection system operated by the City of Lake Lotawana, the Carriage Oaks sewage collection-treatment facility and numerous home owner septic treatment systems mostly located outside the subdivision limits of Lake Lotawana.

a) City of Lake Lotawana Sewer District: The City of Lake Lotawana operates 23 lifts stations that pumps sewage to its treatment facility located below the lake's dam. The lift stations are located around the lake, generally along its shore line. In some locations sewage waste water piping is located in the lake. The lift stations operate using submersible wet well pumps to move waste through the collection system. Infiltration of ground water into the collection system continues to be a significant problem during significant rain events.

b) Jackson County (Carriage Oaks Sewage Treatment Plant): The Carriage Oaks development, located immediately north of Lake Lotawana, is served by pressurized grinder sewage collection system that terminates at a packaged treatment facility and lake reservoir located just ahead of Quantrall's Cove. The treatment plant is operated by Jackson County Public Works. Discharge water from the plant, as well as surface water from approximately 600 acres flows into the Carriage Oaks Lake. Water overflow eventually moves through an outlet tower structure and then travels a short distance to Quantrall's Cove.

Recommendations:

i) Cooperate with the City on its sewer collection system testing program.
ii) Consider adopting Association rules and regulations supporting City efforts, along with possible Member point assessments for violations.
iii) Revisit the lake water testing program for determining mammal and human fecal waste levels, as discussed above.

5) Invasive Species: By definition, an invasive species is a fungus, plant, or animal species that is not native to a specific location which demonstrate a tendency to spread to a point that causes harm to the environment, human health or the economy. Invasive species, whether plants, mammals or aquatic vertebras have the potential to affect a lake's naturally occurring balance. In some instances, invasive species, such as Zebra Mussels currently found in Lake Lotawana or excessive

aquatic plant growth, can have a significant impact on a lake's overall water quality and aquatic life, either directly or indirectly. Identifying and understanding invasive species are important steps toward preventing the introduction of harmful species; mitigating environmental damage when already present, or outright elimination.

Recommendations:

i) Seek assistance from the Missouri Department of Conservation. This agency has extensive background and experience in confronting invasive species throughout the State. Educating the public on invasive species in Missouri is a key objective.
ii) Seek professional consultation for identifying, preventing, controlling and eliminating invasive species. This should include guidance for aquatic weed control, invasive fish and vertebras.
iii) Identify and catalog invasive species and plants already found in the Lake and identify threats and harm.
iv) Inform Association leadership and Members about local invasive species, their prevention and treatment measures.

6) **Wetland Determination:** Understanding rules and regulations regarding wetlands utilization and management is an important concern for the Association and its stewardship of the Lake. Determining the status of wetlands located within the subdivision of Lake Lotawana can have a serious effect on how the Association goes about silt remediation and other lake maintenance activities. The Association faces tremendous challenges and costs to remove silt, whether by hydraulic dredging or by conventional excavation and hauling. Sites are needed to build additional silt deposit basins within the horizontal and vertical pumping distance limits of the hydraulic dredge. Silt waste sites are also needed for silt trucked away for disposal.

The Association's Board of Directors has discussed preliminary plans to build a second boat lunching facility intended to reduce dependence of its boat ramp located at the dam. Facilities also need to be developed for harboring the hydraulic dredge, the recently purchased weed harvester and a planned mini-excavator barge operation. The harbor facility will require space for loading and offloading contractor equipment, construction materials, boat docks and silt spoils dug by the mini-excavator and unloaded off the barge.

The upper end of Sunrise Bay has been identified as the only area of the lake that is potentially suitable for the new boat ramp and lake maintenance equipment harbor. To accommodate these activities, it is anticipated that the channel leading to this area will need to be deepened an additional 3-4 feet and increased in width up to 30 feet.

Recommendations:

i) Secure professional services to determine wetland status in Sunset Bay and Sunrise Bay. Both coves have experienced over 85 years of siltation since the manmade lake was first constructed. As a result, much of these coves are now unnavigable and infested with aquatic plants.
ii) Following wetland determination and mitigation options, undertake the design engineering and cost estimates for a second boat ramp and a harbor work area for lake maintenance

equipment and related operations. It should be noted that other long-term planning issues and concerns will most likely materialize as a result of this planning process and as details emerge.

7) **West Branch Sni-A-Bar Creek Management Consortium:** The Consortium was organized in 2008 to create a management plan for the creek's watershed area extending from its confluence with the Sni-A-Bar Creek, to the southwest just beyond Lake Lotawana. Its watershed area consists of approximately 18,525 acres and includes unincorporated areas of Jackson County and portions of three cities: Grain Valley, Blue Springs and Lake Lotawana. Membership and participation is open to the public and governmental and private entities.

   Lake Lotawana Association and The City of Lake Lotawana were founding members of the Consortium. In 2011 the Association's Board of Directors agreed to provide funds to the Consortium for the development of the "West Fork Sni-A-Bar Watershed Management Plan". The watershed plan was authored by Olsson Associates. It was completed in 2012 with amendments made in 2013.

   According to the plan document: *"The purpose of the plan is to provide tangible recommendations for achieving the six principal goals of this program:*

   1) *To protect the quality of streams and other natural resources within West Branch Sni-A-Bar Creek Watershed from nonpoint source pollutions*
   2) *To protect West Branch Sni-A-Bar Creek and its tributaries from damages attributable to increased storm water runoff that will result from new development and construction in the watershed*
   3) *To assist in reducing pollutant loads to West Branch Sni-A-Bar Creek*
   4) *To facilitate cooperation between local governments, stakeholders, and citizens*
   5) *To promote low-impact development planning and practices*
   6) *To facilitate public and community education and involvement."*

   Recommendation: Due to Lake Lotawana's large watershed area within the overall West Branch Sni-A-Bar Creek Watershed and the Association's goal of protecting lake water quality, the Association should continue to play an active role in the Consortium. Looking forward, it will be important for the Association to work with other local stake holders to minimize potentially negative impacts of future land uses and development within the watershed.

Chapter 3

Purpose of Chapter

To update current land use mapping of the watershed, using the support of existing exhibits, to analyze the current siltation impacts to Lake Lotawana.

Mapping

Figure 3-1 is a descriptive vicinity map of Lake Lotawana's location within Jackson County, Missouri, as well as the lake cove and bay names. The cove annotations were compiled from the 1985 Black and Veatch study.

The Current Land Use map was compiled from multiple exhibits provided to Larkin Lamp Rynearson from Lake Lotawana Association. The types of land uses consist of cropland, improved, grass land, and woods. These areas were then cross referenced to ensure accuracy.

All sixteen (16) sub-drainage watershed areas were individually analyzed and summed into the perspective land use types. Lake Lotawana's sub-watershed land use types are summarized in Table 3-1. In total there is 1,746 acres of cropland, 3,156 acres of improved, 1,216 acres of grass land, and 1,759 acres of wooded area.

Figure 3-2 is the current Lake Lotawana Zoning Map (dated September 15, 2009). The county also provided tax parcel data containing land use data per parcel. Jackson County tax parcel data includes property ownership and land use codes. The land use codes were per a county nomenclature. After converting the county codes, the parcels were then used to compare with the current land use areas. Since the land use codes were for the parcel as a whole, and some individual parcels contained all four land uses, the parcel shapefile solely could not be used as a tool to determine the areas.

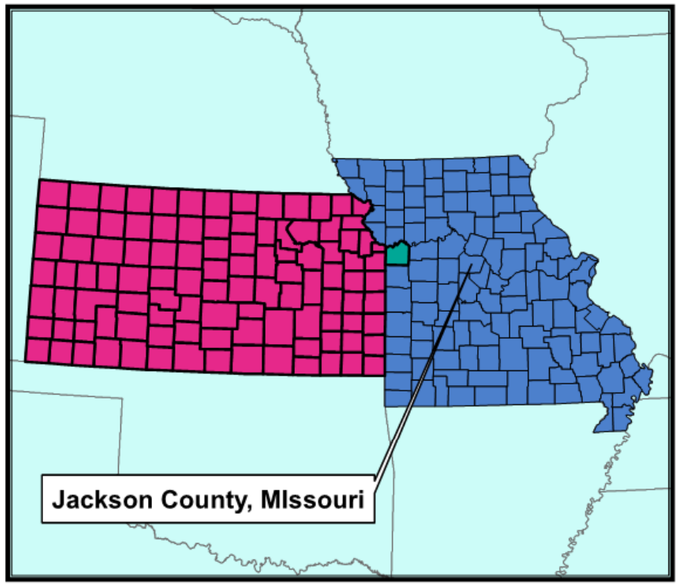
The City of Lake Lotawana Master Plan and Future Land Use Map reflects what future city development entails. This siltation study primarily focuses on current land use, although future developments have been noted.

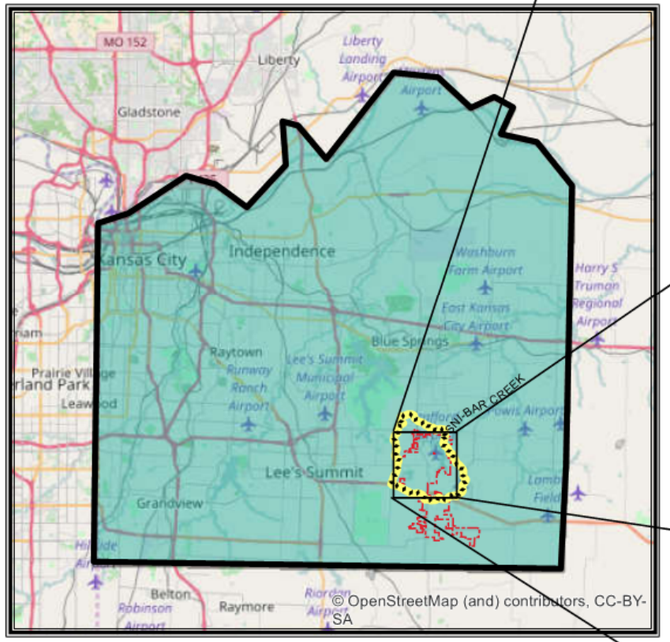
After comparing to all the above mentioned exhibits the Current Land Use map, Figure 3-4, was completed to illustrate land uses in the Lake Lotawana watershed. To ensure accuracy these areas were compared to images in Google Earth and discussed with the Lake Lotawana Association. In addition to land type, plotted within this figure is the city limits, tax parcels, and sub drainage areas. The purpose of

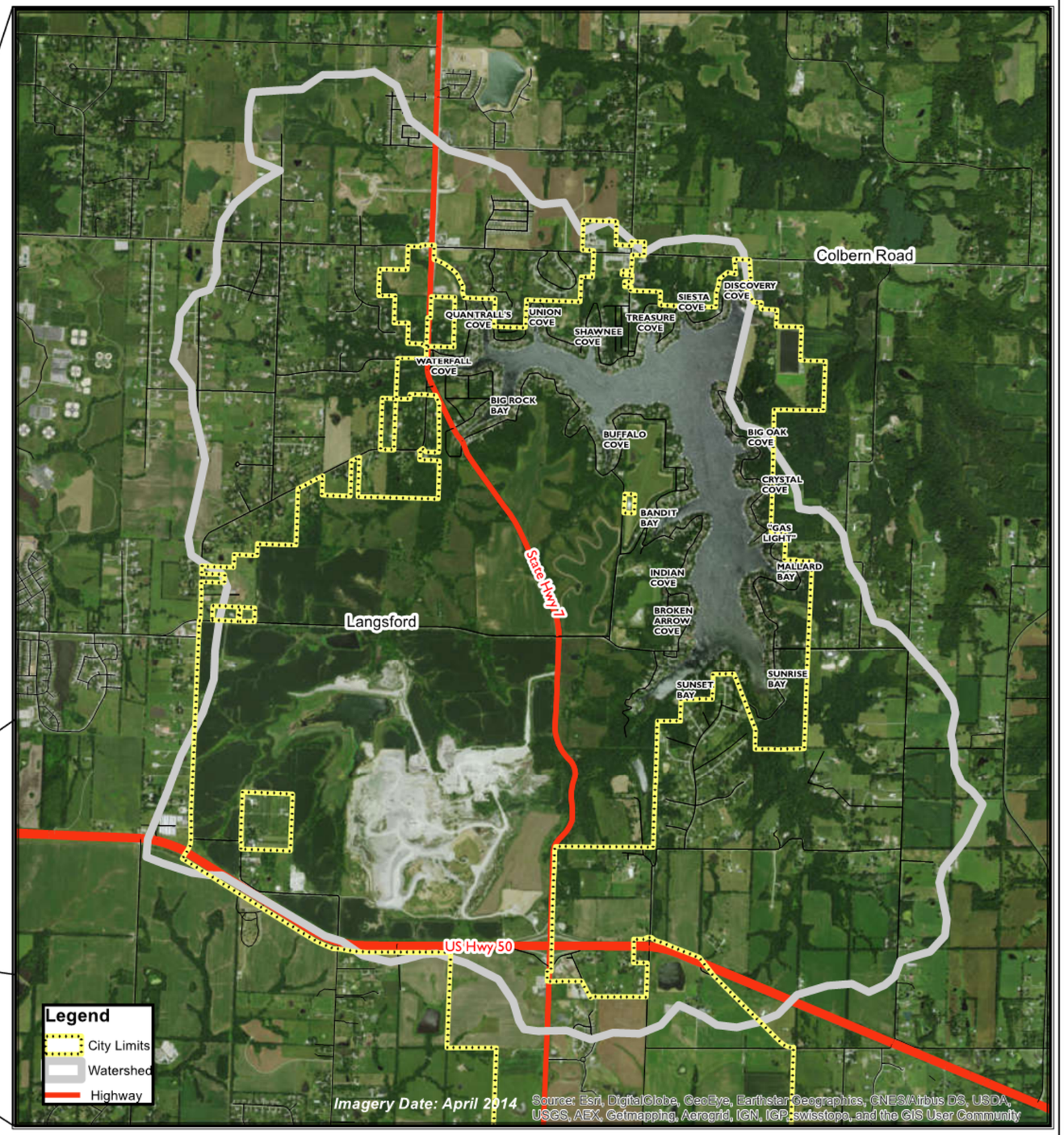
Figure 3-4 was to analyze the historical land changes and effects of siltation loads to the lake, which are discussed in the following chapter.

Table 3-1: Land Use Acreage

Drain-age Area	Type	Area [acre]
1	Cropland	140.0
	Improved	337.8
	Grass Land	79.8
	Woods	68.8
2	Cropland	66.3
	Improved	604.9
	Grass Land	93.3
	Woods	129.4
3	Cropland	377.9
	Improved	281.6
	Grass Land	222.9
	Woods	321.3
3a	Cropland	171.5
	Improved	34.6
	Grass Land	21.1
	Woods	16.0
3b	Cropland	226.7
	Improved	280.6
	Grass Land	132.6
	Woods	103.0
4	Cropland	146.8
	Improved	73.2
	Grass Land	69.4
	Woods	102.9
5	Cropland	47.2
	Improved	68.6
	Grass Land	13.9
	Woods	41.6
6	Cropland	244.5
	Improved	768.1
	Grass Land	216.0
	Woods	343.5
7	Cropland	298.9
	Improved	451.2
	Grass Land	289.5
	Woods	429.1
8	Cropland	0.0
	Improved	53.2
	Grass Land	10.4
	Woods	53.5
9	Cropland	0.0
	Improved	17.5
	Grass Land	0.0
	Woods	28.3
10	Cropland	7.3
	Improved	11.4
	Grass Land	0.0
	Woods	16.4
11	Cropland	0.0
	Improved	24.9
	Grass Land	0.0
	Woods	7.5
12	Cropland	0.0
	Improved	25.4
	Grass Land	23.0
	Woods	8.4
13	Cropland	0.0
	Improved	14.3
	Grass Land	0.0
	Woods	11.5
14	Cropland	0.0
	Improved	45.4
	Grass Land	7.0
	Woods	38.4
15	Cropland	0.0
	Improved	75.5
	Grass Land	7.4
	Woods	27.1
16	Cropland	18.5
	Improved	61.1
	Grass Land	29.1
	Woods	12.5







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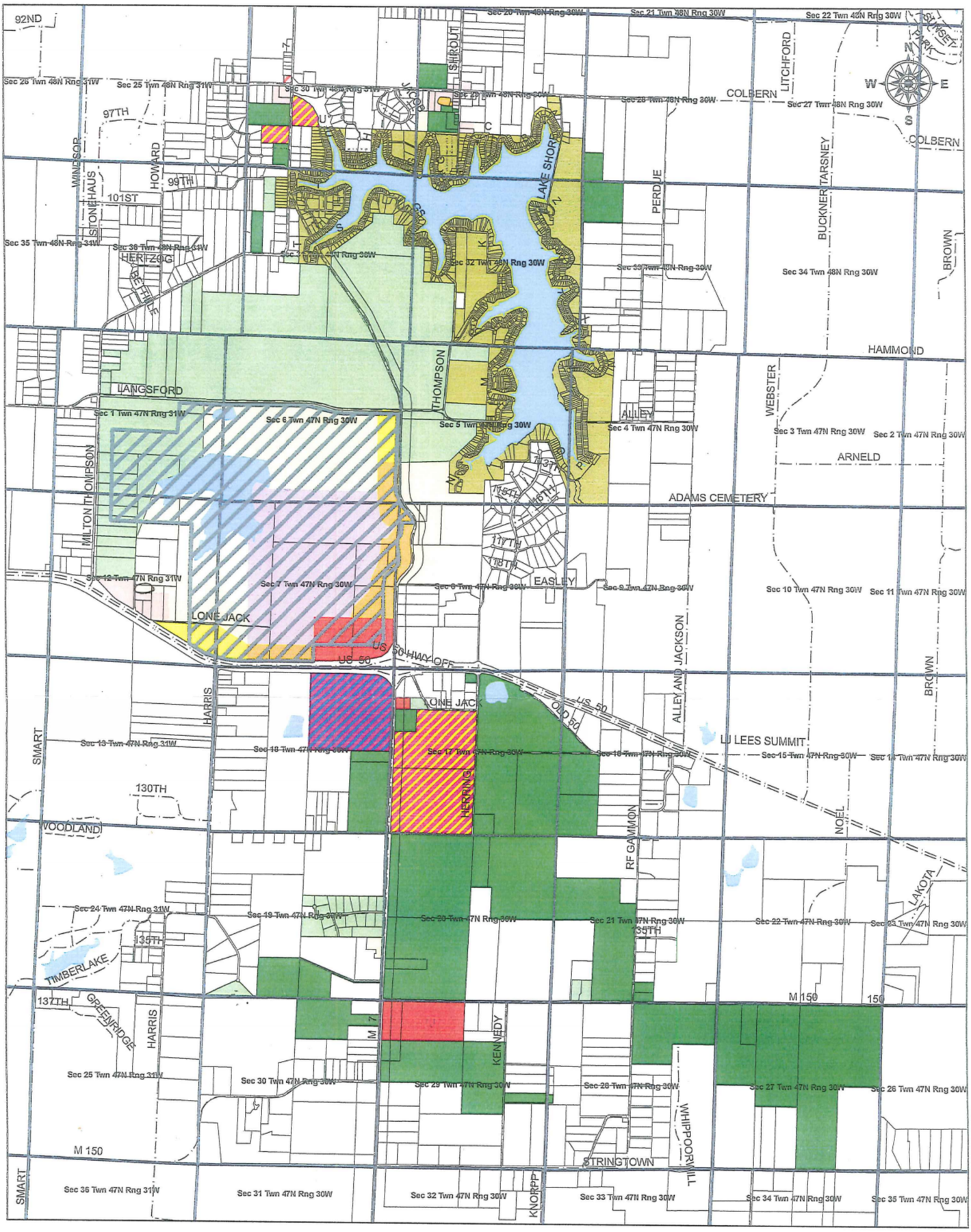
LARKIN LAMP RYNEARSON

LAKE LOTAWANA WATERSHED
FIGURE 3-1 : VICINITY MAP

0 0.125 0.25 0.5 Miles

Zoning - Lake Lotawana, Missouri



0 0.5 1 2 Miles

Attest

Mayor: _____

City Clerk: Rhonda Littrell

Date: Sept 15, 2009

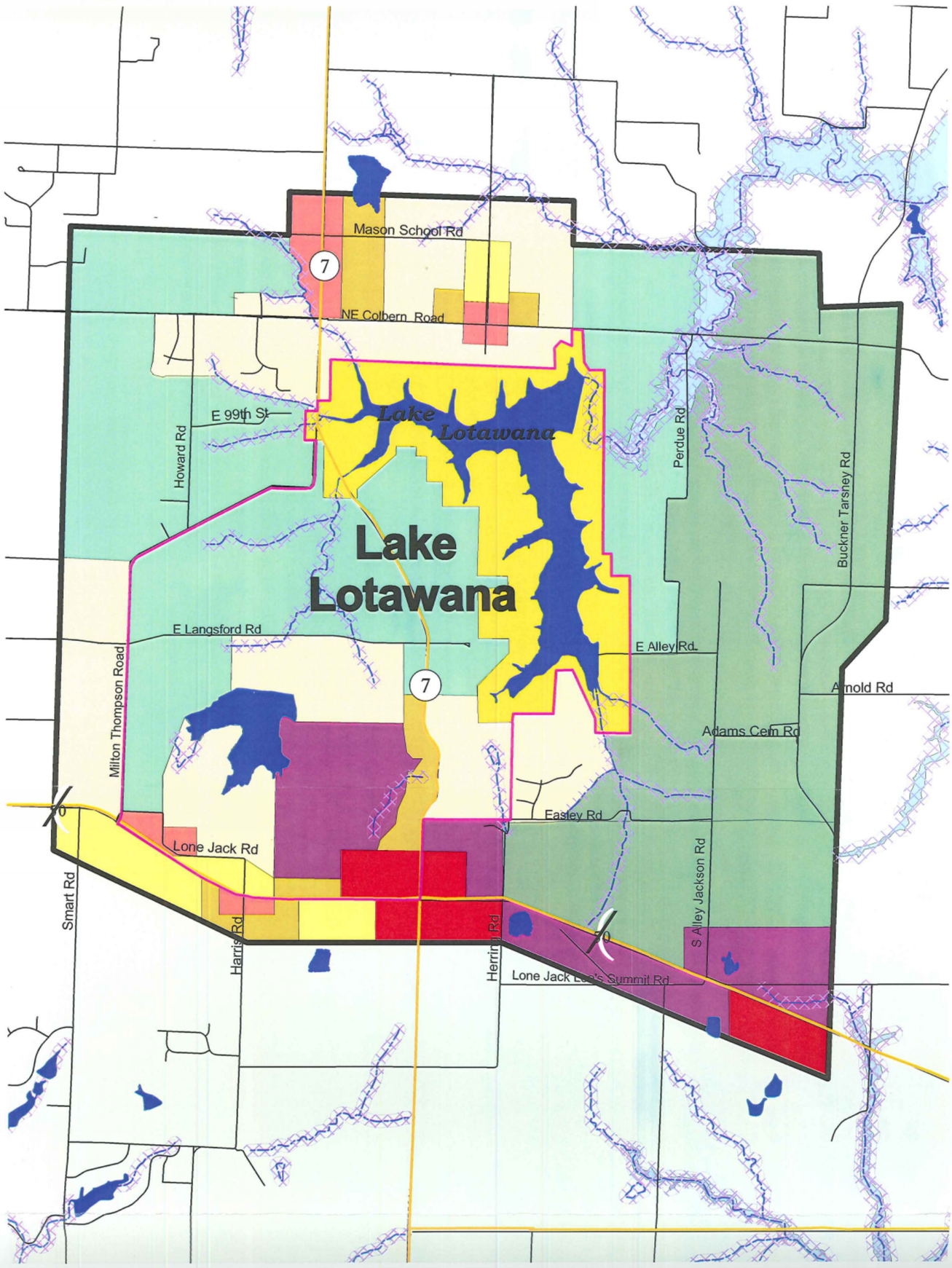
Independent verification of all data contained herein should be obtained by any user of these map products, or the underlying data. The City disclaims, and shall not be held liable for, any and all damage, loss, or liability, whether direct, indirect, or consequential, which arises or may arise from these map products or the use thereof by any person or entity.

Legend

- Road
- Quarry Opperations Overlay
- PLSS
- Water
- Lot Line

Zoning District

- RU / AG County Zoning
- ER - Estate Residential
- LDR - Low Density Residential
- MDR - Medium Density Residential
- LR - Lakeside Residential
- THR - Townhome Residential
- PD - Planned Development
- PD-R - Residential/Neighborhood Commercial
- PD-OC - Office/Commercial
- NC - Neighborhood Commercial
- NC - Neighborhood Commercial (County GB)
- HC - Highway Commercial
- OTC - Office/Technology Center



Legend

- Streams and Rivers
- Roads
- Highways
- City Limits
- Scenario Boundary
- Incorporated Areas
- Stream Buffer 200 ft
- Floodplain
- Office and Technology Center
- Highway Commercial
- Neighborhood Commercial
- Townhouse Residential
- Lakeside Residential
- Medium Density Residential
- Low Density Residential
- Estate Residential
- Agricultural

0.5 0 0.5 Miles

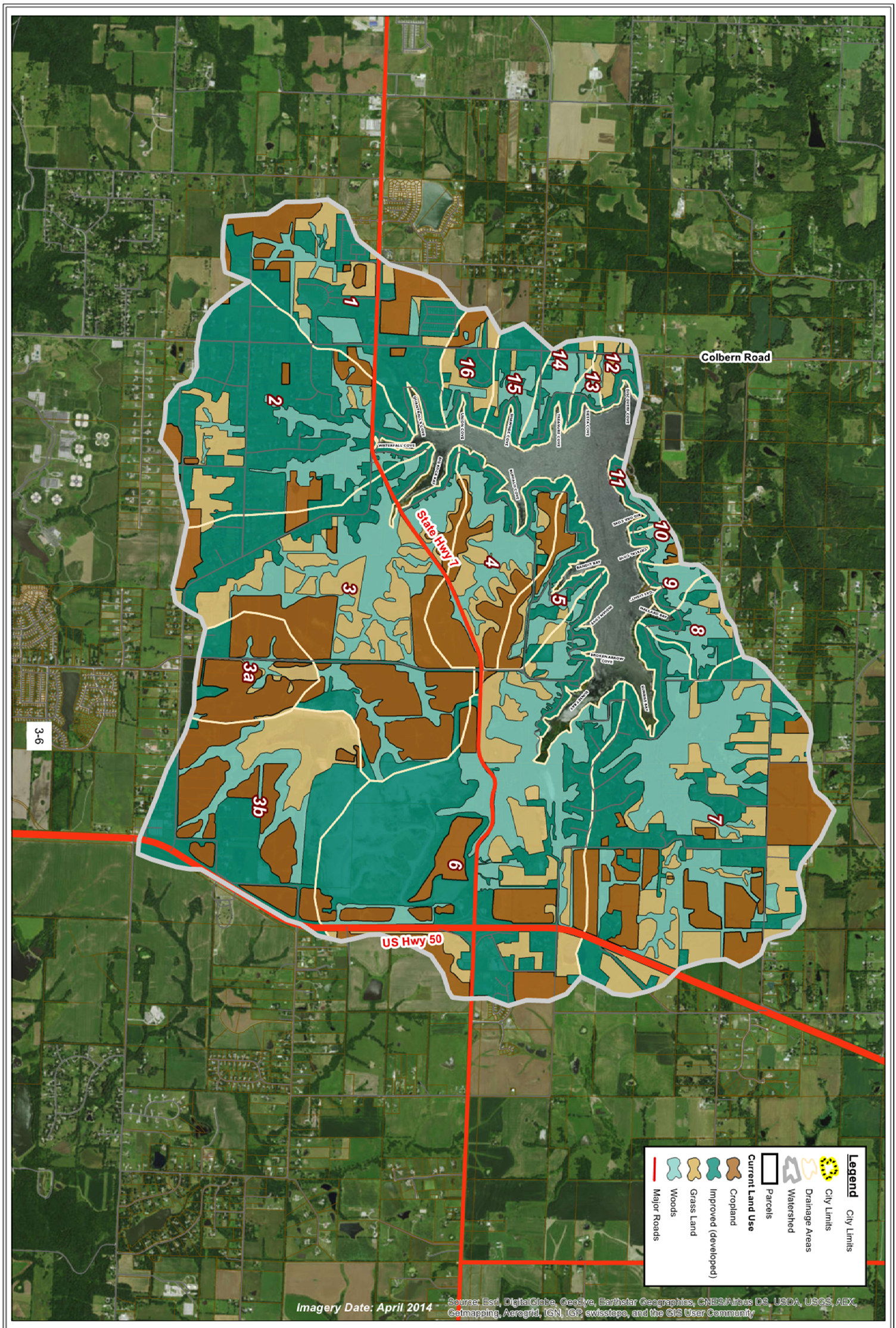
N

Nov. 11, 2002

PLANNING WORKS

Please use this map as a guide and not as definitive information. The areas depicted by this map are approximate and are provided for illustrative purposes only. While every effort has been made to ensure the accuracy, completeness, correctness, and timeliness of information presented within this map, the burden for determining appropriateness for use rests solely with the user. This map is provided "as is" with no waranties, express or implied.

Map 12
Future Land Use



3-6

0 0.1250.25 0.5 Miles

LAKE LOTAWANA WATERSHED
FIGURE 3-4 : CURRENT LAND USE

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Chapter 4

The purpose of this chapter is to update calculations for expected annual silt contribution for each of the 16 previously studied sub-watersheds.

Introduction

Sediment delivered from water erosion causes substantial waterway damages and water quality degradation. Sediment discharge is a critical pollution source in Lake Lotawana. Controlling sediment loading requires the knowledge of the soil erosion and sedimentation. A number of factors such as drainage area size, basin slope, climate, and land use/land cover all affect sediment delivery processes. The goal of this study is to estimate the tons of sediment being delivered per year to each cove of the lake, and to make recommendations of land treatment measures to reduce sediment delivery to an acceptable level.

There is increasing interest in improving water resources development, watershed management, land use, and land productivity. Problems caused by soil erosion and sediments include losses of soil productivity, water quality degradation, and less capacity to prevent natural disasters such as floods. Sediments may carry pollutants into water systems and cause significant water quality problems. Sediment yield is usually not available as a direct measurement but estimated by using a sediment delivery ratio (SDR). An accurate prediction of SDR is important in controlling sediments for sustainable natural resources development and environmental protection.

Soil erosion is the first step in the sedimentation processes which consist of erosion, transportation and deposition of sediment. A fraction of eroded soil passes through channel system and contributes to sediment yield while some of them deposit in water channels. Sediment yields can be quantified using the SDR, expressed as the percent of gross soil erosion by water that is delivered to a particular point in the drainage system. SDR is sometimes referred to as a transmission coefficient. It is computed as the ratio of sediment yield at the watershed outlet (point of interest) to gross erosion in the entire watershed. Gross erosion includes sheet, rill, gully and channel erosions. The Revised Universal Soil Loss Equation (RUSLE) estimates sheet and rill erosion only, the majority of the soil erosion in most cases.

The RUSLE is an improved version of the USLE model that has been used to predict soil loss by water erosion. The equation is:

A = R x K x (LS) x P where:

A = the predicted average annual soil loss in tons per acre per year calculated from a given slope.

R = the rainfall factor. It is a measure of rainfall energy and intensity rather than just rainfall amount. The R-factor values are specific by county.

K = the soil erodibility factor. It is a measure of the relative resistance of a soil to detachment and transport by water; K-factor values vary throughout the year based on seasonal changes of temperature and rainfall. K-factor values for any particular soil in Missouri will be found in the Field Office Technical Guide (FOTG), Section II, Engineering Interpretations, Physical Properties of Soils Reports.

LS = the slope length and steepness factor.

C = the crop and management factor. It is the ratio of soil loss from land cropped under specified conditions to the corresponding soil loss from clean-tilled, continuous fallow.

P = the support practice factor. It is the ratio of soil loss with a specific support practice to the corresponding soil loss with up-and-down hill tillage.

Study Area

The motivation of our analysis lies in the extensive information of the RUSLE; together with topographic attributes from soil mapping, such as flow lengths, gradients, curvature and contributing area. Attached is a soil map field sheet that identifies Coves 1 through 16 and their respective drainage areas. Compared with the study that was done by the SCS in 1984, the overland cropland areas have reduced significantly. The cropland areas in Cove 1 and 2 have reduced by 75% and 87%, respectively. The cropland area in Cove 6 has reduced by 70%. Coves 8-16 haven't changed much with respect to cropland acreage. Also, the area of improved areas (residential) has increased. These changes have reduced the total amount of sediment delivery as shown in Table 4.1.

In this study, the Lake Lotawana watershed is broken down into 16 sub-watersheds (coves). Cove 3 drainage area is the largest sub-watershed. However, most of the high sediment yielding cropland is upstream of two water impoundments, one of which has a very large surface area. These two impoundments have high trap efficiencies and are considered (for this study) to trap all of the sediment

from upstream thus preventing it from entering Cove 3. For this reason, Coves 3a and 3b have not been included in the sediment delivery analysis.

The 1984 SCS study only had two categories for land type: pasture/timber and cropland. In our study we included 4 categories: cropland, improved, grassland and woods/forest. It can be presumed that information drawn from maps in 1984 was insufficient, and also over the years the acres of improved (residential) areas have increased greatly.

Summary of Results

Table 4.1 shows a total of approximately 62,000 tons of sediment delivered per year to the Lake. This is nearly 10,000 tons of sediment less than what was reported in the 1984 study done by the SCS. Again this decrease in sediment delivery is due to the decrease of cropland areas and increase of residential/improved areas. The density of the sediment is estimated at 85 pounds per cubic foot, so the estimated sediment delivered in cubic yards is roughly 54,000 CY.

The first 8 cove watersheds are contributing nearly 82% of sediment into the lake. Cove 6 (Sunset) has the highest sediment delivery which is almost 30% of the calculated total sediment delivery.

TABLE 4.1 - SEDIMENT DELIVERY FOR LAKE LOTAWANA

Cove No.	DRAINAGE AREA (ACRES)	CROPLAND AREA (ACRES)	IMPROVED AREA (ACRES)	GRASSLAND AREA (ACRES)	WOODS / FOREST AREA (ACRES)	SEDIMENT DELIVERED (TONS PER YEAR)					
						CROPLAND**	IMPROVED	GRASSLAND	WOODS	GULLY EROSION	TOTAL
1-Quantrill's	626	140	338	80	69	2520	1614	1.2	0	564	4699
2-Waterfall	894	66	605	93	129	613.8	1497	1.0	0	805	2917
3-Big Rock*	2190	378	282	223	321	7560	1533	3.3	0	1204	10300
4-Buffalo	392	147	73	69	103	1911	258	0.9	0	392	2562
5-Bandit	171	47	69	14	42	799	329	0.2	0	188	1317
6-Sunset	1572	245	768	216	344	8820	7972	4.1	0	1415	18211
7-Sunrise	1469	299	451	290	429	5980	2596	4.4	0	1322	9902
8-South Mallard	117	0	53	10	54	0	766	0.2	0	129	895
9-North Mallard	46	0	18	0	28	0	306	0.0	0	60	366
10-Crystal	35	7	11	0	16	438	178	0.0	0	46	662
11-Big Oak	32	0	25	0	8	0	369	0.0	0	42	411
12-Discovery	57	0	25	23	8	0	543	0.7	0	74	617
13-Siesta	26	0	14	0	12	0	168	0.0	0	41	209
14-Treasure	91	0	45	7	38	0	251	0.1	0	118	369
15-Shawnee	110	0	76	7	27	0	782	0.1	0	121	904
16-Union	121	19	61	29	13	380	346	0.5	0	109	835
TOTAL	**7950**	**1348**	**2914**	**1061**	**1641**	**36277**	**19508**	**17**	**0**	**6629**	**62431**

* Drainage areas (3a and 3b) above existing lakes not included

** 25 percent added for ephermal erosion (29,022 + (29,022*.25) = 36277)

Comparisons

Table 4.2 shows the RUSLE values for soil loss in certain drainages compared to the reported sediment removal volumes for their corresponding coves. Based on the time lapse between dredging projects in

those coves, a rate of deposition is estimated and compared to the RUSLE values. Based on this data, The RUSLE values are about 70% higher than the reported dredging volumes on an annualized basis. The RUSLE is a planning tool with numerous built-in assumptions and generalizations. There is also uncertainty in the dredged volume estimates. But, based on this comparison, it is reasonable to anticipate sediment accumulation rates of approximately two-thirds of that calculated by RUSLE.

TABLE 4.2 - COMPARISONS OF ACTUAL DREDGE REPORT AND RUSLE

Cove	Years (between dredging projects)	Sediment Removed (CY)*	Sediment Removed (tons/yr)**	Sediment Delivered based on RUSLE	% of How Much Greater RUSLE Results are Compared to Dredging Report
1 - Quantrils	16	18,000	1294	4699	72%
2 - Waterfall	15	12,000	920	2917	68%
3 - Big Rock Bay	22	60,000	3136	10300	70%
4 - Buffalo	16	12,000	863	2562	66%

* Based on dredge report done by LLA.

**Density of sediment estimated at 85 lbs per cubic foot.

Sheet and Rill Erosion

Sheet and rill erosion is the detachment and removal of soil from the land surface by raindrop impact, and/or overland runoff. Sheet and rill erosion generally occur in fields or tilled lands. The following assumptions have been made:

- Erosion delivery rate per year to each cove is based upon calculations utilizing the RUSLE.
- Long term use of cropland will be a rotation of corn, soybeans and wheat.
- Improved areas (developed) are defined as 85% concrete paving and 15% construction w/ temporary practices.
- Grassland is defined as dense grass.
- The sediment delivery for the woods/forest area is zero.

Gully Erosion

Gullies are caused by runoff water cutting, or collecting in, surface depressions and flowing at a velocity sufficient to detach and carry away soil particles. The same assumptions were made as in the 1984 SCS study, as recommended by the NRCS:

Gully erosion in the watershed is judged to be moderate as defined in the Soil Conservation Service Engineering Field Manual. The description of moderate is: bank is predominantly bare, with some rills and vegetative overhang, some exposed tree roots, but no slumps or slips.

Sediment delivery rate to each respective cove is 100 percent.

Methods of Controlling Erosion

Mulch: a type of protective covering which is in direct contact with the ground, provides more protection than canopy cover. It can vary from straw, to compost, to wood chips, or saw dust. Spread evenly onto the ground, mulch helps to reduce water evaporation, control weeds, and enrich the soil. It is also significant in protecting soil where vegetation has not had ample time to establish itself. By absorbing the destructive forces of raindrops and wind, mulch reduces erosion until the seedlings mature enough to provide their own protective cover.

Terracing: a combination of contouring and land shaping in which earth embankments, or ridges, are designed to intercept runoff water and channel it to a specific outlet. Terraces reduce erosion by decreasing the steepness and length of the hillside slope and by preventing damage done by surface runoff. There are basically two types of terraces:

Bench terraces, perhaps one of the oldest forms of terraces, is used to reduce land slope.

Broad base terraces, used to control and retain surface water on sloping land.

Vegetated Waterways: protect soil against the erosive forces of concentrated runoff from sloping lands. By collecting and concentrating overland flow, waterways absorb the destructive energy which causes channel erosion and gully formation. Waterways can have cross sections in parabolic, trapezoidal, or triangular form, depending on the functional requirements. Several of these requirements are climate, channel capacity, and desired flow velocity. Grass linings should be hardy, dense - growing perennials adapted to the geographical region and soil. The grass should be cut periodically, fertilized as needed, and not subjected to prolonged traffic by either livestock or vehicles.

Contouring: entails performing all tillage and planting of crops on or near the same elevation or "contour." It is applicable on relatively short slopes up to about 8 percent steepness with fairly stable soils. By planting across the slope, rather than up and down a hill, the contour ridges slow or stop the downhill flow of water. Water is held in between these contours, thus reducing water erosion and increasing soil moisture. Contouring's impact on annual soil loss rates vary with slope steepness, but

typically it's reduced about one half from up - and - downhill farming when the slope is between 4 and 7 percent.

Strip cropping: a very effective and inexpensive method for controlling soil erosion. Strip cropping is a combination of contouring and crop rotation in which alternate strips of row crops and soil conserving crops (sods) are grown on the same slope, perpendicular to the wind or water flow. When soil is detached from the row crops by the forces of wind or water, the dense soil conserving crops trap some of the soil particles and reduce wind translation and/or runoff.

Chapter 5

Purpose of Chapter

Review and analyze silt removal and prevention practices; associated costs including hydraulic dredging, mechanical excavation, silt basins and silt disposal; and upstream silt mitigation measures.

Hydraulic Dredging

The 1996 Larkin report tabulated hydraulic and mechanical dredging practices and costs to that date provided by LLA. All dredging was performed through contracts, which enabled, and required for payment purposes, accurate accounts of the amount of silt removed for payment purposes. In 1996 the remaining locations to be dredged from the 1985 B & V report were the undeveloped sides of Sunset Bay and Sunrise Bay, Mallard Bay, Crystal Cove, Big Oak Cove, Treasure Cove, and Shawnee Cove. Contract dredging and drag line excavation projects removed approximately 210,500 cubic yards of silt. The total cost of the removal, including land acquisition, engineering fees, and all miscellaneous construction costs was approximately $856,000, with an average cost of $4.07/CY of material excavated. The 1985 engineering report estimated that a total of 369,300 cubic yards of material needed to be removed to accomplish the Level 3 restoration (removal of sediments to provide a minimum of 8' depth, except immediately adjacent to the shoreline or seawalls), so that an additional 158,800 cubic yards remained to be removed. Subsequent work in the 1996 engineering study estimated that 74,250 cubic yards remained at the conclusion of the contract dredging program. The differences in the amounts are largely due to the 1985 report estimating dredging both Sunrise and Sunset Bays completely, with an estimated volume for just those two sites of almost 260,000 cubic yards. Subsequent to the 1985 study the LLA decided to just dredge the developed sides of Sunrise (North/East) and Sunset (West) that account for most member residences and boat docks.

Between 1996 and 2001 there were no additional projects completed as the LLA worked towards a method of financing and performing silt removal in house. The 1997 Larkin study addendum was primarily focused on establishing parameters for future work. In 2001 the LLA purchased an IMS 7012 Versa-dredge to begin the dredging program. The Association also purchased additional equipment for supporting purposes, including a Link Belt long arm excavator and later a 2010 Cat track loader as the major items of purchase. Table 5-1 is an update to Table III-1 Hydraulic Dredging Projects from the 1996 Larkin Study, bringing the dredging amounts and locations up to date as of 2015. As of this date the locations that remained from 1996 were all addressed in some form. Sunrise Bay was only dredged on

the north/east side where there are existing Association member docks. Table 5-1 includes silt removal projects after 2001 regardless of whether they were performed by dredging or silt was removed with the long arm excavator. In some cases the dredge was used for most of the cove, with the excavator being used at the ends. On smaller coves, such as Gaslight Cove, the removal was exclusively performed by excavator. As of the end of 2015 the total estimate of removal volume performed in house is 237,000 CY. Estimates of removal volumes were provided by Mr. Greg Rudder of the LLA.

In addition to the initial dredging of remaining locations, a number of projects were accomplished to dredge or excavate locations previously addressed. These locations are shown on Table 5-1 with notations (2nd pass), or in the case of Big Rock Bay there has also been a 3rd Pass of dredging. These projects are significant because they provide some useful information as to how much dredging might be required over the long term to maintain the minimum 8’ depth in the lake.

Table 5-1

Dredging Projects

Cove	Year	Volume Removed	Basin Pumped to	Total Cost	Av. Cost/CY
Quantrall's	1989	30,419	C-1	$ 75,420	$ 2.48
Waterfall	1990	17,769	C-2	$ 68,200	$ 3.84
Union	1990	3,065	C-2	$ 29,890	$ 9.75
Sunset Bay					
*SB I	1990	24,000	B-1	$ 50,380	$ 2.10
*SB Creek	1990	2,000	B-1	$ 4,580	$ 2.29
*SB West	1990	3,180	B-1	$ 5,038	$ 1.58
*SB II	1991	8,000	B-1	$ 21,600	$ 2.70
Bandit Bay	1990	5,448	B-1	$ 15,345	$ 2.82
Buffalo	1991	14,000	B-2	$ 34,860	$ 2.49
Broken Arrow	1991	1,000	B-1	$ 2,790	$ 2.79
Siesta	1992	5,000	B-4	$ 13,950	$ 2.79
Big Rock					
*BR I	1992	71,000	B-3	$ 139,600	$ 1.97
*BR II	1993	9,608	B-3	$ 19,024	$ 1.98
		194,489		$ 480,677	$ 2.47
Big Oak and Crystal	1996?	2,300		$ 8,000	$ 3.48
(Drag Line by Critchfield)					
In House Dredging after 2001*					
Mallard	2003	10,000	Kenard		
Gaslight	2003	2,000	Long arm trucked out		
Sunrise (E.Side)	2004	35,000	Kenard		
Quantralls (2nd pass)	2005	18,000	Basin-3		
Waterfall (2nd pass)	2005	12,000	Basin-3		
Big Rock (2nd pass)	2006	60,000	Basin-3		
Buffalo (2nd pass)	2007	12,000	Basin-2		
Sunset (2nd pass)	2007	16,000	Keller		
Treasure	2008	2,000	Long arm trucked out		
Shawnee	2008	2,000	Long arm trucked out		
Big Rock (3rd pass)	2012-14	60,000	Basin-3		
Buffalo (3rd pass)	2015	8,000			
Total from 2002 to 2015		237,000			
11 years (3 idle) average		21,545			
* IMS 7012 Dredge Purchased in 2001					
New IMS 7012 Dredge Purchased in 2015					

Estimating the total cost and cost per cubic yard of material removed from the lake during the 2002-2015 time period is more complicated than the contract work performed previously. On the cost side, the LLA has some records of these activities, purchase prices for equipment and other relevant data, however manpower and equipment is used not only for dredging activities but a number of other LLA functions. The LLA provided information as shown in Table 5-2 to assist in estimating the total equipment costs, operating costs, and equipment maintenance costs.

For future reference it is recommended that the LLA invest more effort in documenting in house dredging practices, results, and costs. Information that could be routinely recorded on an annual basis might include:

- Activity and methods, i.e. hydraulic dredging or mechanical excavation, silt basin cleanout etc.…
- The dates of starting and completing the activity.
- Results of the activity including estimates of the amount of material moved and how close to completion in any area or silt basin the work progressed.
- Labor estimates and other costs involved, i.e. fuel.
- Engine hours that the dredge was operating and estimates of % of run time spent dredging.
- Maintenance activities.
- Capital Costs for new equipment.

Table 5-2

Dredging and Excavating Costs – 2002 through 2015

Dredging Costs with IMS 7012 and Track Hoe	Amount	Notes:
Equipment Costs		
Dredge Purchase	$ 261,000	New dredge not included as most work was performed with the original IMS 7012
Dredge Sale	$ (137,000)	
12" pipe and accessories (4,000 lf)	$ 40,000	
Link Belt Long Arm Track Hoe	$ 98,000	
Cat Front End Loader	$ 65,000	
Operating Cost		
Lake Lifts (12 yrs @ $6k/yr))	$ 72,000	2 years idle, $5k @ beginning, $7k now
Fuel (7,000 hrs @ 25 gal/hr @ $3/gal)	$ 525,000	22 gal/hr is spec for new dredge
Operator (6 mo. @ $3000/mo, 12 years)	$ 216,000	$75/hr. Loaded Rate
Silt Basin Cleanouts since '01		
Basin-1	$ -	Not Cleaned
Basin-2 (Buffalo Cove)	$ 12,000	2004, 1st Cleanout (by contractor)
Basin-2 (Buffalo Cove)	$ 21,000	2015, 2nd Cleanout (in house)
Basin-3 (Gates 3 and 4)	$ 30,000	2004, 1st Cleanout (by contractor)
	$ 60,000	2010-2011, 2nd Cleanout (in house)
Basin-4 (B-Block)	$ -	Not Cleaned
Basin-5 (Keller)		Not Cleaned
Basin-6 (Kenard)	$ 100,000	2014-2016 (in house)
Equipment Maintenance Costs		
2015	$ -	
2014	$ 10,000	
2013	$ 30,000	
2012	$ 40,000	
2011	$ 20,000	
2010	$ 10,000	Assuming $10k/yr before 2010
2009	$ 10,000	
2008	$ 10,000	
2007	$ 10,000	
2006	$ 10,000	
2005	$ 10,000	
2004	$ 10,000	
2003	$ 10,000	
2002	$ 10,000	
Total	$ 1,553,000	
Cost/CY	$ 6.55	Based on 237,000 cubic yards dredged

On the dredging quantity side, since the LLA was not paying contractors to perform the work, it was not as necessary to maintain exact numbers regarding the volumes excavated. However, it is possible to make an estimate compared against the silt basin filled estimates provided by the LLA, based on the capabilities of the old 7012 Versi-Dredge. Table 5-3 shows an estimate of the material volume that the machine might have been capable of removing given the time on the engine, physical capacity of the pump, and efficiency of the system and operator.

Table 5-3

Dredge Volume estimate based on 7012 Parameters

Old 7012 Versi-Dredge			**Notes:**
Hours	5600		From LLA - Both engines 7,000 on hour meter use 80% dredging time
Flow Rate (GPM)	2500		Average
% Solids by Volume	8%		Between 5% and 10%
Conversion	0.297		Factor to convert from gpm to CY/Hr
Operational Efficiency	70%		70-80% Typical
Solid Removal Rate (CY/HR)	41.58		
Total Solid Removal (CY)	232,848		

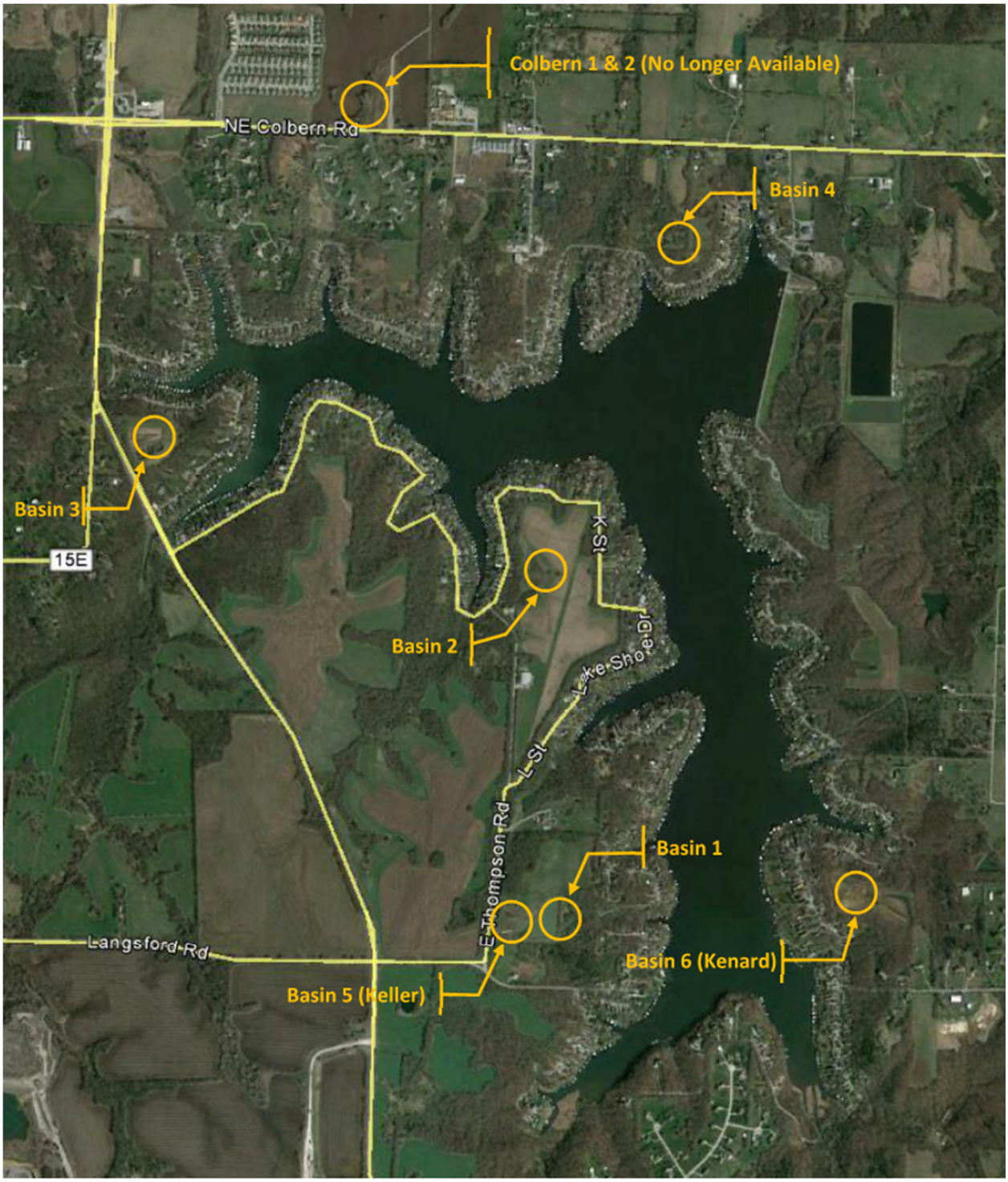
On the other hand the estimated volumes provided by the LLA indicate a total of 237,000 cubic yards was removed during this period. Considering the variabilities involved in the calculations the numbers are surprisingly close. Changes to any of the factors can make a considerable difference in the outcome. For example, if the solids removal is 10% by volume then the calculated theoretical volume removed increases by about 20%.

Silt Disposal Facilities

A number of changes occurred regarding the silt disposal facilities to support the dredging operation between 2002 and 2015. All of the previous and current silt disposal basin locations are shown on Figure 5-1.

Figure 5-1

Silt Disposal Basin Locations



- The originally constructed Colbern-1 and Colbern-2 basins, located north of Colbern Road, across from Jacob Lane, were not located on property owned by the LLA. They were temporary and are no longer available due to development.
- Basin-1, a 41,500 cubic yard basin located west of Broken Arrow Cove, was filled with the contract dredging program from Sunset Bay and has not been cleaned out.
- Basin-2, located east of Buffalo Cove on land owned by LLA, has been retained and continues to be used for dredging of Buffalo Cove. The basin was cleaned out with the Cat loader and long arm track hoe with silt deposited next to the basin.
- Basin-3, located on land owned by LLA, continues to be used for dredging, primarily servicing Quantrall's Cove, Waterfall Cove, and Big Rock Bay. It was originally designed as a 70,000 cubic yard basin but has been pushed to approximately 80,000 cubic yards by reduction in freeboard. Subsequent clean out by LLA raised the basin levee an additional three to four feet.
- Basin-4, a 6,000 cubic yard basin located northeast of Treasure Cove was filled with the contract dredging program and has not been cleaned out. It has the ability to be restored by the Cat loader.
- A second new 60,000 cubic yard silt disposal basin was constructed, on land donated to the LLA, immediately west of Basin-1. Referenced as the Keller basin (Basin-5), the estimated cost of construction was $112,000. This basin, like the old Basin-1, services Sunset Bay, Bandit Bay, and Broken Arrow Cove.
- A new 60,000 cubic yard silt disposal basin was constructed, on 10 acres +/- of land purchased by the LLA, to service Mallard Bay and Sunrise Bay. Referenced as the Kenard basin (Basin -6), the land purchase cost was $40,000 and the estimated cost of construction was $105,000.
- The LLA currently has, in serviceable long term basins, approximately 217,000 cubic yard of storage available for hydraulic dredging operations.
- Silt cleaned out by LLA is placed on or adjacent to existing silt basins. At this time hauling earth materials away by truck is not considered economically viable. Long term silt disposal will continue to be a significant challenge as some basins sites become overburdened.

An update to the 1996 study Table III-2 Silt Holding Pond Construction is shown below:

Table 5-4

Silt Holding Basin Construction and Status

Basin Name	Silt Removed From	Construction Year	Basin Capacity (CY)	Basin Cost	Storage Cost/CY	Filled Status
Colbern-1 *	Quantrall's	1989	30,419	$18,537	$ 0.61	No longer exists
Colbern-2 *	Waterfall, Union	1989	20,834	$12,882	$ 0.62	No longer exists
Basin-1 *	Sunset Bay, Bandit Bay, Broken Arrow	1990	41,500	$23,834	$ 0.57	Full
Basin-2 *	Buffalo	1991	17,000	$35,127	$ 2.07	Reused 2 times, full
Basin-3	Big Rock	1992	80,000	$67,270	$ 0.84	Reused 2 times, full
(Land Cost)				$45,446	$ 0.57	
Basin-4	Siesta	1992	6,000	$20,400	$ 3.40	Full
(Land Cost)				$11,800	$ 1.97	
Totals				$178,050	$ 0.91	
	with land			$235,296	$ 1.20	
Basin-5 (Keller) *	Bandit, Broken Arrow, Sunset		60,000	$112,000		30% full
Basin-6 (Kenard)	Mallard, Sunrise		60,000	$105,000		Cleaned out 2016
(Land Cost)				$40,000		
Current Basin Capacity			264,500			
* No land acquisition costs						

Some issues that the LLA is facing regarding silt disposal are:

- The silt disposal basin volumes do not necessarily match dredging requirements of the coves and bays that they service. The larger bays, in particular, tax the ability of the silt basins servicing them to be able to dredge and dispose of the desired material amounts in a single operation. These silt basins have to be cleaned out completely prior to each dredging operation in order to most efficiently perform the hydraulic dredging and disposal operations.
- At the current average rate of hydraulic dredging, about 21,000 cubic yards per year, the total storage volume theoretically will last 20 years. However, the LLA has purchased a new Versi-Dredge 7012, a machine potentially capable of two to three times the production capacity as the original 7012. It appears that dredging production rates will be high enough that the limiting factor in hydraulic dredging will be the ability to store, dewater, and remove silt from the silt disposal basins.
- Silt basin dewatering and maintenance are challenges. Up to two years is typically required to dewater the silt for removal by excavation. Additionally, there needs to be land available to remove the silt to after it is dewatered, preferably immediately adjacent to the basin. Basin-2 and the Keller basin appear to have adequate land for application and enlargement of the basins

if necessary. The Kenard basin has some land for enlargement and disposal to the east and south, but does not have significant amounts of LLA owned land adjacent to it. Basin-3 has a similar situation.

Long Term Silt Disposal Locations

It is prudent for the LLA to continue to look for opportunities to increase silt disposal capacity. The watershed upstream of the lake was mapped using Geographic Information System data to allow analysis of several layers of data for this purpose. The critical elements that were mapped are:

- A watershed radius of 4,000 feet from the furthest 8' dredging line in the lake. Given silt basin elevations above 950, this is anticipated to be the limit of pumping dredged material with a booster pump. It may be theoretically possible to obtain this distance with the new 7012 without use of a booster pump, however, depending on vertical lift, this has the potential to lower production rates to an undesirable level and risk dropping below settling velocities in the pipe.
- Land slopes below 4% were identified as those that are easiest to excavate and construct containment berms for the silt disposal basins.
- A minimum land elevation above 950 was specified. Experience of the LLA in silt basin construction has shown that this is the elevation at which rock is typically encountered, so that silt basins are difficult to construct below this elevation. Since the dredge is always operating above the permanent pool at a level of about 885, the static head for pumping is normally in the range of 65 feet.
- Jackson County property ownership information was mapped to show properties currently owned by the LLA. This information is included in Appendix 5.

Figure 5-2 shows the mapping of these parameters. As expected, the combination of 4% land slopes and elevations above 950 result in the hilltops of the watersheds being the likely locations for silt disposal facilities. The three permanent disposal locations recommended in the 1997 study are also shown for reference, and they match the current mapping and criteria fairly well.

In the current dredging program all of the silt disposal sites currently being used appear to meet the criteria. Findings from the mapping include:

- The LLA owns considerable land upon which Basin-1 and Keller are located. It appears that long term disposal for the coves that these basins service is accommodated. However, if the LLA

decides to dredge considerable additional areas of Sunset Bay the silt volumes could tax the storage and disposal capability of the basin. It is recommended that a more detailed analysis of this location be made prior to any such decision.

- The LLA owns considerable land at the old airfield (the former Stafford property) upon which Basin-2 is located. Buffalo Cove is serviced by this site, and it appears that Bandit Bay could be serviced as well if the basin were enlarged, or an additional basin constructed along the southeast line of the site. Construction of such a basin would reduce the demand on Keller and Basin-1.
- LLA owns land around Basin-3. This basin is highly in demand as it serves Big Rock Bay. Most of the area has been cleared except the easternmost end. This is a location where silt removal is critical. It is recommended that a topographic survey of the property and current silt volumes be made to estimate the long term storage capability. This will inform the LLA as to when decisions must be made for further accommodations for Big Rock Bay storage. The likely long term storage solution for Big Rock Bay is land owned by Mr. Barber east and/or south of the bay, identified in both the 1997 and current mapping. It would be best if Big Rock Bay silt could be diverted as soon as possible to this location so that Basin-3 only needs to service Waterfall and Quantrall's Coves, thus prolonging the time until silt trucking from the site must occur.
- On the east side of the lake, the Kenard basin is already under significant use. The LLA owned property has been mostly cleared except for the northeast corner. It is recommended that a topographic survey of the property and current silt volumes be made to estimate the long term storage capability of this site. The LLA should investigate any opportunities to purchase additional property adjacent to the site, to the south. While those areas are not well suited to enlargement of the silt basin, they provide opportunity for permanent silt disposal.
- There are other opportunities for silt accommodation from Sunrise Bay on the east and south.
    - The Lake Lotawana Sportsman's Club owns approximately 60 acres east of Sunrise Bay, a portion of which they actively use. Some of that property, notably the west field, appears suitable for construction of a silt disposal pond.
    - The LLA owns low land immediately at the southeast head of Sunrise Bay. It may not be entirely suitable for silt pond construction as it is adjacent to the incoming stream, but might be usable for some storage. The site would need a wetlands analysis and survey to determine the feasibility and storage capacity.

    - The wooded property southeast of the Sunrise Bay headwaters, directly east of the LLA owned property, is a possible location. The ownership shown by Jackson County is an out of state owner.
- The LLA owns land along the north side of the lake in several locations, including adjacent to Shawnee Cove and the filled site of Basin-4, east of Treasure Cove. Since all of those coves are anticipated to be, for the most part, dredged by mechanical methods, it appears that adequate locations can be found for silt disposal. The trucking would be over short distances if the silt excavation is performed with the long stick hoe, provided that access can be arranged.

Maintenance Program Dredging

Analysis of some coves that have been dredged a second time provided a basis to compare the RUSLE sediment loading estimates with the amount of dredging volume from several of the coves. These dredging estimates can also be used to estimate the annual dredging requirements for the locations where the dredge has historically been used, assuming that these locations will be dredged again. The following table indicates these parameters, from which some general conclusions can be drawn. Note that, in all cases, the annual dredging requirement volume is based on an assumed unit weight of silt as it exists at the time that the silt basin is filled at the end of dredging. This unit weight is assumed at 85 pounds per cubic foot. This unit weight was used to assist in evaluation of the adequacy of silt removal pond capacities.

Table 5-5

Redredging Estimate

Cove	First Year	Volume Removed	Redredge Year		Volume Removed (CY)	# of years	CY/Yr	Drainage Area (ac)		CY/Acre/Yr
Quantralls	1989	30,419	2005		18,000	16	1125	626	5	1.80
Waterfall	1990	17,769	2005		12,000	15	800	894		0.89
Big Rock	1992-93	80,000	2006		80,000	13	6154	1204	2	5.11
Buffalo	1991	14,000	2007		12,000	16	750	392		1.91
Sunset	1990	37,180	2007		16,000	17	941	1572		0.60
Big Rock 2nd	2006	80,000	2014	1	80,000	8	10000	1204	2	8.31
Big Rock	1992-93	80,000	2006		80,000	13	6154	2190	3	2.81
Big Rock 2nd	2006	80,000	2014	1	80,000	8	10000	2190	3	4.57
						Average CY/Acre/Yr			4	1.60
						Standard Deviation				0.88
						67% confidence level				2.48
Notes:										
1. 2011-2014 Actual, used 2014 for calculation purposes										
2. Drainage area below quarry dams only, as noted in RUSLE analysis										
3. Used total drainage area, including quarry.										
4. Average using total drainage areas and rates for Big Rock Bay 2nd pass.										
5. Quantrall's Cove dredging requirement is expected to be lowered by the Carriage Oaks silt basin construction.										

- From the five watershed used in the average calculation for dredging volume per acre per year the maximum amount was 2.81 CY/Ac/Yr, and the minimum was 0.60 CY/Ac/Yr. The average amount was 1.60 CY/Ac/Yr.
- When using just the drainage area below the ponds on the quarry for Big Rock Bay the rate was significantly higher, 5.11 CY/Ac/Yr on the second pass, and 8.31 CY/Ac/Yr on the third pass. For the purposes of estimating rates for other locations it was decided to use the amounts for the total drainage area, including the quarry, for the second pass. The Big Rock Bay watershed produces a high amount of sediment that must be dredged, but it is atypical of the other watersheds. This is possibly due to a number of factors, including a significant amount of development in this watershed over the last decades causing land disturbance, a high amount of cropland, and the long, slender configuration of the bay allowing more sediment to remain in the waters less than 8’ deep.

- The standard deviation for the average was 0.88, meaning that there is 67% confidence that the dredging volumes will be at or below 2.48 CY/Ac/Yr, based on the available data.

Table 5-6 shows the estimate of future annual dredging requirements based on redredging the coves that have already been dredged. Where individual rates existed from Table 5-5 those rates were used. The average of the rates was used where a second pass has not been made on any particular cove.

Table 5-6

Annual Dredging Requirement

Cove	Drainage Area (Ac)	Rate (CY/Ac/Year [4])	Annual CY	Notes
Quantralls Cove	626	1.80	1,125	5
Waterfall Cove	894	0.89	800	
Union Cove	128	1.60	205	
Sunset Bay	1,572	0.60	941	2
Bandit Bay	180	1.60	289	
Buffalo Cove	392	1.91	750	
Siesta Cove	23	1.60	37	
Big Rock Bay	2,190	2.81	6,154	1
Mallard Bay	123	1.60	197	
Sunrise Bay	1,400	0.60	838	2, 3
Total Annual Dredging Estimate (Cubic Yards)	7,528		11,336	
Total Annual Dredging Estimate (One Std. Deviation)			18,694	
Notes:				
1. Using Big Rock 2nd pass total acreage and dredge rates.				
2. Assume dredging to existing limits in each bay.				
3. Used Sunrise dredging rate as drainage areas are similar in land use.				
4. Coves not dredged a second time used average of second pass.				
5. Quantrall's dredging requirement is overestimated due to Carriage Oaks silt basin construction				

- The annual dredging requirement was estimated to be 11,336 Cubic Yards.
- The annual dredging requirement was also estimated by using the higher rate with 67% confidence at 18,694 cubic yards.
- Over the life of the old 7012 dredge the estimated annual dredging rate was 21,545 CY/year. This included coves that were dredged for the first time. However, it appears that the LLA has adequate capacity to perform maintenance dredging with the new 7012 Versi-Dredge.

Maintenance Program Mechanical Excavation

The LLA plans to continue to excavate small coves, where access is available from land, by using a long stick track hoe. Additionally, plans are underway to purchase and use a mini-track hoe on a barge for small projects where access by land is not possible.

The watershed area that is dredged is 7,528 acres out of a total watershed area of 7,950 acres. This leaves potentially 422 acres that drain into the smaller coves on the lake. A conservative assumption for mechanical excavation assumes that all of these coves needs to be addressed. Using the average annual dredging rate of 1.60 CY/Acre/Yr for mechanical excavation results in an annual requirement to excavate about 676 CY of material per year. This amount is increased to 1,047 CY per year using the higher confidence level rate.

LAKE LOTAWANA WATERSHED
FIGURE 5-2: SILT HANDLING FACILITIES

Chapter 6

The purpose of this chapter is to perform a review of potential permitting issues associated with silt removal and prevention practices.

There are a number of agencies that potentially have jurisdiction over silt removal and prevention practices of the Lake Lotawana Association. These agencies include:

- The United States Army Corps of Engineers (USACE)
- The Federal Emergency Management Agency (FEMA)
- The Missouri Department of Natural Resources (MDNR)
- Jackson County
- The City of Lake Lotawana, Missouri

United States Army Corps of Engineers

History

The LLA has previously obtained USACE nationwide permits for work related to dredging and silt storage. The most recent permit on file with the Kansas City District is from 2001 and appears to be related to hydraulic dredging from 3 sites, including Mallard Bay, Gaslight Bay, and Sunrise Bay. The permit number is 20012023. The permit indicates that the disposal site is an upland basin on the southeast side of the lake, probably the Kenard silt basin. It is possible that work performed in the late 1980's and early 1990's by contractors was permitted through the USACE, however, the agency does not have electronic records prior to about 2001. Any permitting investigation prior to 2001 would require a manual request for file searches and is considered unnecessary at this time.

The USACE has a permit from 2006 that notes Emory Sapp and Sons performed some work but it doesn't appear that this permit is related to the LLA silt basin work.

The USACE has a permit from 2009 that permitted work to clean up and remove sediment from the Carriage Oaks pond. This work was authorized under Nationwide Permit 27, which provides for wetland, stream, and pond enhancement.

Brian Donahue, a veteran employee of the USACE, Kansas City District provided the following information related to potential USACE permitting requirements for activities that the LLA performs in association with silt removal, dewatering, and storage.

Hydraulic Dredging

Brian did note that dredging, in particular, is a subject with considerable nationwide discussion by the various elements of the USACE and the Environmental Protection Agency.

The nationwide permitting system is the vehicle by which EPA requirements are met, and the USACE is the agency tasked with execution of the permitting system. It is the position of the Kansas City District, for determining whether they have jurisdictional authority over the activity, that "clean excavation" from waters of the United States is not a regulated function. The USACE only regulates fills in waters of the United States. Therefore, hydraulic dredging, provided that it removes sediment directly from the lake to an upland basin, is not a regulated activity that requires a USACE permit.

Mechanical Excavation

Excavation by mechanical methods, either by dragline or long stick hoe, is a more complicated subject. This activity is considered non jurisdictional only if it is "clean excavation", and removes sediment directly from the lake. Removing buckets of sediment from the lake bottom for deposition directly on to shore, or in a container for transport to shore, appears to meet this definition. However, if sediment is redeposited in the lake during operations by dragging it underwater into a pile, or closer to the equipment, prior to actually removing it from the lake, then there is a possibility of jurisdiction by the USACE. Additionally, if the LLA constructs any type of temporary soil or sediment barriers across the headwaters or coves to limit the movement of silty water, then those activities would be considered fill in waters of the United States requiring a permit.

Silt Holding Basin Activities

The USACE has determined that returning the silt basin water to the lake is an activity that is jurisdictional and it authorized under a nationwide permit. This is due to the fact that the return water is draining into jurisdictional waters of the United States, and has been administratively defined as a "discharge of dredged material", which is regulated by the USACE. The LLA has previously obtained permits for this activity as indicated above, most recently in 2001 (by USACE records). The previous permit, and the permit generally used for this activity is Nationwide Permit 16 - Return Water from Upland Contained Disposal Areas. The USACE also requires that each applicant for a Nationwide Permit 16 shall contact the MDNR for a water quality for evaluation through the section 401 certification procedures, discussed below. A review of Missouri Nationwide Permit Regional Conditions does not reveal any additional conditions affecting NWP 16. It is important to note that, generally, the permit is

valid for a period of two years, so the LLA should track activities to ensure that they are either completed prior to permit expiration, or an extension is granted to allow completion of dewatering at any particular silt holding basin.

Silt Trap Construction

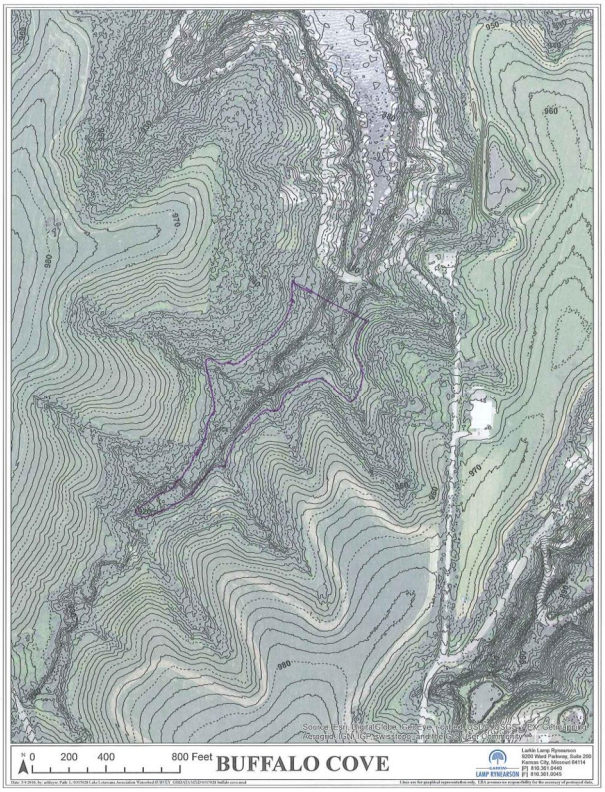
Previous reports have considered the construction of silt traps at various locations upstream of some of the larger watersheds draining in the lake. Changes in national environmental policy over the last decade have altered the manner in which those activities are regulated by EPA through the USACE. In addition to the costs of construction and permitting that were evaluated in the 1985 B & V report, and the 1996 Larkin report, mitigation for loss of wetlands and native stream length are issues. In most cases a mitigation fee must be paid to the USACE to compensate for the loss of stream length associated with construction of any type of silt trap.

The USACE would consider the stream length loss to be from the toe of the embankment to the maximum flooded area, generally being about the top of dam for conservative estimates. Essentially the USACE calculates the mitigation fee based on this stream length, and the type of stream, i.e. intermittent, ephemeral, or perennial. The larger the stream is, the higher the mitigation fees are. The fees are calculated in terms of “stream credits”, which are in currently in the general range of $30k to $40k per stream credit that the applicant must compensate for to obtain a permit for the activity.

The USACE, Kansas City District, was contacted with an example silt trap for evaluation to determine the likely compensatory mitigation cost. The example basin is located upstream of Buffalo Cove as shown in Figure 6-1.

Figure 6-1

Buffalo Cove Silt Trap Example



The Buffalo Cove example is a basin with surface area in the order of 6 to 9 acres. The stream distance from toe of dam to upper end is about 1,400 to 1,600 feet. The USACE calculated the total stream debit resulting from the silt trap construction using the 2013 Missouri Stream Mitigation Method Adverse Impacts Worksheet, with a total of 4,112 stream debits, as shown on Table 6-1. The USACE also noted that the purpose and need for the work and alternatives would require quite a rigorous analysis through the Section 404 permit process before mitigation would be considered by the USACE.

Table 6-1

Buffalo Cove Adverse Impacts Worksheet

2013 MISSOURI STREAM MITIGATION METHOD									
ADVERSE IMPACTS WORKSHEET									
Stream Type Impacted	Ephemeral			Intermittent			Perennial		
	0.3			0.4			0.8		
Priority Waters	Tertiary			Secondary			Primary		
	0.1			0.4			0.8		
Existing Condition	Functionally Impaired			Moderately Functional			Fully Functional		
	0.1			0.8			1.6		
Impact Duration	Temporary			Permanent					
	0.05			0.3					
Impact Activity	Clearing	Utility Crossing/Bridge Footing	Below Grade Culvert	Armor	Detention Facility	Morpho - logic Change	Impound - ment	Pipe	Fill
	0.05	0.15	0.3	0.5	0.75	1.5	2	2.2	2.5
Linear Impact Calculation	0.0002 Multiplied by linear feet of stream impact recorded in in each column below								

Factor							
Stream Type Impacted	0.3						
Priority Waters	0.1						
Existing Condition	0.8						
Impact Duration	0.3						
Impact Activity	0.75						
Linear Impact Calculation	0.32						
Sum of Factors (M)	2.57	0.00	0.00				
Linear Feet of Stream Impact (LF)	1600						
Credits (C) = M X LF	4112.00	0.00	0.00	0.00	0.00	0.00	0.00
*Compensation Ratio X (C)							
	Total Credits Required from all Columns =						4112.00
	If Compensation Ratio is used, total credit required =						0

At an estimated credit cost of $40/credit the mitigation fee would be $164,480. This amount was included in a total construction cost estimate for the silt trap as shown in Table 6-2.

Table 6-2

Buffalo Cove Silt Trap Cost

Engineer's Opinion of Probable Construction Costs					
Buffalo Cove Silt Basin					
Lake Lotawana Association					
September 6, 2016					
No.	**Item**	**Unit**	**Quantity**	**Unit Cost**	**Cost**
1	Mobilization	L.S.	1	$2,000.00	$2,000.00
2	Clearing and Grubbing	L.S.	1	$5,000.00	$5,000.00
3	Earthwork Excavation	C.Y.	2200	$4.00	$8,800.00
4	Compaction (Type AA MR 3-3)	C.Y.	6500	$1.50	$9,750.00
5	Contractor Furnished Embankment	C.Y.	4300	$15.00	$64,500.00
6	Outlet Structure	EA	1	$40,000.00	$40,000.00
7	Rip Rap (24")	S.Y.	200	$50.00	$10,000.00
8	Seeding	Ac	2	$3,500.00	$7,000.00
9	Erosion Control	L.S.	1	$4,000.00	$4,000.00
10	Construction Staking	L.S.	1	$2,000.00	$2,000.00
				Subtotal	$153,050.00
				Contingency (10%)	$15,305.00
				Total Construction Cost	$168,355.00
	Engineering, Inspection, and Administration (20%)				$33,671.00
	Land Acquisition	Ac	20	$10,000.00	$200,000.00
	Environmental Remediation	L.S.			$164,480.00
	Total Project Cost				$566,506.00

After construction, the silt traps have challenges with regard to maintenance. Silt must be removed by mechanical methods, which have already been shown to be more expensive on a unit price basis. Based on the anticipated cost of all elements involved in this example, it does not appear to be economically viable to construct silt traps as a standard measure of controlling siltation in the lake.

Federal Emergency Management Agency

FEMA regulates activities within the designated 100 year floodplain. The lake area is currently located on four FEMA map panels for the flood study effective on September 29, 2006 (Attachment ZZ). The panel numbers are 29095C0309F, 29095C0317F, 29095C0328F, and 29095C0336F. None of the drainage areas entering the lake are shown to be in the FEMA regulated floodplain. Only the immediate lake is mapped in the 100 year Zone AE floodplain. A water surface elevation of 886 is listed as the 100 year

flood level, no floodways are delineated, and it appears that all ground elevations below 886 are in Zone AE. Any activities that would change the limits of, or raise the level of the designated 100 year Zone AE would be potentially regulated by FEMA. However, none of the current dredging activities appear to have any impact on the 100 year flood elevation since they mostly occur below the normal pool elevation of about 883, and certainly occur below the listed flood elevation of 886. The silt basin activities are all upland, well above the FEMA floodplain. No FEMA regulations related to silt removal and storage are anticipated at this time.

The City of Lake Lotawana will adopt new Flood Insurance Rate Maps (FIRMS) per 60.3(d) Floodplain Management Ordinance and they will be effective on January 20, 2017. The new maps do not show an increase for the base flood elevation within Lake Lotawana; however, boundary changes have occurred within the City limits. The new FIRM Panel Numbers: 29095C0461G, 29095C0442G, 29095C0453G, 29095C0434G. The pending maps should be reviewed to determine any significant changes that may affect the lake.

Missouri Department of Natural Resources

The MDNR regulates water quality in the State of Missouri and returning silt basin water to the lake is regulated by MDNR, as authorized by the USACE Nationwide Permit 16 conditions:

Excerpt from: 2012 Nationwide Permits, Conditions, District Engineer's Decision, Further Information, and Definitions (with corrections)

16. Return Water From Upland Contained Disposal Areas. Return water from an upland contained dredged material disposal area. The return water from a contained disposal area is administratively defined as a discharge of dredged material by 33 CFR 323.2(d), even though the disposal itself occurs in an area that has no waters of the United States and does not require a section 404 permit. This NWP satisfies the technical requirement for a section 404 permit for the return water where the quality of the return water is controlled by the state through the section 401 certification procedures. The dredging activity may require a section 404 permit (33 CFR 323.2(d)), and will require a section 10 permit if located in navigable waters of the United States. (Section 404)

The LLA has a current Missouri State Operating Permit for this purpose, Permit No. NOG690001, issued on July 9, 2013, and effective until March 13, 2018.

The permit lists 5 outfalls, by the coordinates on the permit they are outfalls from the following silt holding basins:

Outfall	Silt Holding Basin
1	Basin-6 (Kenard)
2	Basin-1/Basin-5 (Keller Addition)
3	Basin-2
4	Basin-3
5	Basin-4

From the information on the permit it appears that all of the silt holding basin outfalls that exist, whether they are being actively used or not (Basin-4 and the original Basin-1 are inactive) have valid water quality permits from MDNR.

Silt Holding Pond Construction and Modification – Silt holding pond construction or modification will require a Land Disturbance Permit from the MDNR if the total disturbance area is one acre or greater. From observation it appears that all of the current silt holding ponds are well over one acre in size, and it is likely that expansions of any of the ponds will require a Land Disturbance Permit from MDNR. Current information and permit forms are available on the MDNR website under the Department of Environmental Quality, Water Protection, Stormwater tab. The Department uses an ePermitting system to accelerate review and approval. The LLA should note that a Stormwater Pollution Prevention Plan (SWPPP) must be prepared and executed in accordance with the requirements and guidelines specified within the general permit for stormwater discharges from land disturbance activities. Some of the types of best management practices that should be included in a SWPPP plan, and employed on site are perimeter controls outside the grading limits, stabilized construction entrances, and provisions for final stabilization of exterior slopes and graded areas within specified time frames from the beginning of the land disturbance. Additionally, there are periodic inspection and record keeping requirements associated with a SWPPP.

Jackson County/City of Lake Lotawana

Jackson County does not regulate activities inside the City Limits of the City of Lake Lotawana. The City of Lake Lotawana has permit requirements specific to land disturbance not associated with construction of a structure or subdivision, provided that the disturbance area is not located within the FEMA floodplain. Section 500.130 of the Municipal Code City of Lake Lotawana specifies as shown:

Section 500.130 – Excavations

Excavations of every nature where heavy equipment or trucks are required or used in connection therewith shall require a building permit. Temporary culverts shall be removed and all mud resulting from the excavation work shall be removed daily from the roads. The excavator and the owner shall be held jointly and severally liable for any and all damages to adjoining property resulting from their operations. All excavations shall comply with the provisions of Section 440.011 of this Code. (Ord. No. 390 §§I,V, 12-20-83; Ord. No. 697 §1, 10-21-03)

There is a permit fee of $50.00 associated with an Excavation Permit.

Chapter 7

This chapter summarizes the historical background of the dam registration with the Missouri Department of Natural Resources Dam Safety Division and provides the current status of the dam classification as it relates to habitable structures in the downstream environment; those structures subject to inundation based on the predictions of a dam break simulation.

Overview of Regulatory Environment

Lake Lotawana and its dam structure is subject to Missouri statutes and rules established by the Dam and Reservoir Safety Council. The dam is further subject to periodic inspection by the Missouri Department of Natural Resources (MDNR) Dam Safety Division and operates under permit issued by this department. Lake Lotawana is regulated, in part, because the dam is more than 35 feet in height.

The part of these rules most relevant to this chapter is the requirements placed on dam structures depending on their downstream environmental classification. Downstream environment classification is based on the number of permanent dwellings (or public buildings or campgrounds) that are located in the inundation zone. The inundation zone is that area subject to a flooding depth of 2 feet in the event of a dam breach. The downstream environment is considered Class 1 if 10 or more permanent dwellings are found in the inundation zone whereas a Class 2 downstream environment is nine or less structures. Dam requirements are more stringent for a Class 1 downstream environment compared to a Class 2. Both the required freeboard and the spillway flow capacity of a Class 1 dam is significantly greater than a Class 2 dam.

One of the regulatory requirements for the dam is that an Emergency Action Plan be developed according to guidelines provided by MDNR. The EAP for Lake Lotawana was completed in 2008 as shown in Appendix 7. Some items in the EAP should be reviewed and updated with current information.

Historical Background

The following section is summarized from several documents included in Appendix 7 and listed in the bibliography at the end of this Chapter.

In 1988—shortly after LLA acquired ownership of the Dam and other common areas, i.e. the lake, roadways, parkways, etc…—the MDNR Dam Safety Division inspected the dam and found it to be inadequate per the regulations. The structure was also determined to be a Class 1 dam based on the count of habitable structures in the downstream inundation zone. After evaluating alternatives to

improve the dam to Class 1 standards, LLA decided to conduct the necessary analysis to prove Class 2 status and thereby reduce the scope, scale, and cost of improvements needed to bring the dam in compliance with the State regulations. The results of the original dam breach simulation and flood routing (to define an inundation zone) identified eight houses—less than the maximum allowable 10 structures—in the inundation zone and, therefore, the structure could be reclassified as a Class 2 dam. The state approved reclassification based on the Dam Breach Analysis and Inundation Study, and proposed dam improvement plans.

The significant reconstruction of the dam was completed in 1993. The work consisted of reconstructing the principal/emergency spillway to increase its flow capacity, raising the dam to provide the regulated freeboard, and flattening the slope on the landside face of the dam, resulting in a larger dam footprint.

After restoration was completed, a new breach analysis and flood routing was performed in 1994 reflecting the changes in dam geometry. The findings of revised analysis showed nine structures in the inundation zone, allowing LLA to maintain the Class 2 designation.

After 1994, an overlay district was adopted in the Jackson County Unified Development Code with the expressed purpose of regulating the construction of habitable structures within the Lake Lotawana inundation zone. The overlay district is described in Section 24004.17, as shown in Appendix 7, along with the inundation map. Jackson County also provided the study authors with Geographical Information System shapefiles of the inundation map for use in this study.

The status of the downstream environment was re-evaluated in 2009 by Larkin Group. The Dam break simulation from 1994 was compared to 2009 survey data of existing structures. Subsequent to the last evaluation, three of the original nine houses reported in 1994 had been removed and three new homes had been constructed within the inundation zone. In March of 2010, MDNR conducted their own survey of structures and determined 13 houses located in the inundation zone.

On October 13, 2011, LLA was issued a notice of violation because the dam was found to be non-compliant with Class 1 standards. By March 2012, LLA had acquired and removed several of the properties within the inundation zone in order to re-establish their Class 2 status. In August 2012, MDNR inspected and acknowledged that eight houses were located in the Inundation Zone, qualifying for Class 2 status.

MDNR again inspected the dam and the downstream environment in August of 2014. They verified the presence of eight homes in the inundation zone. Lake Lotawana Dam is currently permitted by MDNR as

a structure with a Class 2 downstream environment. The current permit is scheduled for renewal in August 2017.

Current Status of Downstream Environment

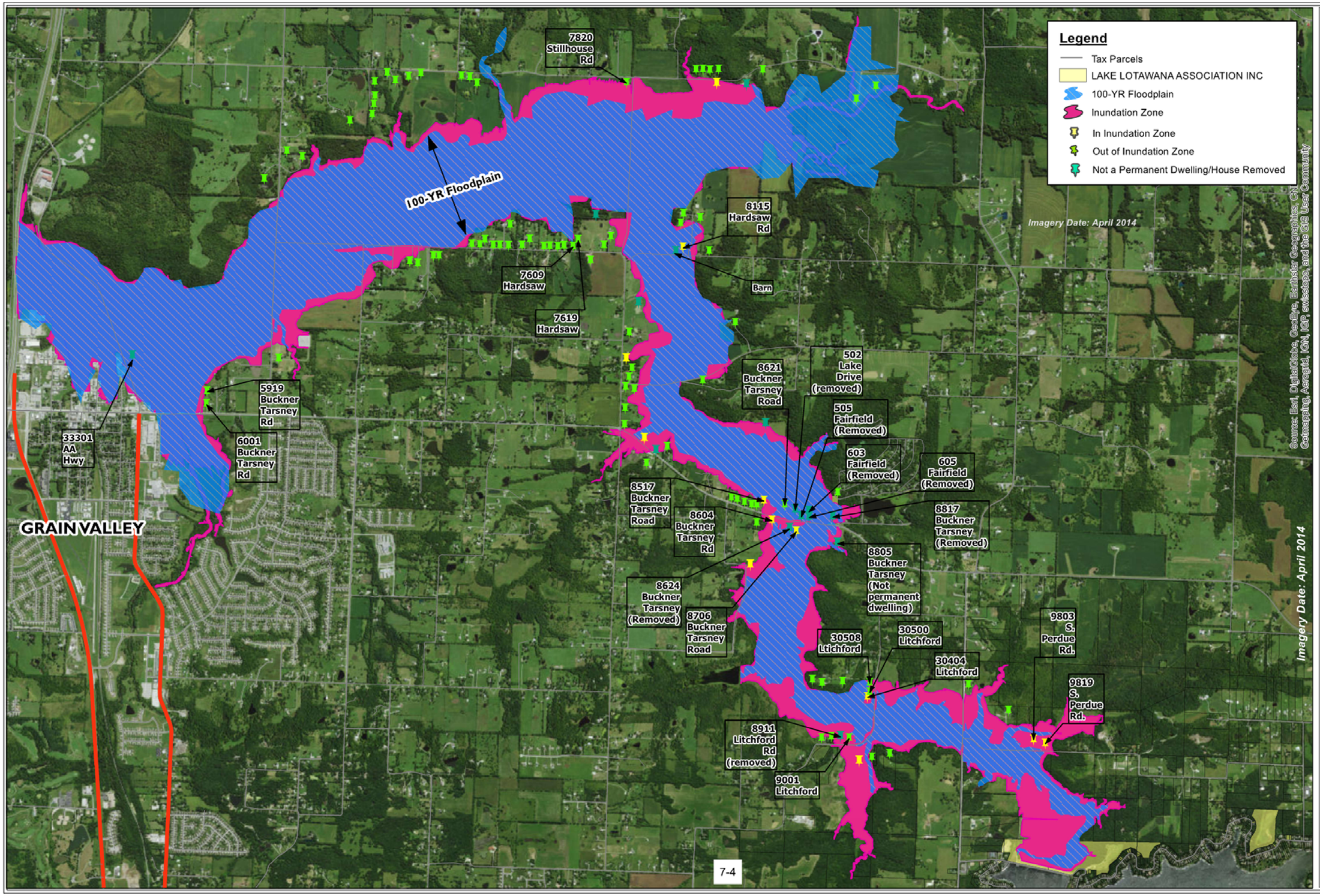
The current status presented here is based on:

- Field topographic survey data of lowest adjacent grades, previously collected by Larkin and MDNR.
- Water surface elevations from the 1994 Breach analysis done by Larkin.
- Inundation limits mapped in 2009 by Larkin.
- Aerial photography taken March 30, 2015 (as provided on Google Earth).
- Observations from windshield survey conducted with Dave Wagner, September 2015
- Ground surface elevations available from Google Earth.

In accordance with MDNR definition, a permanent dwelling is considered in the inundation zone if the adjacent grade or low opening is 2 feet or more below the predicted water surface elevation (from the dam breach simulation).

There are seven permanent dwellings located in the inundation zone:

- 9819 South Perdue Road
- 9803 South Perdue Road
- 8706 Buckner Tarsney Road
- 30404 Litchford Road
- 8604 Buckner Tarsney Road
- 8517 Buckner Tarsney Road
- 8115 Hardsaw Road



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LAKE LOTAWANA WATERSHED
FIGURE 7-1: STRUCTURES IN THE INUNDATION ZONE