SECTION V – RECREATIONAL AND ENVIRONMENTAL RESOURCES OF THE PROJECT

5.01 GEOLOGIC

a. Geologic Setting. The predominant geologic structure controlling the local dip of rock strata at the project is the Lincoln Fold, a complex plunging asymmetrical anticline located in northeast Missouri. The axis of this structure trends structure results in the slight (1 to 3 degrees) northwesterly dip present in the rock strata of the project area. The project area is located in the Dissected Till Plains Section of the Central Lowlands Physiographic Province. The geologic formations occurring at the surface within the project area include Paleozoic sedimentary rocks (primarily limestones and shales) Pleistocene glacial drift, and recent alluvium. The area is characterized by low to moderate relief in the uplands with locally high relief (up to 200 feet) occurring in the bluffs along the Salt River and its tributaries. Some karst features are present in the project area, most notably, solution cavities in the limestone bluffs.

b. Geologic Formations. The stratigraphy in the area consists essentially of nearly flat-lying sedimentary strata of Mississippian and Pennsylvanian formations on the uplands. These in turn, are overlain by Pleistocene deposits of glacial till, residuum, or on the floodplains, by recent alluvium.

(1) Hannibal Formation. The oldest exposed unit is the Hannibal Formation of Early Mississippian (Kinderhookian) age. It is a bluish-green, moderately hard, sublimated shale and siltstone. The shale contains some pyritized fossils, irregular tubular markings (probably worm borings) and “Rooster Tail” markings (Taonurus causagalli) that are common throughout the formation. The Hannibal outcrops in the eastern portion of the project area, from approximately elevation 535 to 590 feet NGVD. The Hannibal Formation is overlain by the Chouteau Formation.

(2) Chouteau Formation. The Chouteau is a gray to “mouse-gray”, Lower Mississippian (Kinderhookian) limestone. On weathered outcrops, it generally has a light to dark brown color and earthy texture. It is generally an argillaceaus dolomitic thin-bedded limestone, but occurs as a medium to coarsely crystalline, competent limestone in portions of the project area. It is a cliff-forming unit with a well developed joint and fracture system. The Chouteau contains some calsite, pyrite, marcasite, and sphalerite-lined vugs. The Chouteau outcrops in the eastern portion of the project area, from approximately elevation 590 to 620 feet NGVD. The Chouteau is overlain by the Burlington Formation.

(3) Burlington-Keokuk Formations. The Burlington and Keokuk formations are similar lithologically and are assumed to contact conformably. The contact between the Burlington and the overlying Keokuk is not characterized by any significant change in the physical properties of the rock, and they are therefore treated here as one unit. The Burlington-Keokuk Formation is a light gray, coarse to fine crystalline, middle-Mississippian (Osagean) limestone. The upper section of the unit is a cherty limestone with chert occurring in nodular form throughout. Geodes are common locally in the upper portions of the formation, and are sometimes found in the weathered residuum of the formation. Bedding planes in the upper unit are generally separated by paper-thin shale partings. The lower unit consists of approximately 20 feet of massive bedded very coarsely crystalline limestone that is practically chert free. The Burlington is extremely fossiliferous, containing an abundance of crinoids. The unit is the primary cliff-former in the project area. The thickness of the Burlington-Keokuk Formation varies depending upon the extent of surface weathering. The unit occurs from approximately elevation 590 to 710 feet NGVD, having an irregularly weathered upper contact with Pennsylvanian deposits and residuum.

(4) Warsaw Formation. The Warsaw Formation is a shaley argillaceous, Middle Mississippian limestone, occurring in limited exposures overlying the Burlington Limestone in several creek valleys in the extreme western portions of the project area. It occurs between elevations 650 and 680 feet NGVD, and unconformable contacts with overlying Pennsylvanian age strata. Chert nodules and some geodes are common in the unit.

(5) Pennsylvanian Age Strata. Several formations of Pennsylvanian age occur, primarily in the western portions of the project area. These strata have been deposited unconformable upon the eroded surface of the Burlington-Keokuk and Warsaw Formations. Their thickness, lithology and areal extent vary greatly. The mapping of these units has not been detailed, as their impact upon the reservoir is negligible, because they occur above the maximum pool elevation. The most persistent and well defined of these units is the Cheltenham, which contains shales, clays, and a basal conglomerate. The clays of the Cheltenham locally contain economic grade fire clay, which has been mined in the past near the towns of Stoutsville and Goss. Also occurring in the western portions of the project area is the cyclothem of the Cabannis Subgroup, which includes the Tebo, Weir, and Scammon Formations. Some minor amounts of low-sulfur coal have been mined from the Cabannis Subgroup near Perry, but no significant reserves are presumed present within the project area.

(6) Pleistocene and Recent Deposits. Overlying the irregularly weathered bedrock surfaces are unconsolidated materials of Pleistocene and Recent age. These include pre-Illinoian glacial till and subsequent loessal deposits, residuum from the weathered sedimentary formations, and recent alluvium in the floodplains. The unconsolidated materials present in the uplands consist of

weathered residuum from the late Mississippian and Pennsylvanian formations, glacial till, and loess. The residuum is characteristically clayey with chert remnants throughout. The glacial till occurs as a more granular soil, and it, as well as the overlying loess deposits, is not as thick in the uplands as in the lowlands and valleys. The flood plain deposits consist of Pleistocene glacial outwash in the deeper pre-glacial river valleys, overlain by finer recent alluvium. The glacial outwash is primarily gravely sand, whereas the recent alluvium consists mostly of silts and clays.

c. Summary of Geology, The nature of significant economic mineral deposits within the project area makes any protective measures beyond slope or erosion protection unnecessary. Sufficient reserves of fire clay, coal, and other geologic resources are present outside the project area to preclude the exploitation of any deposits within Government property lines. Geologic items of a collectible nature such as the geodes present in the Keokuk Limestone and its weathered residuum, and the rather unique pyritized fossils of the Hannibal Shale may be deemed significant enough to consider them a resource that warrants management.

5.02 ARCHAEOLOGICAL/HISTORICAL

a. The St. Louis District Historic Properties Management Report No. 47, Historic Properties Data Synthesis, Mark Twain Lake, Missouri, September 1995 provides site information to project personnel on the subject of identified archaeological sites, material and remains. The Historic Properties Management Report documents archaeological investigations in the Mark Twain Lake region, prior to impoundment. The pre-impoundment archaeological research in the project region is divided into four phases:

1. 1959-64, the University of Missouri surveyed and excavated archaeological sites under a cooperative agreement with the National Park Service.
2. 1967-68, University of Missouri, under contract with the National Park Service, excavated nine archaeological sites.
3. 1974-May 1977, University of Nebraska, under contract with the U.S. Army Corps of Engineers, St. Louis District, conducted further survey and testing.
4. May 1977 - August 1980, the Cannon Reservoir Human Ecology Project (CRHEP) was executed.

The combined archaeological research efforts performed in the Mark Twain Lake Project area identified over 1500 prehistoric sites and 300 historic sites ranging in age from 12,500 to 100+ years old.

b. In addition to the subsurface remains, a total of 225 historic buildings were evaluated prior to impoundment. Of these, a total of 25, were recorded to standards established by the Historic American Building Survey (H.A.B.S.)

standards. Prior to impoundment, and following completion of the H.A.B.S. documentation, all historic structures were raised and removed from the project area.

c. It is the policy of the St. Louis District to manage historic properties at the same level as other programs (i.e. recreation, wildlife, flood control, etc.). The St. Louis District Historic Properties Management Plan, Mark Twain Lake, September 1994 serves as a reference to assist lake personnel in managing identified cultural resources and meeting federal regulations concerning cultural resource management.

5.03 ECOLOGICAL CONDITIONS

a. Wildlife Resources. The wildlife species known or expected to occur on the Mark Twain Lake area are those common to the region in general. The land and its plant association support an upland game population, predators and a variety of non-game mammals and birds. Although the project is located in the Mississippi Flyway, the major flights of waterfowl normally pass down the Mississippi to the east and the Grand River to the west. There are; however, sufficient numbers of waterfowl using the lake to have a huntable population. Some "threatened" or "rare and endangered" species do occur in the area; these are discussed in Section 6.13.

Wildlife population limiting factors at Mark Twain Lake appear to be minimal. The project lands surrounding the lake encompass some of the best upland habitat in northeastern Missouri. The ratio of open land to forest cover creates the desirable edge effect. Food and cover are both abundant and well-interspersed. Woodlots, lake shore, timber and brushy field borders furnish all the requirements necessary to support viable wildlife populations. The presence of the lake benefits some species. For example, flooded timber in the tributary streams furnishes nesting and brood rearing sites for wood ducks. Many more shorebirds and waterfowl utilize this area than ever before.

The Corps has designated and manages 14,536 acres of land exclusively for fish and wildlife purposes at Clarence Cannon Dam and Mark Twain Lake, Missouri. In 1978, the MDC notified the St. Louis District that they could not accept a license at the project for fish and wildlife management. Accordingly, the St. Louis District has accepted the responsibility to implement and manage the program with its personnel and resources. Land management procedures on public lands benefit many of the species present and attract other species to the area. Such procedures are beneficial to songbirds, game birds, and mammals. Trees and shrubs have been and will continue to be planted to provide nesting cover and food for all wildlife species. Wildlife food plots varying in shape, size and species composition are planted in areas to increase available foods for wildlife. Succession control in the form of mowing, disking, and prescribed fire eliminates woody plants while providing diversity among herbaceous plants, in contrast to adjacent untreated areas. Nest boxes

provide additional nesting spaces for wood ducks, purple martins, house wrens, tree swallows, bluebirds, and squirrels. Together, the private farms and the public wildlife areas provide a proper balance of food and cover for wildlife over much of the project. Nine wetland sub-impoundments have also been developed to provide for waterfowl management. These areas are managed by periodically manipulating water levels to provide resting and feeding areas for migratory waterfowl. Areas that are in the agricultural lease program provide additional food and cover for waterfowl and other wildlife species. Civic and private organizations in partnership with the Corps of Engineers assist in the development of structures beneficial to all wildlife on public lands.

b. Aquatic Resources. The impoundment of Mark Twain Lake has caused a decrease in fast-water adapted fish species, and an increase in slow-water adapted fish species. Species found in the lake pool include the following: black bass, white bass, black crappie, white crappie, bluegill, green sunfish, and several species of minnows including common carp, several species of suckers, gars, freshwater drum, and gizzard shad. The tailwater downstream of the re-regulation dam yields sizable concentrations of crappie, white bass, channel catfish, flathead catfish and walleye.

The Mark Twain Lake Project Office coordinates with the MDC on the management of the fisheries resource at the project area. Water regulation aspects at the project having a potential effect on fish include (1) water level fluctuations governed by annual precipitation patterns and power generation demands (2) a weir at the front of the dam that keeps the water released through the turbines close to the natural river temperatures, (3) tainter gates used during high water periods and a concrete apron with force diffusers, and (4) a re-regulation dam that impounds a 9.5 mile pool downstream from the main dam to provide storage for pump-back power generation and dampen fluctuations downstream. The re-regulation pool normally can fluctuate up to eight feet.

To support fisheries habitat, standing timber was left in coves, along some shorelines, and portions of the main lake basin. The lake's fish population is periodically sampled and evaluated by MDC, with age and growth rates of key species determined annually. Periodic checks of reproductive success are made with a comprehensive sample being taken in the fall. In the future, if large numbers of commercial fish species reach a marketable size, a limited commercial fishing program may be considered. However, such a program would utilize that portion of the fisheries not highly desirable or susceptible to sport fishing. Predator species not showing adequate survival or contribution to the creel will not be considered for future supplemental stockings. Sportfish species may be stocked periodically if natural reproduction is insufficient to maintain fishable populations and if such stockings are supported by scientific evaluation and research. As the lake ages, it is expected that the lake's predators will establish an equilibrium between

themselves and the prey species. The more prolific predators will expand to their reproductive potential and become the dominant species. Other predators that are limited by lower reproductive potential or food availability will have a lower standing crop. The white bass can be expected to expand slowly at first, but will probably become a close competitor with the black bass and crappie as a co-dominant species in later years. The catfish species that are stocked will be native species that can be expected to sustain their populations as the lake ages.

The Corps of Engineers developed and operates a brood pond in the Sandy Creek Area of Mark Twain Lake. It is a 3.5 acre nursery pond, supported by two minnow ponds. The purpose of the pond is to raise game fish, such as largemouth bass, to a size where they are less vulnerable to predation. The water level within the brood pond is controlled by a spin-gate structure, which when opened, allows water to pass through the impoundment structure and into a catch basin.

c. Vegetative Resources. Prior to construction of the lake, about half of the present fee-owned project land was forested. The majority of this land was located above the lake pool elevation. The white oak-black oak-northern red oak (Forest Cover Type No. 52) is the most common association on upland sites. The white oak association (Forest Cover Type No. 53) also occurs frequently. Shagbark hickory comprises a substantial stocking on most upland sites. Dominant trees include white oak, northern red oak, and black oak. Hickory spp. and Ash spp. usually occupy the co-dominant or intermediate class. Sugar maple, elm, black cherry, red bud, flowering dogwood, and serviceberry are the predominant understory species. Understory shrub species include fragrant sumac, corralberry, greenbriar, and various forms of shade tolerant grasses.

Successional or invasional species that occur in the openlands include eastern red cedar, elm, sassafras, shingle oak, autumn olive, and honey locust. Herbaceous or woody shrub invasional species include blackberry, multi-flora rose, and sumac.

Flood plain forests of the Salt River basin are predominately silver maple and American elm (Forest Cover Type No. 62); however, local variations do occur in the area with such species as eastern cottonwood, sycamore, river birch, pin oak, green ash, persimmon, hackberry and black willow being common.

Although about half of the fee lands are forested, there is a significant portion in grassland or openlands. Openlands are comprised of cool season/forb grasslands, warm season native prairies, agricultural lands, and early to mid-successional fields. Openlands are managed through various means to provide diverse wildlife habitat. Mechanical manipulations (mowing,

successional disking, and supplemental food resource development), agricultural lease, and prescribed burning are employed to manage and maintain open lands. Even with these practices, portions of open land have reverted to natural succession with the invasion of such species as hawthorn, blackberry, elm, oaks and sassafras.

d. Insect and Vector Problems. For the most part, insects and other vectors are kept in ecological balance. At certain times of the year, mosquito problems arise when the area receives a combination of wet, warm weather. In Missouri, diseases such as St. Louis and eastern equine encephalitis are a potential threat each year, but the much-publicized West Nile encephalitis has overshadowed them recently. West Nile virus was first discovered in the United States in New York City in 1999 and spread to other states in the Northeast and along the Atlantic seaboard during 2000. West Nile virus invaded the Midwest in 2001, and by the fall of that year had been identified in eight crows in eastern Missouri.

The life cycle of these mosquito-borne viruses is complex. Reservoirs include wild and domestic birds, small rodents and other mammals, and perhaps even reptiles and amphibians. Vectors for these viruses include mosquitoes that feed on both birds and mammals. Horses and humans are accidentally infected when the level of virus activity in normal hosts becomes so great that it begins to "spill over" into other species.

Ticks can potentially transmit Rocky Mountain spotted fever, tularemia and lyme disease. In the past, none of these diseases have been a major health problem in the area. Other pests found in the Salt River Basin are chiggers, horseflies, leeches, and yellow jackets. Occasionally, rats present a minor problem in recreation areas where litter or food is overly abundant. Periodic checks of levees and dams on the project are conducted to survey for damage caused by ground hogs and other burrowing rodents that can weaken these structures. Pigeons roosting on the dam can create a health hazard and maintenance problems on the metal portions. There are no known significant adverse effects of any pest control programs now being carried out. Pest control programs are closely coordinated with appropriate-agencies to insure that the environmental effects are adequately considered. Pest control programs are discussed in detail in the OPERATIONAL MANAGEMENT PLAN.

5.04 ENVIRONMENTAL AND SCENIC QUALITIES

a. Geologic Qualities, The site of the Clarence Cannon Dam is on the Salt River in northeastern Missouri, 63 river miles west of the Mississippi River. Mark Twain Lake is principally located in Ralls and Monroe Counties, and at normal pool extends 34 miles upstream on the North Fork of the Salt River, which is the main stem. The highest altitudes in the project area are on the flat upland divides, which reach a maximum altitude of about 780 feet. The local relief is

about 100 feet along the major tributaries and increases to about 200 feet along the main stem. The sides of the major valleys are dissected by short tributaries whose gradients extend from the flat upland to the valley bottoms; and the divides between these tributaries form a continuous belt of hills along either side of the major valleys. The Salt River and its major tributaries flow through meandering valleys bordered by steep rocky walls. Nearly all the valley meanders occur where the valleys are incised into limestone strata of the Mississippian age, or, near the Clarence Cannon Dam, into limestone above and below shale. An unusual feature of the valley bottoms along the Salt River is their great variability in width that is now reflected in the variable width of Mark Twain Lake.

b. Vegetative Qualities. The vegetative types are discussed in paragraph 5-03c. These different vegetative types combine to form moderate scenic qualities.

c. Land-Uses. Land management on project lands is, for the most part, complementary to scenic qualities. The majority of the adjacent lands are forested, but there is also a significant portion in open land.

d. Water Quality. The current water quality monitoring program is conducted every six weeks between the months of March and October. There are a total of ten samples collected, four lake sites, four tributary sites, one just below the dam and one below the re-regulation dam. These samples are taken to provide information on the following water quality parameters: alkalinity, total organic carbon (TOC), metals, ammonia-nitrogen, nitrate-nitrogen, ortho-phosphate, total phosphate, total suspended solids (TSS), total volatile suspended solids (TVSS), fecal coliform, pH, dissolved oxygen, specific conductance, oxidation-reduction potential (ORP), chlorophyll, pheophytin-a, sulfur bacteria, atrazine and alachlor. Data evaluated for the period from 1984 through 2000 indicate an improving to stable trend of water quality within Mark Twain Lake. Of the seventeen parameters measured, six indicate improved water quality, four are stable and seven suggest a possible degrading trend. The parameters that indicated improvement or remained stable are alkalinity, ammonia, nitrate, total suspended solids, volatile suspended solids, alachlor, and orthophosphate, phosphate, chlorophyll and atrazine. The parameters that suggest a degradation of water quality are: total organic carbon (TOC), iron, manganese, silica, pheophytin, dissolved oxygen and pH. The degrading water quality parameters of iron, manganese, TOC and silica are minor and may have been impacted by the 1993 and 1995 flood events. Pheophytin is increasing with the age of the lake, but is not at levels that would be considered excessive for good water quality. Data of the above degrading parameters over the past 3 years indicate a return to a more stable condition. Dissolved oxygen and pH both have decreasing trends in the lake system. The trends are minor, but should not be disregarded. Wastewater from industry or the general population could be impacting the oxygen demand and pH of the lake. The current trends do not

pose an immediate threat to water quality, but should be monitored to determine if conditions continue to degrade.

In previous years this lake was considered impaired based on the criteria that it exceeded Missouri Water Quality Standards for atrazine. In the past few years atrazine levels have decreased and the lake is scheduled for removal from the state's 2002 303(d) list.

Water quality reports are written and submitted to each Corps lake on a five-year cycle. An annual division water quality management report is also submitted.

The Missouri Department of Natural Resources has established water quality standards for designated uses to adhere to the Missouri Clean Water Law and the federal Clean Water Act. The water quality sampling conducted reflects the minimal parameters needed to indicate if the water quality can sustain adequate plant and animal life and to ensure safety for human recreation.

e. Visual Qualities. The combination of features listed in the above paragraphs form the overall visual qualities of the lake area. For Mark Twain Lake, the overall esthetic qualities are moderate. The primary reasons for this are the moderate relief topography, exposed rock, the interspersion of forest and open land constituting the majority of adjacent land, and moderately turbid waters.

5.05 RECREATION

a. Recreation Development Description. Several areas have been developed at Mark Twain Lake for the visiting public to enjoy a variety of outdoor recreational experiences. The most common activities engaged in are fishing, boating, water-skiing, sailing, camping, picnicking, swimming and hunting. Developed facilities available at the lake include a visitor center, four campgrounds, three group camping areas, five picnic areas, twenty-one boat launching areas, five nature trails, two marinas, and three beaches. Hunting and fishing opportunities are available on all Corps of Engineers lands and waters except where restricted and posted due to recreational development or safety. (Section VIII presents a complete description of all recreational facilities.)

b. Effects of Recreation on the Environment. The development of recreational facilities and associated accesses has provided visitors with quality outdoors recreational opportunities with minimal effect on the environment. Campgrounds, picnic areas, boat ramps, etc. have been designed and developed in order to retain the outstanding esthetic quality on the lake and surrounding area. Waste collection and treatment is stringently regulated in

compliance with state and local regulations. Recreation management including regulating visitor use has kept site deterioration to a minimum. Vegetative and landscape management practices have controlled erosion and prevented potential environmental degradation. Developed roads and hunter fisherman parking areas have controlled off-road vehicle use while providing visitors with access to trails and underdeveloped wooded areas with minimal environmental impact.