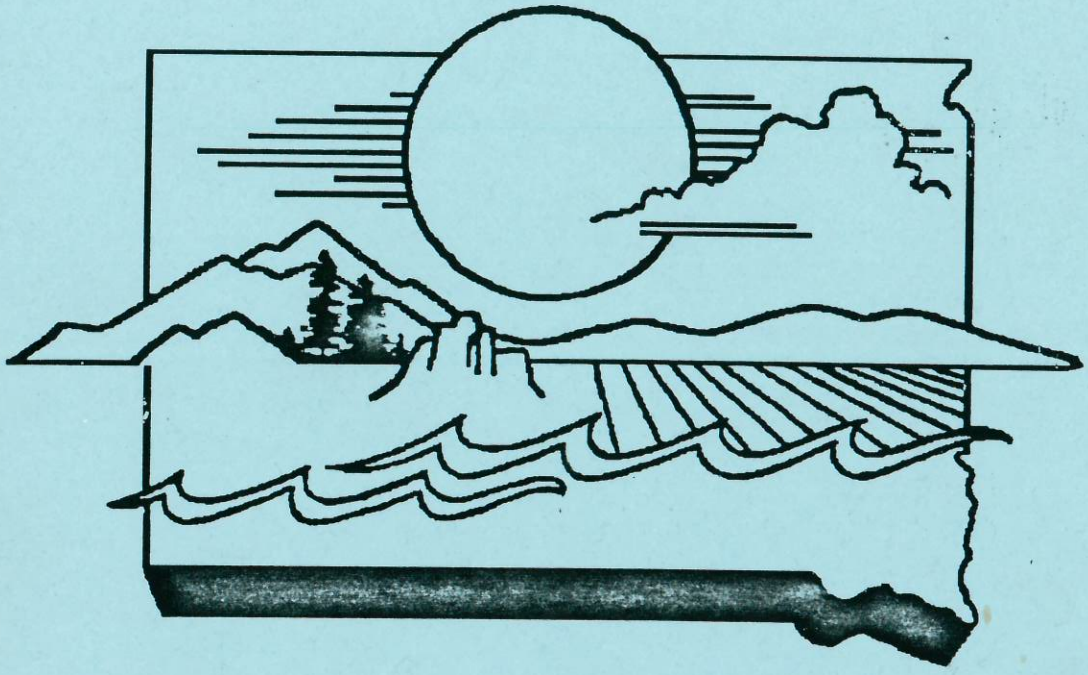
LAKE ASSESSMENT PROJECT REPORT
LAKE REDFIELD
SPINK COUNTY, SOUTH DAKOTA



SOUTH DAKOTA LAKE ASSESSMENT PROGRAM
DIVISION OF WATER RESOURCES MANAGEMENT
SOUTH DAKOTA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
ROBERT E. ROBERTS, SECRETARY
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EXECUTIVE SUMMARY

Lake Redfield was formed in the mid-1930's by damming lower Turtle Creek in southwest Spink County, approximately six miles above its confluence with the James River. The lake basin is long, narrow and convoluted with a irregular shoreline; typical characteristics of man-made lakes that formed over flooded river valleys. Another impoundment of this type is Lake Louise on Wolf Creek. Lake Redfield is used primarily for recreation and flood control. Lake Redfield dam has an outlet control structure so the pool can be fluctuated or drawn down if needed.

The watershed above the dam encompasses an area of 1,414 square miles or nearly 905,000 acres distributed over five counties in east central South Dakota. Surface area of the lake at normal level (at spillway crest) is approximately 170 acres that can increase to 1,900 acres at flood pool (at the dam crest). Present average depth is estimated at 7.0 feet with a maximum water depth of slightly more than 12 feet.

Lake Redfield is well supplied with nutrients and dissolved salts from natural as well as man-made sources in its substantial watershed. Lake waters are stained a coffee color from large quantities of colloidal/dissolved organic matter produced by decaying vegetation in the drainage and in the lake basin. The lake bottom is composed primarily of organic silt and muck with a little sand and gravel near the shoreline. More than three-quarters of the shoreline is covered with a monoculture of cattail beds.

Past studies conducted by the South Dakota Department of Environment and Natural Resources (DENR) in 1983 and 1986 determined Lake Redfield was nutrient-enriched and also impacted by sedimentation which resulted in a rapid expansion of cattail beds along the shoreline and lakeward into previously deeper waters. As a consequence, water holding capacity, public access, and general recreation quality of the lake have been reduced. Data collected from Turtle Creek and an unnamed northern tributary indicated high concentrations of phosphorus and nitrogen were entering Lake Redfield during 1983 (Lake Redfield WQSA Report, 1983). The present assessment indicates in-lake and tributary phosphorus concentrations have doubled and in-lake nitrogen has increased 50% since 1983. Sampling often detected excessive fecal coliform (FC) levels in the tributaries during 1983. The current study implies that tributary FC levels remained high during 1991.

A sediment depth survey carried out by DENR in 1986 indicated that nearly 300,000 cubic yards of loose, soft sediments have accumulated to a depth of 1.5 feet under nearshore cattail beds (approx. 10 acres) and nearly 4.1 feet in the open water area (approx. 42 acres) of the lower lake basin in some 50 years. This sediment volume represents a loss of about 170 acre-ft or roughly one-third of original water holding capacity in the open water area of the lower reservoir.

In January 1991, DENR began a Lake Assessment Project under a Contract/Letter of Agreement with the City of Redfield signed December 5, 1990. Detailed results of that project are presented in this report.

The lake assessment project consisted of water quality monitoring of Lake Redfield, Turtle Creek, and two other major tributaries. In addition, a shoreline erosion inspection was conducted together with a lakeshore vegetation survey; a septic tank survey, and; a watershed inspection/feedlot survey in the Spink County drainage.

The shoreline erosion survey indicated about 3,500 feet of lakeshore were in need of some type of stabilization. Vegetation survey results have been previously mentioned.

Most of the septic systems surveyed appeared to be functioning properly but warrant periodic inspection in the future due to their advanced age. The watershed inspection disclosed that there are approximately 11,700 acres of highly erodible land (HEL) located in Spink County south and east of Redfield, SD that could benefit from Best Management Practices (BMP). A minimum of 9 animal waste management systems (AWMS) need to be installed at feeding operations in the immediate lake drainage.

Results of the water quality monitoring portion of this assessment indicated that the high concentrations of phosphorus and nitrogen recorded a decade ago had increased in Lake Redfield and its tributaries during 1991. Incoming suspended solids concentrations appeared to be relatively low during this study.

The water quality study indicated that the lake is impacted by excessive phosphorus loads from its watershed possibly originating in nearby livestock operations, overfertilization of cropland and soil erosion. Nitrogen loads to the lake appeared to be more moderate.

The study recommendations for lake restoration include, 1) lake drawdown and mechanical removal of approximately 10 acres of cattail from the lower lake basin, 2) establishing 9 to 11 animal waste management systems (AWMS) and several feeding and watering areas away from the lake drainage, 3) implementation of Best Management Practices (BMP) on crop lands and pasture land, 4) establishment of grazing management systems, 5) planting grass and trees to prevent wind and water erosion, 6) establishment of CRP eligibility for highly eroding lands (HEL) and planting of cover crops, and 7) other applicable implementation measures including limited lake dredging.

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INTRODUCTION

This report will present information gathered from a recently completed Lake Assessment Project of Lake Redfield and its watershed. The study was conducted from January 1991 to August of 1992. The project participants responsible for completion of the study were the South Dakota Department of Environment and Natural Resources (DENR), the Spink County Soil Conservation District, and the City of Redfield. The study was initiated at the request of the City of Redfield to assess the current status of the lake and its watershed; to collect water samples and determine the water quality of Lake Redfield, Turtle Creek and two other tributary streams; to identify pollution sources to the lake and watershed, and; develop specific restoration alternatives that would improve the recreational quality of Lake Redfield.

DESCRIPTION OF STUDY AREA

Lake Redfield

Lake Redfield is a man-made lake located on lower Turtle Creek about 1/2 mile west of the City of Redfield, Spink County, SD (Figure 1). The lake was created by the construction of a 600-foot long rolled earth dam in the 1930's under the Work Projects Administration (WPA). An uncontrolled concrete spillway 111.5 feet long serves as the normal lake outlet. In addition, the dam works include a controlled conduit which consists of a single 24-inch diameter reinforced concrete pipe located 13 feet below the spillway crest elevation of 96 feet. The control is a 24-inch gate valve in a manhole. An engineering inspection conducted by DENR, Division of Water Rights, during 1985 indicated Redfield dam had developed several hydrological and structural deficiencies that compromised the safety of residents downstream. By the end of 1988, repairs were effected that included repair of major spalls, cracks, and deteriorated joints, removal of the larger trees and root systems growing on the dam embankment, and replacement of the low level control valve among other repairs and maintenance measures.

The lake at pool elevation covers approximately 170 acres. Recent estimates place the average water depth at about 7 feet, maximum depth at slightly greater than 12 feet, and reservoir capacity at from 900 to 1200 acre-feet. The bottom is composed primarily of silt and muck with a little sand and gravel in some of the shallower areas. Most of the shoreline is overgrown with cattails. The shallowness of the lake basin as well as the southeast orientation of the lower reservoir and prevailing southeasterly winds prevent establishment of an enduring thermal stratification in the deeper parts of the lake. Turtle Creek is the outlet channel for the lake conveying spillway discharges to the James River about 6 miles to the northeast.

Watershed

Lake Redfield has a large watershed encompassing 1,414 square miles or nearly 905,000 acres. The watershed occupies almost the entire northern half of Hand County and also extends into four adjoining counties: Faulk, Spink, Beadle, and Hyde (Figure 2). Most

Figure 1. Lake Redfield Assessment Sampling Sites.

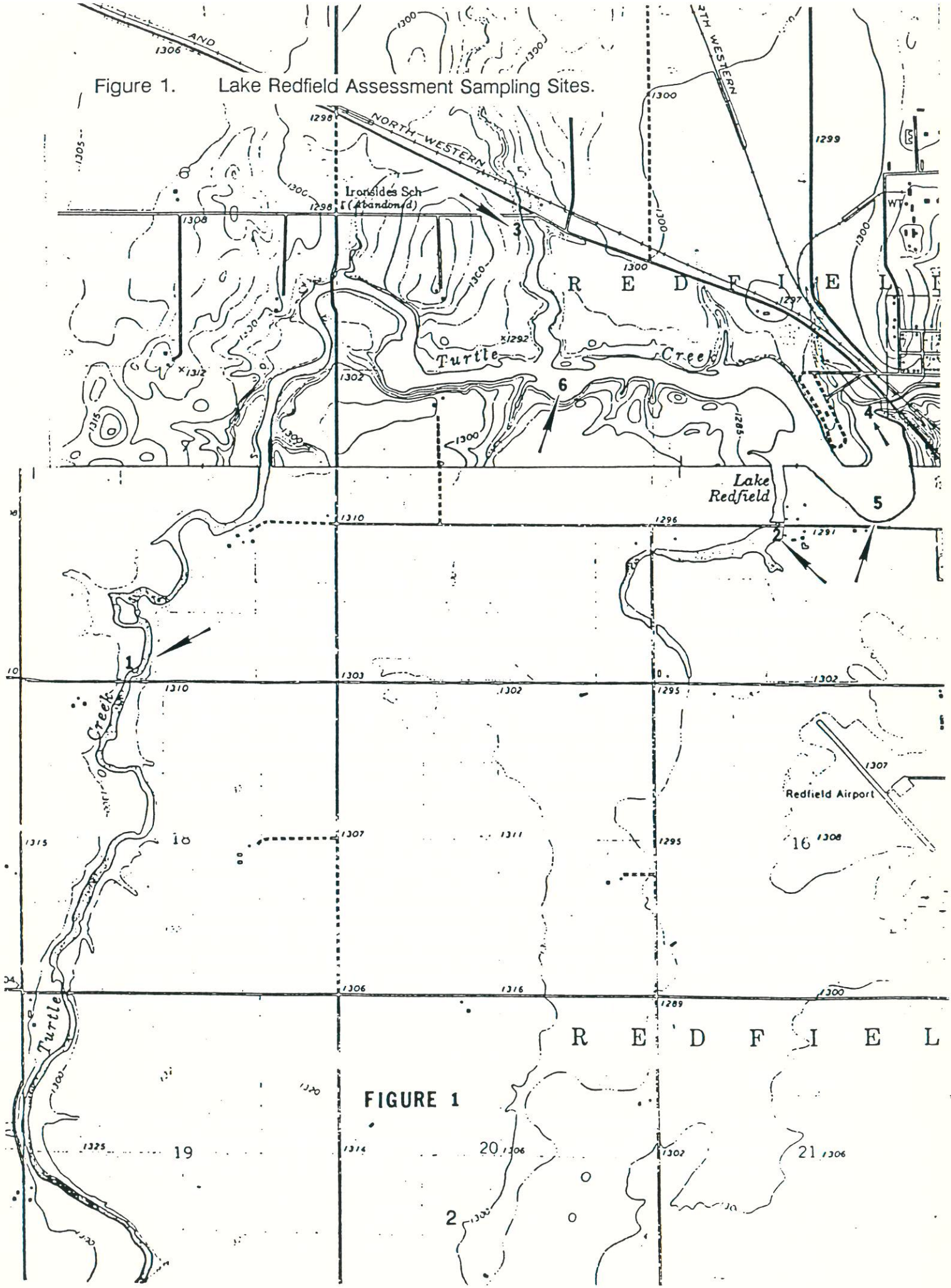


FIGURE 1

of the lake drainage lies in the western part of the James River Lowland physical division whereas Hyde County and the western quarter of Hand County are in the more arid Missouri Coteau physiographic region. Elevations in the watershed range from 1,250 feet MSL (mean sea level) in the Turtle Creek valley of Spink County to about 2,000 feet MSL in the Ree Hills west of Miller, SD. The lowest point in Hand County is 1,350 feet at the northeastern corner. From this location in a southwest heading across Hand County elevation rises only about 450 vertical feet over a horizontal distance of some 38 miles (Figure 2).

The topography of most of the land area drained by Wolf Creek-Turtle Creek-Medicine Creek, the principal tributary system of the Lake Redfield watershed, is similarly level or nearly level. The majority of watershed soils on this relatively flat terrain are derived from glacial till that underlies the entire drainage; secondarily from alluvium (deposited by moving water), and to a lesser extent from loess (wind-borne matter). The parent materials of till which forms the substratum of the watershed are in a large part local Pierre shale formations of the Late Cretaceous period. The upper layers of this bedrock were broken and crushed to smaller fragments by the weight of the moving Mankato ice sheet-the most recent glaciation that occurred in the watershed some 10,000 years ago.

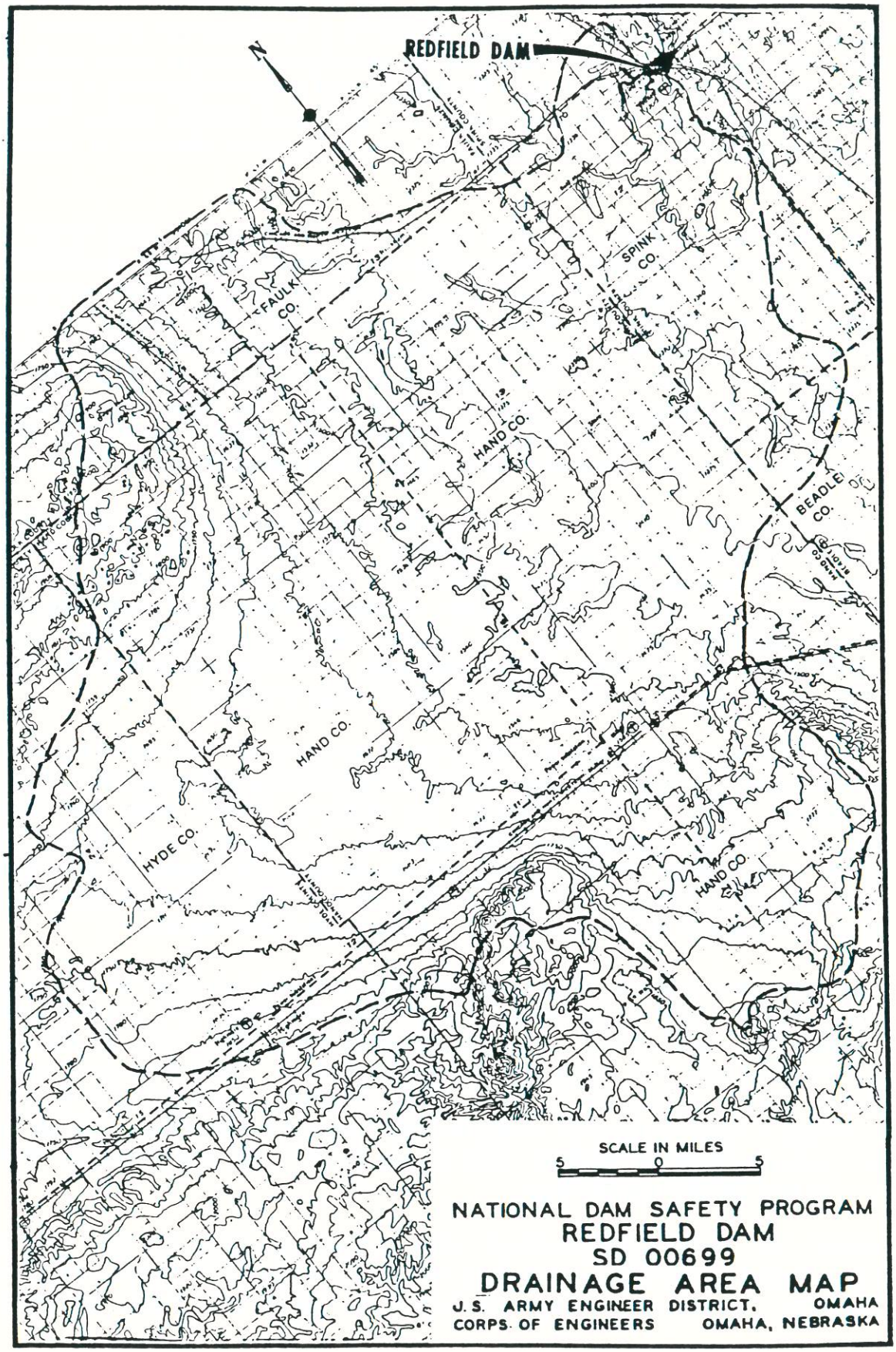
Major watershed soils that have developed through the above processes include Houdek, Bonilla, Hand, Williams, Cavour, and Miranda. The latter two soil series and some less common watershed soils are associated with saline substrata that may influence the quality of local surface and ground water. Precipitation and runoff water seeping through those substrates and coming into contact with salt-laden glacial till may acquire considerable concentrations of dissolved salts. This may account for the mineralized state of the water in Lake Redfield and the drainage in general.

The deep Dakota sandstone formation which rises to within 700 feet of the land surface in one location, is the chief water-bearing formation in the watershed as well as in much of eastern South Dakota. However, the shallower Benton shale and Pierre shale formations contain appreciable water supplies. As a general rule, shallow wells have better water quality whereas water from the deepest wells tends to be too saline for domestic or commercial use. However, salty water in relatively shallow wells (i.e. in glacial till or Pierre shale) is not an uncommon occurrence in this region.

The watershed in Spink County (98,720 acres) contains two other lakes that are major water bodies. Twin Lakes (627 acres) lie about six miles south of Lake Redfield and Cottonwood Lake (1,650 acres) lies approximately nine miles to the southwest. Cottonwood and Twin Lakes are natural lake basins. The former is fed by Medicine Creek flowing in from the northwest. The remaining significant lake in the Redfield drainage is Lake Louise (163 acres) on Wolf Creek in western Hand County and about 34 miles southwest of Redfield. Lake Louise is man-made and similar to Redfield Lake in size and general morphology.

Within the Turtle Creek/Redfield Lake watershed, cropland and grassland are intermingled. Estimates range from 40-45% grassland and 55-60% cropland in the drainage. Grasslands are more common in the western part of the watershed while

Figure 2. Lake Redfield Watershed



cropland predominates in many areas of the eastern drainage. Agricultural income is derived primarily from grazing livestock and several major crops, mainly wheat and corn in rotation with other small grains, soybeans and some sunflowers.

The climate of the Lake Redfield watershed is continental typified by wide temperature variations between seasons. The watershed receives an average of 18 inches of annual rainfall with the area around Redfield recording 18.6 inches. Approximately 14.5 inches of this falls during the growing season (April-September). Precipitation during the study period (1991-92) was above average in the watershed. It is estimated the annual rainfall amount exceeded 22 inches in each of the last two years. In 1991, 19.3 inches had fallen in the Redfield area by June 30.

Temperature in the drainage usually rises to over 100°F for about six days in summer and drops to 20°F below zero for about six days in winter. However, the study period was characterized by unusually mild winters and cool summers. The annual average mean temperature is 44°F and annual lake evaporation ranges from 35 to 36 inches for the study area.

DESCRIPTION OF PUBLIC ACCESS

Lake Redfield has two public access areas and less than five acres of publicly owned acreage adjoining the lake. Most of this land is taken up by a roadside park located near the dam spillway on the east side of the lake. The park and other public lakeshore acreage is owned and managed by the South Dakota Department of Game, Fish, and Parks. Public lakeshore facilities include access to shore fishing, boat ramp, public toilets, picnic grounds, picnic tables, garbage units, and primitive camping grounds without bath facilities. There is no constructed swimming beach although the lake is used for swimming by local residents.

POTENTIAL USER POPULATION

The estimated population within a 65-mile radius of Lake Redfield is 62,644 and 10,152 people reside within a 30-mile radius of the lake. The population of the adjoining City of Redfield is 2,770 (1990 census). Huron, SD, the closest large municipality lies about 38 miles south of Lake Redfield. Huron has a population of 12,448 according to the latest census. Lake use was determined by a 1990 SD GF&P survey at 3,000 man-days per year. Number of boats on the lake in 1990 averaged two per day.

Lakeside development of Lake Redfield is relatively minor. In addition to a small roadside park there are 17 structures located on approximately 14 miles of shoreline (main basin of the lake). There are 10 buildings including one apartment house and 9 permanent residences near the east shoreline; 4 residences on the southeastern lakeshore consisting of 3 houses and one trailer home; a single permanent residence near the northwestern shore; and 2 additional structures on the northeast side of the lake, one of which is a small business. Two small commercial interests are situated along U.S. Highway 212 near the northern tributary inlet (water quality site #3).

BIOLOGICAL DATA

Fish

Water flowing out of Lake Redfield re-enters Turtle Creek and joins the James River approximately six miles downstream. Due to this close connection, any fish species possible in the James River may be present in the Turtle Creek/Redfield Lake drainage (Table 1). The 1988-89 SD Game, Fish & Parks Fisheries Management Plan described Lake Redfield as a marginal lake for game fish, impacted by siltation and nutrient-rich runoff, and one that is subject to frequent winter fish kills. Management goals are directed toward producing a fair northern pike, yellow perch, and black crappie fishery. Currently northern pike and yellow perch are managed as primary species and black crappie as a secondary species. Largemouth bass are an incidental fish in Lake Redfield. Past electrofishing results, together with recent field observation, suggest black bullhead and carp are the most common fish species numerically and/or by weight. The Game, Fish and Parks stocking record for Lake Redfield covering the last decade is listed in Table 2. Due to the marginal conditions for fish life in the lake, stocking has been conducted primarily on the basis of fish kills in recent years.

Table 1. Fish Species Possible in Lake Redfield and the Watershed

COMMON NAME	SCIENTIFIC NAME
Short Nose Gar	*Lepisosteus platostomus*
Gizzard Shad	*Dorosoma cepedianum*
Goldeye	*Hiodon alosoides*
Northern Pike	*Esox lucius*
Muskellunge	*Esox masquinongy*
Carp	*Cyprinus carpio*
Silvery Minnow	*Hybognathus nuchalis*
Emerald Shiner	*Notropis atherinoides*
Common Shiner	*Notropis cornutus*
Red Shiner	*Notropis lutrensis*
Sand Shiner	*Notropis stramineus*
Fathead Minnow	*Pimephales promelas*
Creek Chub	*Semotilus atromaculatus*
River Carpsucker	*Carpiodes carpio*
White Sucker	*Catostomus commersoni*
Smallmouth Buffalo	*Ictiobus bubalus*
Bigmouth Buffalo	*Ictiobus cyprinellus*
Black Bullhead	*Ictalurus melas*
Yellow Bullhead	*Ictalurus natalis*
Channel Catfish	*Ictalurus punctatus*
Tadpole Madtom	*Noturus gyrinus*
Brook Stickleback	*Culaea inconstans*
White Bass	*Morone chrysops*
Green Sunfish	*Lepomis cyanellus*
Orangespotted Sunfish	*Lepomis humilis*
Bluegill	*Lepomis macrochirus*
Largemouth Bass	*Micropterus salmoides*
White Crappie	*Pomoxis annularis*
Black Crappie	*Pomoxis nigromaculatus*
Iowa Darter	*Etheostoma exile*
Johnny Darter	*Etheostoma nigrum*
Yellow Perch	*Perca flavescens*
Walleye	*Stizostedion vitreum vitreum*
Freshwater Drum	*Aplodinotus grunniens*

Sources: Elsen 1977; Frederickson/Houtcooper, 1986; Murphey, 1987; Tol, 1976.

Table 2. Stocking Record for Lake Redfield, Spink County, 1980-1992.

Year	Number	Species	Size
1980	407	Northern Pike	Adult
1981	100,000	Northern Pike	Fry
1982	200,000	Northern Pike	Fry
	400	Black Crappie	Adult
	400	White Crappie	Adult
1983	12,000	Yellow Perch	Fingerling
1984	200,000	Northern Pike	Fry
	23,600	Yellow Perch	Fingerling
1985	100,000	Northern Pike	Fry
1991	100,000	Northern Pike	Fry

Aquatic Plants

Approximately 80% of the Lake Redfield shoreline is covered with vegetation that consists mainly of dense growths of cattails and other emergent aquatic plants according to a vegetation survey completed by the DENR in August 1991 (Figures 3 and 4, Table 3). In addition there are various hardwoods, miscellaneous grasses and other understory vegetation in the vicinity of the lakeshore not identified by the survey.

On the eastern shore, riprapped areas and shoreline development have removed or greatly reduced local emergent plant communities. Submergent (bottom-rooted) aquatic plant species such as pondweed represented the least common group of macrophytes in Lake Redfield primarily due to water turbidity. According to a formula utilized by EPA (Canfield, 1985) which relates plant growth on the lake bottom to secchi disk visibility, little or no growth can be expected in Lake Redfield at water depths of 3.5 feet (1.1 m) under prevailing mean water transparencies of 1.7 feet (0.5 m).

Aquatic plants that are adapted to floating on or near the water surface, such as duckweed and coontail (coontail has no roots), were fairly abundant in the lower reservoir (Figure 4) in wind-protected areas. In all, seven floating/submergent weedbeds were noted during the survey ranging in size from 220 to 900 square feet. Concentrations of pondweed occurred primarily in nearshore locations in water depths of 3 feet or less. Branches of pondweed are easily broken off by wind and wave action. These branches may then aggregate to form floating mats on the lake surface.

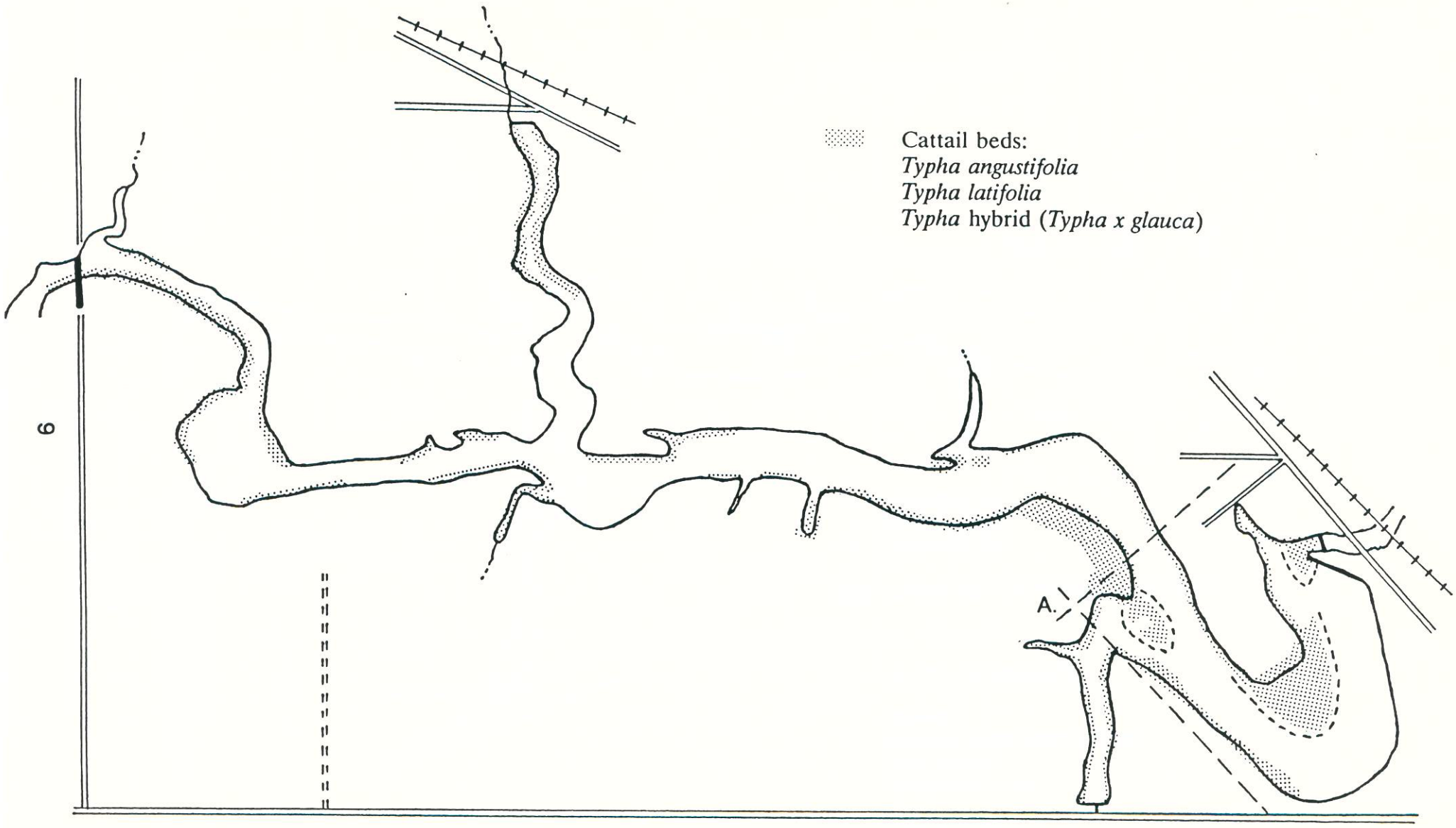


Figure 3. Distribution of cattails (*Typha* spp.) in Lake Redfield (1991).

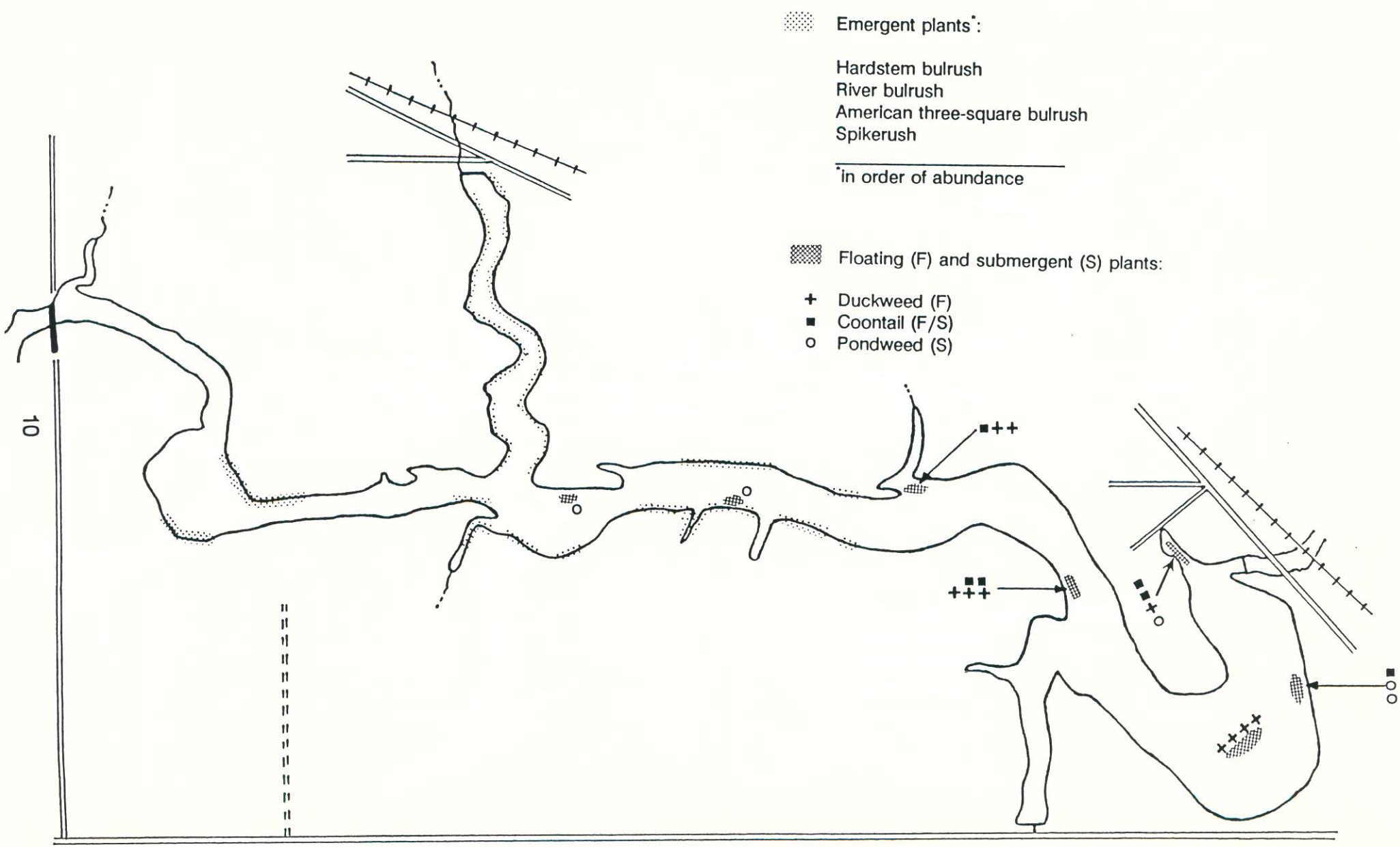


Figure 4. Distribution of emergent (cattails excluded) and floating/submergent macrophytes in Lake Redfield (1991).

Table 3. Lake Redfield vegetation survey, August 23, 1991.

Common Name	Scientific Name	Relative Abundance
Narrow-leaved cattail	*Typha angustifolia*	Major
Broad-leaved cattail	*Typha latifolia*	Common
Hybrid cattail	*Typha x glauca*	Major
Hardstem bulrush	*Scirpus acutus*	Major
River bulrush	*Scirpus fluviatilis*	Major
American three-square bulrush	*Scirpus americanus*	Common
Spikerush	*Eleocharis sp.*	Present
Coontail	*Ceratophyllum demersum*	Major
Sago pondweed	*Potamogeton pectinatus*	Common
Leafy pondweed	*Potamogeton foliosus*	Common
Great duckweed	*Spirodella polyrhiza*	Major
Lesser duckweed	*Lemna minor*	Major
Star duckweed	*Lemna trisulca*	Present

Algae

A single surface water sample was collected for algal analysis from an in-lake site in summer of 1989 as part of the ongoing statewide DENR Lake Assessment Program. Table 4 lists the results of that analysis. Comparison of the summer algae populations in the 100 mostly eutrophic state lakes indicated algal density in Lake Redfield (9,350 units/ml) was higher than that in 2/3 of the lakes assessed during 1989.

Most of the algae collected in Lake Redfield are commonly found in other eutrophic state lakes. *Aphanizomenon flos-aquae*, a principal blue-green species in summer algal blooms of prairie lakes, occurred in lower numbers than expected (Table 4) probably because it was collected too early in the summer. A noteworthy occurrence was the presence of the diatom genus *Chaetoceros* (probably *C. Elmorei)* as a fairly common alga (180 units/ml) in the sample. Most species of this planktonic diatom are marine but *C. Elmorei* occurs in some brackish-water state lakes such as Lake Cochrane and Lake Henry (Bon Homme Co.). Its presence in Lake Redfield indicates moderately brackish water conditions frequently exist in that water body.

Table 4. Algal species and densities in Lake Redfield, 1989.

	Summer 1989	
Taxa	Number Counted	Units/ml
Algae (other)	74	3326
Diatom (centric)	23	1034
Green algae (other)	21	944
Scenedesmus spp.	10	450
Cryptomonas sp. #1	10	450
Aphanizomenon flos-aquae	10	450
Euglena	8	360
Tetrastrum	6	270
Cryptomonas	6	270
Dactylococcopsis	6	270
Nitzschia	5	225
Chroococcus	4	180
Chaetoceros	4	180
Blue-green algae (other)	3	135
Diatom (pennate)	3	135
Phacus	3	135
Characium	2	90
Staurastrum	2	90
Oocystis	2	90
Merismopedia	2	90
Closterium	1	45
Algae (flagellate)	1	45
Schizothrix	1	45
Nitzschia reversa	1	45
Total	208	9350

WATER QUALITY MONITORING

Water Quality Standards

The surface water quality standards for the State of South Dakota are based on the highest ranking criteria assigned to a body of water. Lake Redfield is given the beneficial uses of a warmwater marginal fishery, immersion recreation, limited contact recreation, and wildlife propagation/stock watering. The parameters which have water quality standards are listed in Table 5.

Table 5 - Lake Redfield Water Quality Standards

Parameter	Standard
Total Chloride Residual	<0.02 mg/L
Un-ionized Ammonia	<0.05 mg/L
Total Cyanide	<0.02 mg/L
Free Cyanide	<0.005 mg/L
Dissolved Oxygen	<5.0 mg/L
Undissassociated Hydrogen Sulfide	<0.002 mg/L
pH	>6.5 & <8.3 units
Suspended Solids	<150 mg/L
Temperature	<90°F
Polychlorinated Biphenyls	<0.000001 mg/L
Fecal Coliform Organism	<200colonies/100ml
Total Alkalinity	<750 mg/L
Total Dissolved Solids	<2500 mg/L
Conductivity	<4000 micromhos/cm
Nitrates	<50 mg/L
Sodium, absorption rate	<10:1

SD DENR, Title 74.

Methods and Materials

Sampling Location and Schedule

Water samples were collected at six individual sampling sites in Lake Redfield and the lower lake drainage (Figure 1). Sites 1, 2, and 3 were tributary inlet sites and site 4 was the outlet site on the spillway of Lake Redfield. Site numbers 5 and 6 were in-lake sites. Surface water samples at sites 5 and 6 were collected from 1.5 feet (0.5 meter) below the surface of the lake. At site 6, bottom samples were taken one foot (0.3 meter) above the lake bottom in addition to surface samples. In addition, several duplicate surface samples were collected from both in-lake sites during the monitoring period for quality assurance/quality control purposes. Surface samples were collected at all tributary sites. Descriptions of the sampling sites established for this assessment are as follows:

Site 1. Latitude 44 Deg., 51 Min., 54 Sec., Longitude 98 Deg., 34 Min., 39 Sec. Turtle Creek, located 2.6 miles west of U.S. Highway 281 and 3 miles north

of S.D. Highway 26. T116N, R64W, Sec. 7, SW1/4.

Site 2. Latitude 44 Deg., 52 Min., 20 Sec., Longitude 98 Deg., 32 Min., 8 Sec. Twin Lakes tributary, located 0.8 miles west of U.S. Highway 281 and 3.5 miles north of S.D. Highway 26. T116N, R64W, Sec.9, NW1/4.

Site 3. Latitude 44 Deg., 53 Min., 12 Sec., Longitude 98 Deg., 33 Min., 7 Sec. This site is a minor tributary to Lake Redfield, located along U.S. Highway 212 approximately 1 mile west of the lake's spillway. T116N, R64W, Sec.5, SE1/4.

Site 4. Latitude 44 Deg., 52 Min., 40 Sec., Longitude 98 Deg., 31 Min., 44 Sec. This site is the outlet of Lake Redfield, located at the spillway. T116N, R64W, Sec.9, NE1/4.

Site 5. Latitude 44 Deg., 52 Min., 23 Sec., Longitude 98 Deg., 31 Min., 46 Sec. In-lake, located south of the spillway, in the eastern basin of the lake. T116N, R64W, Sec.9, NE1/4.

Site 6. Latitude 44 Deg., 52 Min., 44 Sec., Longitude 98 Deg., 32 Min., 57 Sec. In-lake, located near the middle of the lake. T116N, R64W, Sec.8, NE1/4. Surface and bottom samples were collected from this site.

Stream stage recorders were installed by DENR personnel on the tributaries and the outlet. At tributary sites 2 and 3 and outlet site 4, sponsors collected water samples at the stage recorder locations. Due to the difficulty involved in installing a recording station on Turtle Creek, a staff gauge was installed at the sampling site (site 1) and the stage recorder 2 miles south (upstream).

The tributary sites were sampled during runoff events and the lake samples were taken on a monthly basis. The earliest sampling date was January 31, 1991 and the last sample date was August 2, 1992. Sixty-seven samples were taken. (Table 6).

Tributary flow stages were measured with a Steven's stage recorder installed at each of the tributary sites. Stage recorders were calibrated for discharge by discrete measurements with a Marsh-McBirney portable flow meter. Daily stream discharges in cubic feet per second (cfs) were obtained from computer generated graphs. These graphs were derived by "best-fit" regression lines fitted to data point values obtained previously during the calibration of the stage recorder where stage height was related to the measured stream discharge (water velocity x stream cross-sectional area). For any stage height on the continuous stage record a stream discharge value can be obtained with the program-generated graphs (Appendix A).

Nutrient and sediment loadings were calculated for each sampling date by multiplying the known nutrient/sediment concentration by the daily water flow (cfs). Daily loads between water quality sampling dates were obtained by averaging nutrient and sediment (TSS) concentrations between consecutive dates. The derived loadings were then summed and

divided by the lake area to provide annual nutrient and sediment loads.

Table 6. Sampling period and number of samples.

Site #	Sample Period	# of Samples
1	4/15/91 to 8/2/91	10
2	4/19/91 to 8/6/91	10
3	4/15/91 to 8/6/91	10
4	4/15/91 to 8/2/91	10
5	1/31/91 to 3/24/92	10
6	1/31/91 to 3/24/92	17
	TOTAL	67

Sample Analysis

Water samples were collected and field tests conducted by City of Redfield personnel. Laboratory analyses were performed by the South Dakota State Health Laboratory in Pierre, South Dakota. Samples were analyzed for the parameters listed in Table 7. The analytical methods used are presented in Table 8.

Table 7. Water Quality Parameters

Field Parameters

Water Temperature	Air Temperature
Field pH	Dissolved Oxygen
Secchi Disk Depth	Visual Observations

Laboratory Parameters

Fecal Coliform Bacteria	Laboratory pH
Total Alkalinity	Total Solids
Total Suspended Solids	Nitrates-Nitrites
Volatile Solids	Total Phosphorus
Total Dissolved Phosphorus	Ammonia
Total Kjeldahl Nitrogen	

Calculated Parameters

Total Dissolved Solids	Non-Volatile Solids
Un-ionized Ammonia	Organic Nitrogen
Nitrogen to Phosphorus Ratio	Total Nitrogen

Carlson's Trophic Status Index (TSI)
for Seechi Disk and Phosphorus

Table 8. Analytical Methods for Physical and Chemical Parameters.

Parameter	Method	Reference
Temperature	Thermometric	APHA (1985)
Secchi Disk	Shaded Side of Boat	Lind (1985)
pH	pH probe	APHA (1985)
Dissolved Oxygen	DO meter	EPA (1990)
Depth	Tape measure	EPA (1990)
Fecal Coliform	Membraned filter	APHA (1985)
Total Alkalinity	Potentiometric titration	APHA (1980)
	to pH of 4.5	EPA (1983)
Total Solids	Evaporation	APHA (1980)
		EPA (1983)
Total Suspended Solids	Evaporation @ 180°C	APHA (1980)
		EPA (1983)
Ammonia	Automated phenolate	APHA (1980)
		EPA (1983)
Nitrate-Nitrite	Automated Cadmium Reduction	APHA (1980)
		EPA (1983)
Total Kjeldahl Nitrogen	Semi-Automated Block Digester AAII	EPA (1983)
Total Phosphorus	Persulfate digestion	EPA (1983)
Total Dissolved Phosphate	Filtered persulfate digestion	EPA (1983)

RESULTS AND DISCUSSION

In-lake Water Quality

In-lake and tributary water quality summaries that appear in Tables 9 to 11 were derived from a base data set that appears in Appendix B. Discussion for the in-lake chapter has been divided into the components of lake trophic condition, fecal coliform bacteria (swimming recreation impact), suspended solids, dissolved oxygen and ammonia (fishery impacts), nutrients, and sediment/nutrient loading to Lake Redfield from its watershed tributaries.

Trophic Condition

The trophic condition of a lake (or trophic state) refers to the amount of organic matter or nutrients in a lake's system and the combined effects these nutrients have on a lake at a given time (Wetzel, 1983). Lakes are commonly divided into four trophic categories: 1) oligotrophic lakes are those which are nutrient poor, relatively clear, and support low numbers of many species of animals and plants and usually have high diversity (Cole, 1983), 2) mesotophic lakes are intermediate in nutrient availability which better supports the plants and animals of the lake system, 3) eutrophic lakes are those with high nutrient loads, large numbers of few species of plants and animals, tend to be more turbid, and have less diversity, 4) hypereutrophic lakes are those which have an overabundance of nutrients, usually very low species diversity, a tendency to be shallow and turbid, and large nutrient loads not only from the drainage basin but also from the lake itself. These lakes, as well as eutrophic lakes, often experience nuisance algal blooms and excessive weed growth.

Lakes naturally age from oligotrophic to eutrophic and hypereutrophic (highly eutrophic) over thousands of years. Human activities, however, tend to greatly accelerate the process by increasing the amount of nutrients and sediment that are carried into lakes via tributaries, surface runoff, and underground seepage.

The Carlson (1977) Trophic State Index (TSI) is a method of ranking the trophic condition of a lake based on three different parameters; total phosphorus, secchi disk visibility, and chlorophyll a measurements. The scale is ranked from 0 - 100, an increase in value of 10 (10 to 20, 20 to 30, etc.) represents a doubling of the algal biomass. A TSI value of 50 is considered eutrophic and a value of 65 is considered hypereutrophic. Although chlorophyll a samples were collected and preserved in storage, analysis of the samples will not be completed until the summer of 1993. At the completion of the analysis, the TSI for chlorophyll a will be provided.

The TSI values determined for Lake Redfield were based on average phosphorus concentration and secchi disk depth for this monitoring period at both in-lake sampling sites (sites 5 and 6). Based on this consideration the TSI values obtained were 70 for secchi depth and 98 for phosphorus (Table 9). These values are on the high end of the Carlson scale (>65) which implies that Lake Redfield is highly eutrophic (hypereutrophic). The TSI's indicate Lake Redfield is turbid with a superabundant supply of phosphorus.

Table 9. In-lake and spillway water quality data mean, median, and range values, Lake Redfield, January 31, 1991 to March 24, 1992 (n = 10, 9, 9).

Parameter	Parameter mean, median, and range			
	Site 4 (Spillway)	Site 5 (Surface)	Site 6 (Surface)	Combined Mean for Sites 5 & 6
Site Depth ft (m)	-	10.1 (3.1m)	10.7 (3.3m)	-
Secchi Disk (ft)	-	1.7, 1.7 (1.0 - 2.0)	1.5, 1.7 (1.0 - 2.0)	1.6 ft (.49m)
Dissolved Oxygen (mg/l)	5.5, 5.4 (2.8 - 11.3)	9.3, 7.9 (5.1 - 14.4)	11.2, 10.4 (6.6 - 23.4)	10.2
Lab pH (s.u.)	8.0, 8.0 (7.7 - 8.3)	8.4, 8.4 (7.6 - 8.7)	8.5, 8.5 (8.2 - 8.9)	8.4
Fecal Coliform (#per/100 ml)	183, 250 (10 - 320)	8, 10 (2 - 20)	68, 10 (2 - 220)	38
Total Alkalinity (mg/l)	178, 196 (38 - 292)	309, 274 (205 - 537)	304, 275 (210 - 455)	306
Total Solids (mg/l)	540, 458 (205 -1237)	965, 894 (434 - 1983)	998, 922 (453 - 2022)	982
Total Dissolved Solids (mg/l)	510, 426 (190 - 1182)	930, 855 (426 - 1906)	960, 900 (440 - 1952)	945
Total Suspended (Susp.) Solids (mg/l)	25, 26 (4 - 58)	19, 18 (10 - 36)	22, 22 (9 - 30)	20
Total Volatile Susp. Solids (mg/l)	14, 14 (2 - 32)	10, 10 (2 - 22)	8, 8 (2 - 14)	9
Total Non-Volatile Susp. Solids (mg/l)	10, 4 (2 -26)	8, 10 (0 -20)	13, 14 (2 - 18)	10
Total Ammonia (mg/l)	.07, .02 (.02 - .36)	.08, .03 (.02 - .36)	.07, .02 (.02 - .23)	.08
Nitrate + Nitrite (mg/l)	.42, .50 (.10 - .60)	.26, .10 (.10 - .70)	.23, .10 (.10 - .60)	.24
TKN (mg/l)	1.26, 1.28 (.70 - 1.91)	2.04, 1.53 (1.40 - 4.39)	1.76, 1.70 (1.12 - 2.57)	1.90
Organic Nitrogen (mg/l)	1.19, 1.21 (.68 - 1.55)	1.96, 1.51 (1.35 - 4.23)	1.69, 1.63 (1.10 - 2.43)	1.82
Total Nitrogen (mg/l)	1.68, 1.76 (.80-2.09)	2.29, 1.92 (1.51 - 4.49)	1.98, 1.94 (1.62 - 2.58)	2.14
Total Phosphorus (mg/l)	.75, .85 (.28 - 1.02)	.76, .66 (.24 - 1.95)	.60, .61 (.25 - .88)	.68
Dissolved Phosphorus (mg/l)	.64, .74 (.26 - .92)	.64, .61 (.15 - 1.63)	.49, .53 (.15 - .98)	.56
Nitrogen to Phosphorus Ratio	2.2:1	3:1	3.3:1	3:1
TSI for Secchi Disk		69	71	70
TSI for Total Phosphorus		100	96	98

Table 10. Comparison of surface and bottom samples for Lake Redfield in-lake site 6, January 31, 1991 to March 24, 1992 (n = 9, 7).

Parameter	Parameter mean, median, and range	
	Site 6 (Surface)	Site 6 (Bottom)
Site Depth ft (m)	-	10.7 (3.3m)
Secchi Disk (ft)	1.5, 1.7 (.10 - 2.0)	-
Dissolved Oxygen (mg/l)	11.2, 10.4 (6.6 - 23.4)	7.0, 6.0 (1.7 - 12.1)
Lab pH (s.u.)	8.5, 8.5 (8.2 - 8.9)	8.4, 8.4 (8.0 - 8.8)
Fecal Coliform (#per/100 ml)	68, 10 (2 - 220)	71, 2 (2 - 190)
Total Alkalinity (mg/l)	304, 275 (210 - 455)	335, 310 (211 - 558)
Total Solids (mg/l)	998, 922 (453 - 2022)	1063, 920 (459 - 2073)
Total Dissolved Solids (mg/l)	960, 900 (440 - 1952)	1018, 878 (439 - 1996)
Total Suspended (Susp.) Solids (mg/l)	22, 22 (9 - 30)	26, 24 (11 - 40)
Total Volatile Susp. Solids (mg/l)	8, 8 (2 - 14)	10, 16 (2 - 32)
Total Non-Volatile Susp. Solids (mg/l)	13, 14 (2 -18)	15, 19 (2 - 22)
Total Ammonia (mg/l)	.07, .02 (.02 - .23)	.07, .02 (.02 - .24)
Nitrate + Nitrite (mg/l)	.23, .10 (.10 - .60)	.27, .10 (.10 - .90)
TKN (mg/l)	1.76, 1.70 (1.12- 2.57)	1.42, 1.30 (0.90 - 2.40)
Organic Nitrogen (mg/l)	1.69, 1.63 (1.10 - 2.43)	1.35, 1.22 (0.88 - 2.16)
Total Nitrogen (mg/l)	1.98, 1.94 (1.62 - 2.58	1.69, 1.55 (1.27 - 2.50)
Total Phosphorus (mg/l)	.60, .61 (.25 - .88)	.67, .69 (.29 - 1.15)
Dissolved Phosphorus (mg/l)	.49, .53 (.15 - .98)	.54, .59 (.15 - 1.03)

Fecal Coliform Bacteria

Fecal coliform bacteria cell counts, or more frequently, counts of bacteria colonies, are used as indicators of human pathogens in water. Although fecal coliforms, with few exceptions, are not pathogens themselves, they exhibit a close relationship with a number of human pathogens such as *Salmonella*, and *Shigella*. When large numbers of fecal coliform occur in a water body it is highly likely that significant numbers of human pathogens are also present. Fecal coliform bacteria live in the digestive tracts of warm-blooded animals including man. Major sources of these bacteria in lakes, therefore, may be livestock, watershed feedlots, failing lakeside and tributary septic tank systems, human sewage in the lake drainage, as well as wastes from waterfowl and other wildlife on the lake or in the general vicinity.

The South Dakota Surface Water Quality Standards state water is unsafe for immersion recreation if a twenty-four hour composite sample has a bacteria count above 200 colonies per 100 ml. It is also unsafe if any one grab sample is found to be over 400 colonies per 100 ml. There were no exceedences of these standards at in-lake sites during this study period. However, a potential problem may exist at site 6 where coliform densities of 220 and 190 were recorded on August 19, 1991 and where densities of 180 and 160 were present one month earlier (Appendix B).

Dissolved Oxygen

The State of South Dakota has assigned the beneficial use of warmwater marginal fish life propagation to Lake Redfield. During the present study in-lake dissolved oxygen levels were generally sufficient to support a warmwater fishery. Oxygen levels averaged 10.2 mg/l (sites 5 and 6) and ranged from 5.1 to 23.4 mg/l in surface waters (Table 9). In deep waters above the lake bottom, oxygen content averaged 7 mg/l and ranged from 1.7 to 12.1 mg/l (Table 10). Oxygen concentration in bottom samples at site 6 fell to 4.2 and 4.5 mg/l in late May and mid September, respectively. During late February 1991, oxygen level at site 6 had declined to 1.7 mg/l on one sampling date in the bottom sample. On the same date, surface oxygen concentration at site 5 decreased to 5.1 mg/l. No bottom samples were collected at site 5. These limited data along with past observations suggest Lake Redfield may experience low oxygen conditions (<5 mg/l) during extended windless periods in spring and summer and in late winter under ice cover, particularly in the deeper waters near the bottom.

Suspended Solids and Secchi Disk Visibility

The limits for suspended solids established for a warmwater marginal fishery is 150 mg/l. Excessive suspended solids in a body of water can have a detrimental effect on a lake's fishery. In 1965, the European Fisheries Advisory Committee identified four means by which suspended solids can affect fish and fish food populations (EPA, 1976). Fish swimming in waters with high suspended solids can be killed directly, their growth rate reduced, or their resistance to disease reduced. In addition, suspended solids can prevent the successful development of fish eggs and larvae and reduce the abundance of food available to fish.

No exceedences of suspended solids (TSS) standards were observed in Lake Redfield during the present study. TSS for the combined in-lake sites averaged 20 mg/l and ranged from 9 to 36 mg/l in surface samples and from 11 to 40 mg/l in bottom waters. Suspended volatile solids (algae and other living and dead organic matter) made up nearly 50% of total suspended solids and ranged from 2 to 22 mg/l in surface waters and from 2 to 32 mg/l in bottom water samples.

The water clarity and aesthetic appearance of a lake is often not apparent on examination of TSS levels. When suspended particles are very small such as colloidal clays and colloidal/dissolved organic matter, it does not require a large mass of TSS to discolor the waters of a small lake or create turbid conditions. This may represent the situation in the Lake Redfield drainage where decaying vegetation in standing water throughout the watershed releases sufficient amounts of colloidal/dissolved organic matter to stain water brown. This process is aided by flood irrigation practices in the drainage. An additional large amount of organic matter is provided to the lake by decay of thick stands of emergent aquatic vegetation (cattails) growing around most of the shoreline.

Water clarity in Lake Redfield as measured by secchi disk visibility averaged 1.6 ft (.50 m) and ranged from 1.0 to 2.0 ft. This is considered poor water transparency even for productive lakes. The causes are organic staining as discussed above, and but also seasonally dense algal populations and to some degree suspended clay and silt particles.

Phosphorus

Phosphorus is an essential nutrient for plant growth and is typically the cause of excessive growth of algae and aquatic plants in many water bodies. Total phosphorus (TP) concentrations as low as 0.03 mg/l can trigger nuisance growth (NIPC, 1989; Wetzel, 1983). According to Reckhow (1989), TP concentrations greater than .05 mg/l are indicative of hypereutrophy.

During the present study, total phosphorus concentrations in Lake Redfield far exceeded the above values in both surface and bottom samples. Phosphorus levels ranged from 0.24 to 1.95 mg/l in surface waters and from 0.29 to 1.15 mg/l in deepwater samples. Surface and bottom samples exhibited similarly high phosphorus concentrations and similar annual means indicating the lake remains mixed throughout most of the annual cycle.

The annual TP mean (January 1991 - March 1992) of the combined in-lake samples was 0.68 mg/l for surface waters and 0.67 mg/l for bottom samples (site 6 only). It is of interest that 81% of lake TP and 78% of tributary TP during the study period was in the form of dissolved phosphorus which is indicative of one or more major pollution sources in the watershed. Runoff from livestock operations in the watershed is primarily suspected since yields of dissolved phosphorus (and nitrogen) in feedlot runoff are often much larger than those of other non-point sources in rural areas. Wastewater from human and animal sources contains a high percentage of dissolved phosphorus.

In-lake total phosphorus concentrations appeared to have doubled in the last 10 years

from an annual mean of 0.34 mg/l reported in 1983 (DENR, 1983). Major sources of phosphorus to Lake Redfield may be livestock operations on tributary drainages in the general vicinity of the lake, soil erosion and overfertilization of croplands in the watershed. In general, the increase in TP seems to indicate an increase in agricultural activities in the watershed over the past decade.

Nitrogen

Nitrogen in its various forms is the second most important nutrient for growth of algae and other aquatic vegetation. Inorganic nitrogen concentrations (primarily nitrates and ammonia) in excess of 0.3 mg/l may be sufficient to stimulate algal growth (Sawyer, 1952).

Inorganic nitrogen concentrations in Lake Redfield exceeded 0.3 mg/l primarily during summer due to increases in nitrate levels in the water column (Appendix B). At other times both ammonia and nitrate/nitrite levels were low, often below detection limits.

Nitrate/nitrite (NO_3 + NO_2) values ranged from 0.10 to .90 mg/l; and total ammonia (NH_4) concentrations from 0.02 to 0.36 mg/l throughout the study. The fishery standard for un-ionized ammonia as part of total ammonia was never exceeded. The maximum value obtained was 0.038 mg/l - substantially below the 0.05 limit allowed under a warmwater marginal fishery classification.

Relatively high NO_3/NO_2 values (0.4 - 0.9 mg/l) observed in-lake from July to September may be attributed in a large part to tributary input during stormwater runoff. Tributary NO_3/NO_2 concentrations during summer were comparable to in-lake readings (Appendix B).

Nitrogen is believed to be the limiting nutrient for algal growth if the ratio of total nitrogen (N) to total phosphorus (P) is less than 10:1 (Wetzel, 1983). Blue-green algae may become dominant in lakes with a low N:P ratio since they are able to utilize atmospheric nitrogen (N_2) dissolved in water. Other algae must rely on inorganic nitrogen. Due to the extremely high phosphorus concentration in Lake Redfield, the mean N:P ratio was 3:1 (2.5:1 in bottom waters) indicating a pronounced 'nitrogen limitation' for the lake during the present study. In 1983 the N:P ratio was approximately 4:1. Nonetheless, it was noted during the present study that in-lake nitrogen concentrations appeared sufficient to support a large and diverse algal community during the growing season of 1991.

A comparison of nutrient data from the 1983 DENR monitoring study with those of the present assessment indicated that average in-lake organic nitrogen increased from 1.18 mg/l in 1983 to 1.82 mg/l in 1991 (Table 9). Concentrations of organic nitrogen usually range below 1.0 mg/l in relatively unpolluted waters (Boyd, 1979).

Inorganic nitrogen averages increased only slightly from 0.25 mg/l to 0.32 mg/l during the same period. However, this relative stability was due to a decline in ammonia with a concomitant rise in NO_3/NO_2 levels over the last decade. Apparently, phosphorus levels have increased twice as rapidly as nitrogen in Lake Redfield from 1983 to 1991-92.

Nutrient and Sediment Loadings to Lake Redfield

The extent of nutrient and sediment loading to Lake Redfield from its three tributaries during 1991 was estimated in the final phases of this assessment. The period of stream flow during 1991, a year of above average rainfall in the Redfield area, extended from April through September and October (Turtle Creek). Tables 11 and 12 present total and areal loadings to Lake Redfield and the net nutrient and sediment mass accumulated in the lake during 1991.

This portion of the assessment was hampered by the difficulty of accurately measuring tributary water flows (cfs) into Lake Redfield on an annual basis to arrive at a representative hydrologic budget for the lake. Due to the flat terrain of the immediate watershed, water flows at the inlet sites abated at times and then reversed direction to move 'upstream' on several occasions in July when the lake was apparently in overflow after being temporarily filled to capacity during this high rainfall year.

The results presented in Table 12 imply Lake Redfield is receiving extremely high loads of phosphorus and moderate loads of nitrogen from its large watershed. Surprisingly, Turtle Creek contributed only slightly more than 52% of the phosphorus load while the northern tributary at site 3 accounted for 33%. Nitrogen and suspended solids (sediment) loads were more nearly proportioned with Turtle Creek providing nearly 60% and 73% respectively (Table 11). Suspended solids (sediment) loads appear to be minor but may represent a considerable underestimate. Suspended solids loads (TSS) are probably not equivalent to annual sedimentation that accrues to Lake Redfield from those tributaries.

Due to the large outflow of water (high reservoir flushing rate) from Lake Redfield in 1991, most of the incoming nutrients and sediments were not retained (accumulated) in the lake basin (Table 12).

Table 11. Nutrient and Sediment Total Loads and Areal Loads to Lake Redfield - 1991.

	(acre-ft)	Total Load (kg/yr)			Areal Load (g/m ^ 2/yr)		
Sites	Water Inflow	Total Phosphorus	Total Nitrogen	Total Susp. Sediment	Total Phosphorus	Total Nitrogen	Total Susp. Sediment
1	3,041	2,852	7,431	152,409	4.42	4.15	10.80
2	961	791	1,962	21,224	1.40	1.15	2.85
3	1,502	1,828	3,082	36,534	2.18	2.66	4.48
TOTAL	5,504	5,471	12,475	210,167	8.00	7.95	18.13
* Permissible Load		536.2	7,660.0	----	0.07	1.00	----
* Excessive Load		995.8	15,320.0	----	0.13	2.00	----

* Vollenweider (1968) phosphorus and nitrogen loadings based on Lake Redfield's mean depth (<5 meters) and surface area (69 ha = 170 ac).
Permissible Loads= Those which would cause the receiving lake to become less eutrophic or mesotrophic.
Excessive Loads= Those which would cause the receiving lake to become eutrophic or remain eutrophic.

Table 12. Lake Redfield Water, Nutrient, and Sediment Mass Balance - 1991.

Parameter	Inflow	Outflow	Accumulated	Percent Accumulated	Net Area Load (g/m ^ 2/year)
Water Flow acre/feet	5,504	4,517	987	17.93%	-----
Total Nitrogen kg/year	12,475	10,542	1,933	15.49%	1.23
Total Phosphorus kg/year	5,471	4,169	1,302	23.80%	1.90
Sediment kg/year	210,167	189,973	20,194	9.61%	1.74

Tributary Water Quality

Tributary inlet sites 1, 2, and 3 were sampled a total of 10 times during this assessment (Table 13). Water quality data from those sites indicated that Turtle Creek (site 1), the Twin Lakes tributary (site 2), and a minor northern tributary (site 3) experienced high levels of phosphorus and nitrogen contamination and delivered those high concentrations to Lake Redfield. Incoming suspended solids (TSS) from all tributaries were of lesser importance and appeared to exert only a moderate impact on the lake.

All three tributaries contributed high concentrations of fecal coliform bacteria to the lake. Turtle Creek would be expected to have a greater effect on the lake due to higher water flows in this stream, however, fecal coliform concentrations in the minor northern tributary (site 3) averaged 10 times higher (Table 13) so the impact of this smaller stream on Lake Redfield must be considered as major in this case.

Fecal Coliform

Fecal coliform concentrations exceeding 200 per 100 ml of lake water is considered potentially unsafe for immersion recreation, as previously discussed. Although this standard does not apply directly to streams, it may be used to illustrate the amount of contamination that may be occurring in the tributaries. During the study period, fecal coliform concentrations exceeded 200/100 ml in 43% of samples tested from Turtle Creek, 33% from site 2, and 71% from the northern tributary site 3 (Table 13).

While no exceedences of the lake coliform bacteria standard were detected during this assessment (possibly due to insufficient sampling frequency) the elevated in-lake bacteria concentrations recorded at site 6 (downstream of tributary site 3) and the spillway (site 4) during periods of runoff, indicate a likely effect of tributary fecal coliform contribution mitigated by lake dilution (Table 9). Sources of fecal coliform contamination should be identified and controlled to prevent a possible public health hazard and to protect immersion recreation in Lake Redfield.

Nitrogen

Excessive nutrient concentrations transported to state lakes are the primary cause of uncontrolled growth of nuisance blue-green algae and aquatic weeds. All tributaries contributed high concentrations of phosphorus and nitrogen to Lake Redfield, particularly phosphorus. Total nitrogen input averaged 2.08 mg/l at Turtle Creek site 1; 1.74 at site 2, and; 2.07 mg/l at site 3 (Table 13).

Inorganic N (ammonia, nitrates, nitrites), the form of nitrogen most readily utilized by algae and aquatic plants, comprised nearly 22% of tributary nitrogen input. Site 1 accounted for an average of 0.43 mg/l of inorganic N; site 2 - also 0.43 mg/l, and ; site 3 - 0.41 mg/l, for the study period.

Organic nitrogen made up 78% of total tributary nitrogen. As with inorganic N, mean concentrations of organic nitrogen were similar between sites 1, 2, and 3 - 1.65, 1.31, and

Table 13. Lake Redfield tributary water quality parameter means, medians, and ranges, April 15, 1991 to August 6, 1991 (n = 10, 10, 10).

Parameter	Parameter mean, median, and range		
	Site 1	Site 2	Site 3
Dissolved Oxygen (mg/l)	9.7, 9.7 (4.2 - 16.1)	7.0, 6.2 (1.4 - 13.5)	3.8, 3.0 (1.2 - 10.7)
Lab pH (s.u.)	8.5, 8.6 (7.7 - 9.0)	8.0, 8.0 (7.3 - 8.7)	7.8, 7.6 (7.1 - 8.5)
Fecal Coliform (#per/100 ml)	295, 50 (2 - 1280)	252, 35 (2 - 730)	2884, 1100 (30 - 12000)
Total Alkalinity (mg/l)	271, 289 (135 - 351)	179, 184 (57 - 279)	215, 223 (39 - 397)
Total Solids (mg/l)	888, 835 (416 - 1644)	661, 552 (303 - 1539)	665, 543 (163 - 1533)
Total Dissolved Solids (mg/l)	828, 783 (389 - 1549)	616, 506 (265 - 1463)	607, 488 (135 - 1484)
Total Suspended (Susp.) Solids (mg/l)	46, 45 (26 - 70)	27, 27 (10 - 38)	49, 26 (6 - 252)
Total Volatile Susp. Solids (mg/l)	23, 24 (16 - 36)	12, 12 (3 - 20)	18, 12 (4 - 72)
Total Non-Volatile Susp. Solids (mg/l)	23, 20 (6 -40)	13, 12 (2 - 28)	29, 4 (2 - 180)
Total Ammonia (mg/l)	.07, .02 (.02 - .28)	.06, .02 (.02 - .22)	.04, .03 (.02 - .06)
Nitrate + Nitrite (mg/l)	.36, .45 (.10 - .70)	.37, .50 (.10 - .60)	.37, .50 (.10 - .60)
TKN (mg/l)	1.72, 1.70 (1.26 - 2.34)	1.37, 1.39 (1.12- 1.61)	1.70, 1.69 (.60 - 3.16)
Organic Nitrogen (mg/l)	1.65, 1.63 (1.16 - 2.32)	1.31, 1.36 (1.03 - 1.53)	1.66, 1.46 (.68 - 3.13)
Total Nitrogen (mg/l)	2.08, 1.98 (1.45 - 2.94)	1.74, 1.77 (1.22 - 2.21)	2.07, 1.99 (.81 - 3.66)
Total Phosphorus (mg/l)	0.98, 1.04 (.36 - 1.38)	.71, .75 (.22 - 1.02)	1.00, .83 (.30 - 2.10)
Dissolved Phosphorus (mg/l)	.69, .72 (.10 - 1.19)	.57, .61 (.09 - .79)	.84, .64 (.14 - 2.01)
Nitrogen to Phosphorus Ratio	2 : 1	2.4:1	2:1

1.66 mg/l, respectively.

Only limited comparisons regarding tributary nitrogen can be made between the present assessment and the 1983 DENR study since TKN-nitrogen was not determined and site 2 had not been established at that time. Inorganic N levels appear to have increased by 87% at Turtle Creek site 1 from 0.23 mg/l in 1983 due to increases in NO_3/NO_2 compared to a 30% increase in-lake during this period for the same reason. There was insufficient 1983 data from site 3 for comparative purposes.

Phosphorus

Tributary average phosphorus (TP) concentration (.90 mg/l) was nearly one-third higher than the in-lake mean (.68 mg/l). Mean phosphorus levels in the tributaries ranged from 0.71 to 1.00 mg/l with the lowest average recorded at site 2 (Table 13). Nevertheless, nearly all of the readings obtained represent extremely high amounts of phosphorus that have been transported to the lake where they are available to produce algal blooms and nuisance weed growth.

Dissolved phosphorus, the form most readily available to plants, made up an average of 78% of total phosphorus (TP) at the three tributary inlet sites. The percentage of dissolved phosphorus at sites 2 and 3 (82%) was similar to the in-lake value (83%). Turtle Creek had the lowest percentage of dissolved phosphorus as part of TP (70%). Those high percentages of dissolved phosphorus may be indicative of water contamination from animal and/or human wastes and runoff from overfertilized cropland. Tributary phosphorus levels appeared to have doubled in the last 10 years when comparisons were made with the 1983 DENR monitoring study. The increases were similar to those recorded for in-lake phosphorus.

Suspended Solids (TSS)

There was only one exceedence of the 150 mg/l TSS standard for warmwater marginal fisheries recorded during this study (site 3). Average suspended solids concentrations at tributary sites ranged from 27 mg/l at site 2 to 46 and 49 mg/l at sites 1 and 3, respectively. The TSS values for site 2 can be considered to be in the moderate range whereas those of sites 1 and 3 are probably near or below the average for prairie streams during periods of significant flow. With few exceptions, those TSS levels did not appear to represent a serious sedimentation problem for Lake Redfield (Table 13, Appendix B).

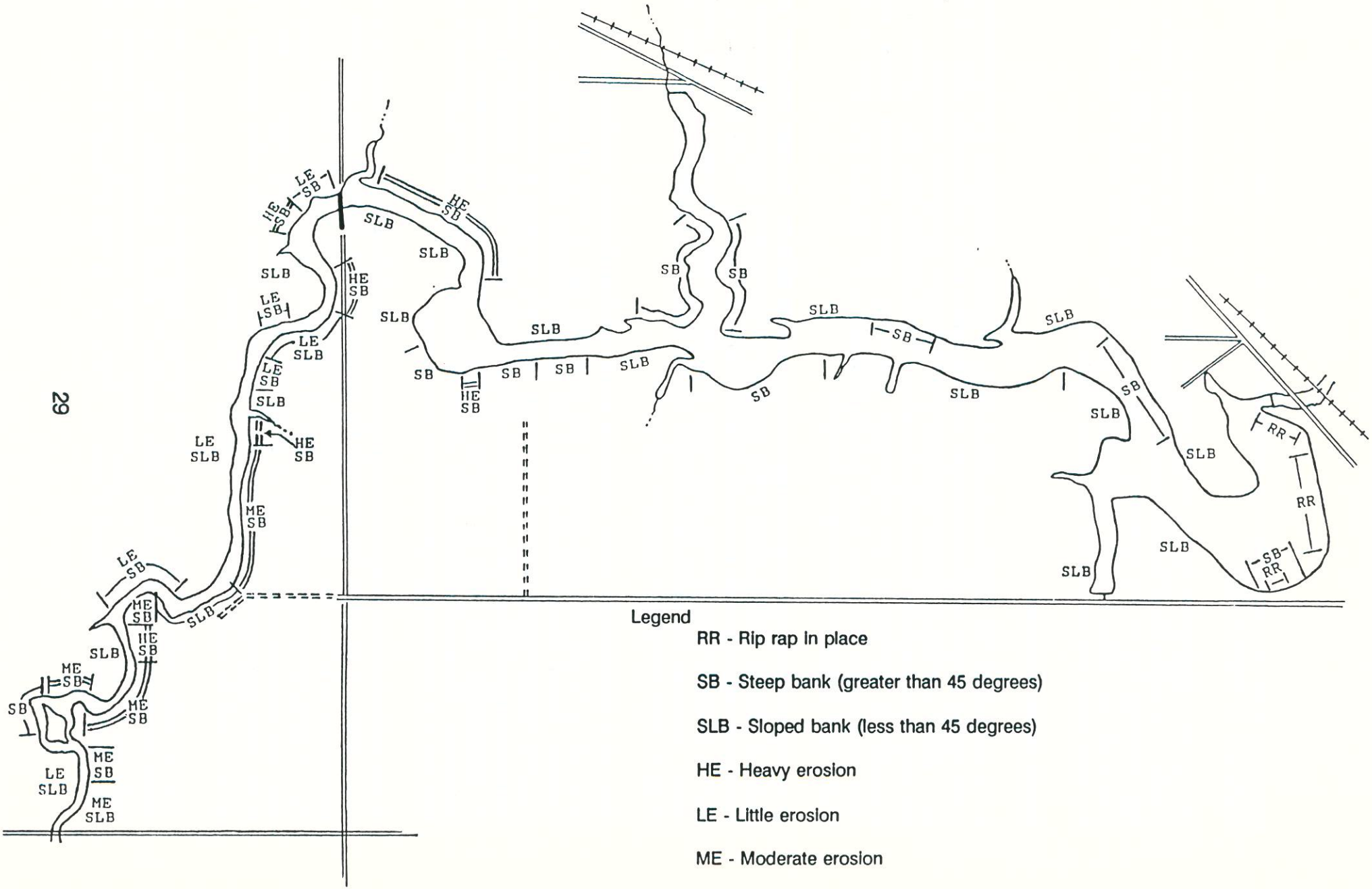
However, the low dissolved oxygen levels (mean: 3.8 mg/l) at site 3 suggest that large accumulations of organic material may have been present and decomposed upstream of this site (Appendix B). This organic material may have originated in livestock waste or septic tank effluent. In the process of undergoing decay (oxidation) excessive organic matter in a small stream may deplete dissolved oxygen supplies faster than they can be replenished from the air.

Shoreline Erosion

A shoreline survey was conducted during the summer of 1991 by personnel of the City of Redfield to identify and categorize those stretches of Lake Redfield shoreline that may be contributing significant sediment loads to the main basin of the impoundment.

Twelve such shoreline segments consisting mainly of steep or sloped banks 3 to 8 feet high and 168 to 1,320 feet in length were noted around the lake periphery shown in Figure 5. Those segments were qualitatively rated according to perceived erosion potential using such characteristics as amount and type of vegetative cover, steepness of slope, type of surface, and actual signs of erosion. Using these criteria, shoreline

Figure 5. Shoreline slope and bank erosion areas in Lake Redfield (1991).



segments were separated into four categories as having no perceptible erosion, little, moderate, or heavy erosion.

The results indicated that heavy erosion may be occurring on approximately 3,506 feet (1,069 m) or nearly 5% of the shoreline and moderate erosion on 4,455 feet (1,358 m) or approximately 6% of the lakeshore. Nearly all of the significant shoreline erosion (moderate and heavy erosion) appeared to be occurring near the western boundary of the main basin and immediately upstream (Figure 5).

Septic System Survey

In the summer of 1991 DENR conducted a survey of on-site wastewater disposal facilities in the vicinity of Lake Redfield and those near tributaries within a three-mile radius of the lake. DENR and City personnel distributed a septic system survey form to lakeshore and tributary creek residents in the designated areas. The forms that were returned (49) were analyzed by comparing the information submitted (some returned forms were incompletely filled out) to the South Dakota Regulations on Individual and Small On-site Wastewater Systems under chapter 74:03:01.

All surveyed residences relied on septic tanks and tile fields for sewage treatment and disposal. Overall working order of the surveyed on-site systems appeared adequate to satisfactory with only a few examples of below standard operation. There was not a large number of system failures that could result in contamination of the lake or local ground water. However, four septic tank systems did not meet state guidelines for location and distance from the lake or occupied residences.

One major characteristic of the lakeshore and immediate tributary residences that may give rise to future problems involved the advanced age of most of their wastewater systems. Ten of 15 septic tanks (67%) in this surveyed area for which construction date could be determined were over 20 years old. Generally, 15 years is considered the limit for effective operation of many septic tank systems after which time an increasing number of malfunctions are likely to develop, if proper repairs and maintenance are not performed. These malfunctions hinder proper treatment and disposal of wastewater loads and result in increased pollution to local water bodies.

Some present defects noted in existing systems included the presence of open drainage pipes where 'gray water' poured into the ground or was pumped into dry wells, an excavation, or a tree line. One tile field was installed 20 feet from the lakeshore and at least 3 septic tanks were placed less than 10 feet from occupied residences. There was only one probable surface failure of a septic system noted in the vicinity of the lake. None were observed near the surrounding tributaries. About 10% of the systems in this group could be recommended for upgrade at this time.

The domestic water supply for 53% of the survey respondents in this area is the WEB Water Development Corporation. This included 11 private residences and one small business, the Farmer's Union Co-op (a fertilizer storage and mixing facility) located near water quality monitoring site #3 (Figure 1). The remaining 48% of respondents relied on

private wells for their drinking water. These were nine residences, mainly farms, and one small meat processing concern near the northeast lakeshore. A junk dealership, also near site #3, had no apparent water supply. Lake and tributary water was used only to water lawns and gardens by local residents.

Shar-Winn Estates, a residential development about 0.7 mile south of the Lake Redfield dam, also was surveyed in August 1991. Responses were obtained from 26 residents. The septic tank systems of 23 residences (89%) appeared to be in good working condition. There was probable surface failure in the septic systems of the remaining 3 residences. Prompt repair to these systems is recommended to avoid a possible future public health hazard and to prevent contamination of local ground water.

Sediment Survey

DENR in cooperation with the City of Redfield and the Spink County Conservation District conducted a sediment depth survey on August 6, 1986 to measure the accumulation of loose, soft sediments in the lower lake basin since the closure of the Lake Redfield dam in the mid-1930's. Seven transect lines that were originally plotted on a large photographic map across the open water areas of the lower reservoir are shown in Figure 6. Detailed sediment depth sounding data including oversize cross-sectional depth diagrams will be made available from the Division of Water Resources Management (WRM), Pierre, SD.

A winter sediment survey scheduled by DENR for early 1992 could not be carried out due to an unusually mild winter that resulted in hazardous thin ice conditions on Lake Redfield.

A data summary of the 1986 sediment survey is presented in Table 14. The results indicated average sediment depth in the lower Lake Redfield basin was 4.1 feet (1.2m). Mean sediment depth in the seven transects ranged from 3.2 feet at site A to 5.7 feet at site B (Figure 6). Heaviest accumulations of sediment occurred off the eastern lakeshore from B-1 to D-1 (Figure 6, Table 14).

The sediment mean depth of 4.1 feet distributed over the 42 acres of open water area represented by Figure 6 (J. Anderson, 1986) gives an estimate of 170 acre-ft or 275,000 cubic yards of sediment volume accumulated over a reservoir life span of some 50 years.

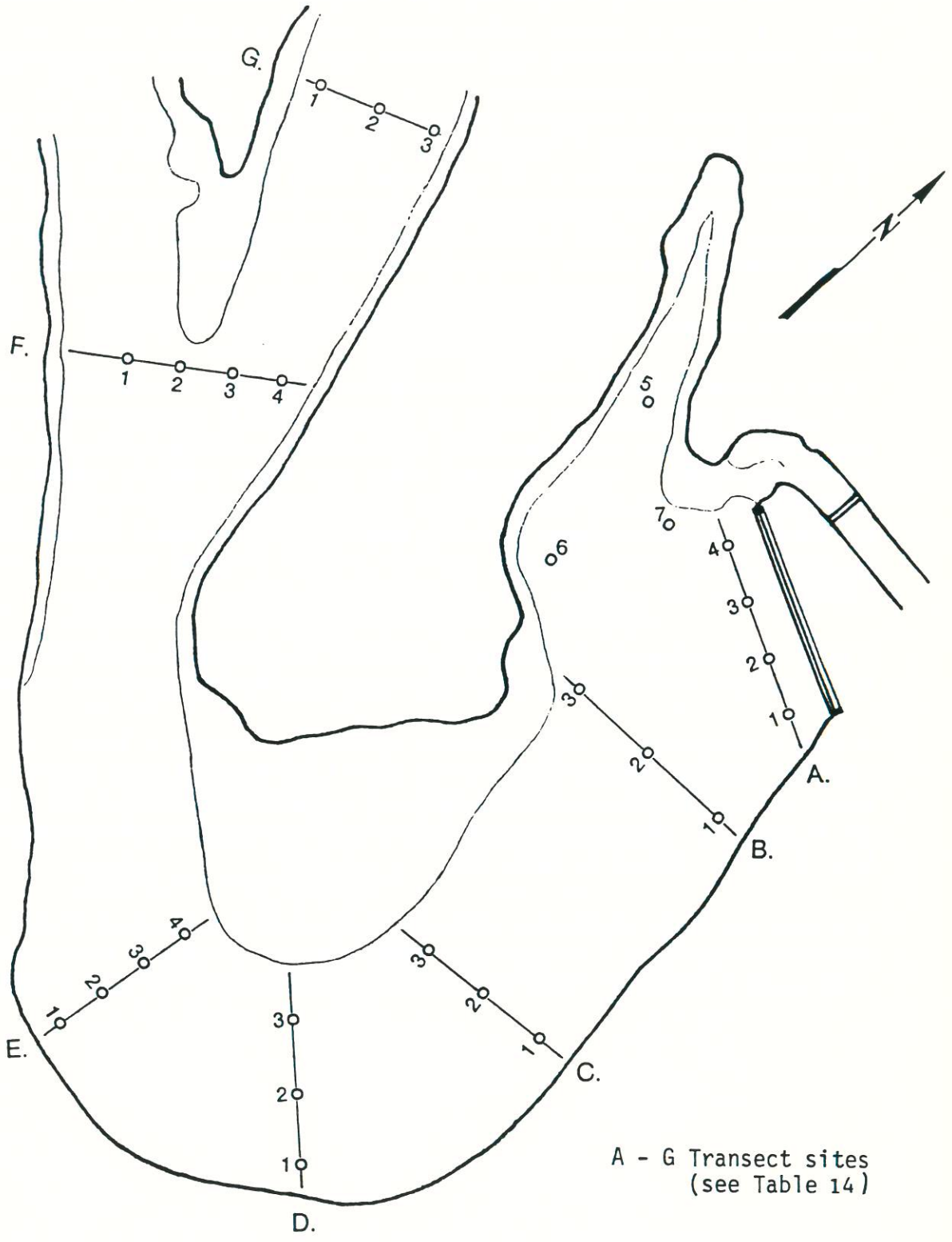


Figure 6. Lower Lake Redfield and approximate distribution of transects for sediment survey (1986).

TABLE 14. Summary of sediment depth survey, Lake Redfield, August 6, 1986.

Site	Water Depth (ft.)	Sediment Depth (ft.)	Type
A 1	9.8	4.4	mud/gravel
2	10.3	1.4	gravel/sand/mud
3	10.1	5.0	mud/rock
4	4.8	2.7	mud
5	5.9	2.5	mud
6	5.4	4.1	mud
7	4.4	2.6	gravel/mud
B 1	12.0	7.9	mud
2	11.4	6.8	mud
3	4.6	2.3	mud
C 1	12.1	9.7	mud
2	8.7	1.9	mud
3	4.8	2.7	mud
D 1	11.9	8.4	mud
2	6.9	1.2	mud
3	4.0	2.2	mud
E 1	10.9	5.3	mud/riprap
2	10.2	6.5	mud
3	6.5	2.2	mud
4	4.2	2.7	mud
F 1	9.6	5.8	mud
2	7.0	1.3	mud
3	9.9	3.5	mud
4	9.8	5.8	mud/gravel
G 1	5.0	2.6	mud
2	10.6	2.5	mud
3	11.6	5.7	mud

Source: J. Anderson, DENR, 1986

- average depth of sediment:
  4.06 feet (1.24m) under open water and 1.5 feet (0.46 m) under cattail beds.

- water flowing 0.2 foot deep over spillway during survey.

This would appear to suggest a moderate annual rate of sediment build-up at least for the lower reservoir. However, considering the small size of the reservoir basin, that sediment volume might be expected to have significantly reduced the water holding capacity of this impoundment over the last several decades.

Watershed Inspection/Land Use

Because of the magnitude of the Lake Redfield watershed, only that portion within Spink County (approx. 100,000 acres) was designated for investigation under this study. The effect of limiting the study to this area is to concentrate efforts in those proximal subwatersheds that have the highest potential for delivery of sediment and nutrients to the lake.

As previously mentioned, this southwestern corner of Spink County contains two other sizeable lakes south of Lake Redfield. In addition, there are many small wetlands scattered throughout this area that make up 15% or more of the landscape. Major tributaries are Turtle Creek, Medicine Creek, and Wolf Creek. Cropland and grasslands are randomly distributed at an approximate ratio of 55% cropland and 45% grassland. Principal crops grown include small grains in rotation with corn, soybeans, and some sunflowers.

The major soils of the region shown in Figure 7 are Houdek and Bonilla along the west, north, and south sides and Hecla/Wessington in the east central portion of the area. The Soil Conservation Service is in the process of completing their updated and revised Soil Survey of Spink County to be released later in 1993 which will contain a more detailed description of the major soils in this part of the Lake Redfield drainage.

According to a watershed survey conducted in Spink County by City of Redfield personnel, the Spink County Conservation District (SCCD) and DENR, there are approximately 207 farmsteads/livestock operations within the eight townships in the inspected area. Those townships are shown in Figure 7 lying north, south, and west of the City of Redfield. Figure 7 also shows acreages classified as highly erodible land (HEL) by SCS. These are mostly cultivated acreages where topsoil losses are likely to exceed 5 tons/acre/yr. Approximately 11,700 acres of HEL occur within the Lake Redfield drainage and nearly 11,500 acres lie east of the watershed boundary (Figure 7). In the past, wind erosion has been a severe problem in the large block of HEL south of the City of Tulare.

In this connection, the watershed inspection noted that windbreaks in the drainage were often in poor condition and too few in number. Additionally it was concluded that large areas of grassland and some wetlands were being overgrazed and that livestock watering areas were too near the tributaries or actually in the streams. Considerable numbers of cattle were observed grazing near the lakeshore and manure-spreading on acreages adjoining Turtle Creek and Lake Redfield was also noted. One of the conclusions reached by the inspection team was that local feedlots were having an appreciable impact on watershed surface and ground water in providing high levels of nutrients to streams, lakes, and both shallow and deep aquifers.

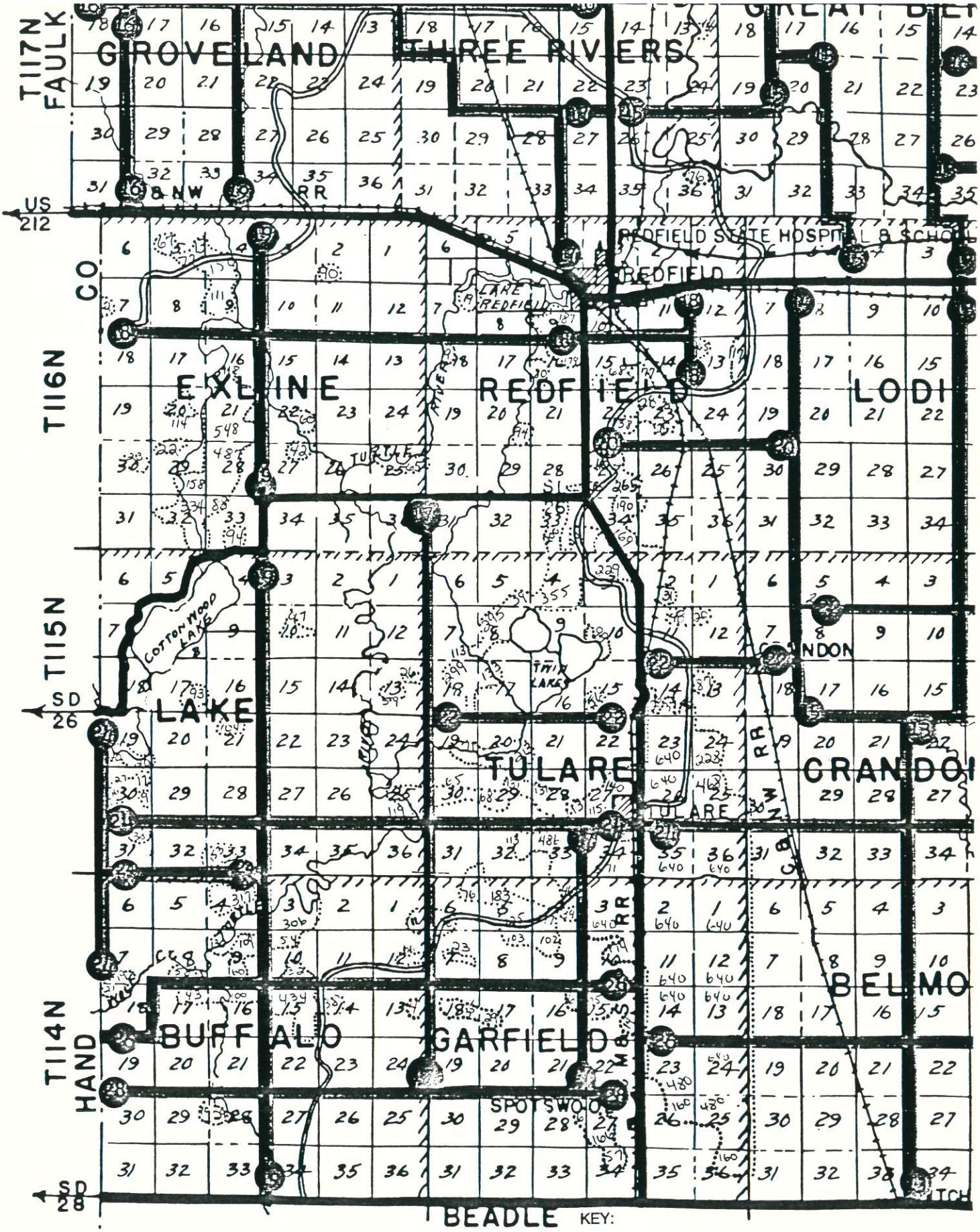


Figure 7. Highly erodible land in the Spink County lake drainage.

To test that evaluation, Redfield personnel and DENR gathered pertinent data from 25 feedlots operating in the drainage and used a feedlot computer model (Young et al, 1982) to objectively evaluate the relative pollution potential of those livestock operations for a design rainfall of 4.25 inches. The essential results of the computer run are summarized in Table 15. An important output of this computer program is a series of feedlot rating numbers from 0 to 100 with zero signifying no apparent feedlot effect. Livestock operations with a rating of 25 or greater may be suspected of producing a significant impact and warrant further investigation while those feedlots with a rating of 50 or more are very likely discharging a considerable pollution load to the receiving water.Table 15 shows that 11 of 25 tested feeding operations (44%) had surface-water ratings of from 36 to 84 indicating (especially for the higher values of this range) those livestock operations have the characteristics of polluting feedlots. However, the feedlot model was unable to demonstrate any significant effect of the same livestock operations on local groundwater (ratings: 0-2).

Table 15. Pollution rating numbers for feedlots in the Turtle Creek/Lake Redfield watershed (Spink County) 1991.

Feedlot No.	Feedlot Outflow Receiving Water	Surface-Water Rating No.	Ground-Water Rating No.
1	Wolf Creek	0	1
2	Twin Lakes	49	0
3	Twin Lakes	0	1
4	Twin Lakes, Redfield Lake	0	2
5	Turtle Creek, Redfield Lake	45	1
6	Turtle Creek, Redfield Lake	37	1
7	Wolf Creek, Turtle Creek, Redfield Lake	0	1
8	Turtle Creek, Redfield Lake	36	1
9	Turtle Creek, Redfield Lake	0	1
10	Turtle Creek, Redfield Lake	42	2
11	Turtle Creek, Redfield Lake	81	2
12	Turtle Creek	0	1
13	Turtle Creek	0	1
14	Turtle Creek, Redfield Lake	0	0
15	Turtle Creek, Redfield Lake	60	1
16	Turtle Creek	45	1
17	Turtle Creek, Redfield Lake	0	1
18	Turtle Creek	0	1
19	Turtle Creek, Redfield Lake	0	1
20	Turtle Creek	0	1
21	Turtle Creek, Redfield Lake	84	1
22	James River	50	1
23	Dove Creek	51	1
24	Dove Creek	0	1
25	Dove Creek	0	1

CONCLUSIONS

1. The 1991 DENR lakeshore vegetation survey indicated approximately 80% of shoreline surrounding the main reservoir basin of Lake Redfield is thickly overgrown with emergent aquatic vegetation, primarily cattail. Overgrowth of cattails presently limits public access to the shoreline and in general reduces the recreational potential of the lake. Submergent and floating aquatic plants were not a serious nuisance at the time of the survey due mainly to water turbidity.

2. Uncontrolled growth and colonization of cattail has taken place in Lake Redfield due mainly to the local phosphorus-rich environment and siltation over the 50-year life span of the reservoir.

3. Excessive growth of emergent vegetation (cattail) has a number of undesirable effects, 1) cattail beds trap additional incoming silt and provide biomass that reduce reservoir water holding capacity, 2) increases water evaporation by plant transpiration processes which significantly increases lake water losses during drier years, 3) reduces convenient lake access for public use, 4) diminishes aesthetics and recreational value of the lake, and 5) creates unnecessary additional nutrient reserves in the lake by decay and recycling of phosphorus and nitrogen. Large masses of decaying vegetation may stain lake water a coffee color.

4. Approximately 10 acres or more of cattails are presently established along the shoreline of the eastern basin of Lake Redfield. Cattail beds are concentrated primarily in the spillway area, the large peninsula immediately to the south, and in a silt-formed, 2-acre island to the east of the spillway. Those areas of concern are designated by a border of short dashes in Figure 3. Area A. in Figure 3 denotes that part of Lake Redfield receiving the most public use where removal of the heaviest growths of cattail is proposed to increase access and in general improve the recreational potential of the lake.

5. Very high concentrations of total phosphorus (TP) (mean: 0.68 mg/l) were present in Lake Redfield during the study period. According to some literature sources, concentrations of total phosphorus greater than 0.05 mg/l are indicative of extremely eutrophic (hypereutrophic) conditions.

6. Dissolved phosphorus made up 83% of in-lake total phosphorus during the study reflecting tributary contributions of this form of phosphorus. Tributary sources of dissolved phosphorus may be feedlot runoff and, secondarily, leaching of phosphorus from nearby fertilized cropland and manured fields.

7. Tributary averages for total phosphorus (.71 to 1.00 mg/l) were higher than in-lake means indicating that the three tributaries may be the principal contributors of phosphorus to the lake.

8. Similar to in-lake samples, dissolved phosphorus comprised 80 and 84% of TP at inlet sites 2 and 3, respectively; and a somewhat lower percentage (70%) was recorded for Turtle Creek inlet site 1.

9. Relative to phosphorus, in-lake organic nitrogen (TKN nitrogen minus ammonia) was present at much less extreme levels (mean: 1.67 mg/l). Generally, organic nitrogen concentrations of 1.0 mg/l or less can be a reasonable goal set for productive lakes. In-lake ammonia levels were low to moderate throughout the study.

10. Mean organic nitrogen concentration in the tributaries (1.54 mg/l) although slightly lower can be considered similar to the in-lake average. However, low dissolved oxygen levels at tributary site 3 (less than 3 mg/l in half of all samples tested) strongly suggested the presence of relatively large quantities of decomposable organic matter upstream of the site that may have come from animal or human wastes.

11. Nitrate/nitrite concentrations increased sharply during summer in the lake and tributaries (0.5 to 0.9 mg/l) from low or undetectable densities (0.10 mg/l) at other times of the year.

12. Based on the excessive quantities of in-lake phosphorus and relatively smaller concentrations of nitrogen, Lake Redfield can be classified as a 'nitrogen-limited' lake during 1991. However, it was also concluded that in-lake nitrogen supplies appeared sufficient to support large algal populations.

13. Lake Redfield is experiencing excessive phosphorus loading and moderate nitrogen loading from its tributaries.

14. In the last 10 years in-lake phosphorus concentrations appeared to have doubled and nitrogen levels increased by 50%. These increases suggest there has been a corresponding increase in agricultural activities in the Lake Redfield immediate watershed over the past decade.

15. Sediment (TSS) accumulation in Lake Redfield during 1991 appeared to be minor (.02 acre-ft). During that year of high rainfall and reservoir flow-through, incoming sediment amounted to 0.20 acre-ft from the three tributaries. Approximately 90% of this sediment (0.18 acre-ft) was discharged from the reservoir and only 10% was retained in the basin. These are very small amounts of sediment and probably represent a considerable underestimate. Total Suspended Solids (TSS) loads do not appear to be equivalent to lake sedimentation.

16. In-lake and spillway fecal coliform bacteria concentrations seemed to reflect high densities present in the tributaries especially at tributary site 3 (mean: 2884/100 ml). There were no actual violations of the lake immersion recreation standard but potential problems are indicated.

17. Site 3 also recorded disproportionately large loads of nutrients entering the lake from this small northern tributary which drains only about 7680 acres or less than 1% of the total watershed.

RECOMMENDATIONS

Based on the results of this study, the DENR recommends the following alternatives for restoration. These recommendations should provide a basis for the development of a complete restoration work plan and subsequent implementation. The recommendations are provided for review only. The following are not to be considered as the only possible methods of restoration.

A. Removal of Cattails:

Removal of approximately 10 acres of cattail mainly from the designated areas in the eastern basin of Lake Redfield shown in Figures 3 and 6 is recommended. Several plausible restoration alternatives for cattail control were examined: 1) Lowering or raising reservoir water level for a sufficient length of time to dessicate or drown cattail beds. 2) Periodic mowing of cattail beds 3) Chemical treatment with EPA approved herbicides. 4) Cattail removal by hydraulic dredge combined with selective dredging of lake sediments, and 5) Mechanical removal using land-based equipment on frozen ground with limited sediment dredging following lake drawdown.

All but the last alternative (5) were rejected after review. Alternative 1 would have little significant effect on cattails. These hardy plants seem to prefer fluctuating water levels for best growth. Alternative 2 may be reasonably economical but is of short-term benefit requiring periodic maintenance. Alternative 3 is cost-effective and easily carried out but results may be relatively short term and residual toxic effects and accumulations of chemicals in lake sediments are a serious concern. Alternative 4 has the advantage of not requiring a lake drawdown. A hydraulic dredge would also be most efficient for removal of lake sediments. However, the hydraulic dredge can not process the heavy root systems of cattails effectively. Past experience has shown that cattail roots and stems easily jam the pump of the dredge making this approach to cattail removal ineffective.

Land based earth moving equipment, such as draglines and backhoes, can be used in the implementation of preferred alternative 5. Lake drawdown can be carried out in late September to provide sufficient drying time for nearshore sediments.

Harvested cattail and associated sediment should be trucked away from the immediate lake watershed and disposed of at carefully selected solid waste locations. As an alternative, dredged soil could be used to build up sections of shoreline, or spread on softball fields and parks.

Cattail removal can best be accomplished in two steps. Cattails can be mowed by a mechanical harvester to nearly ground level. The cut cattails can then be harvested and hauled away for storage or burning, leaving only short stubble and the root mats which can then be bladed or scooped out with land-based equipment such as draglines and backhoes.

Enough sediment should be removed at the sites of former cattail beds to create offshore open water areas at least 3 feet (1 m) deep. If this depth is reasonably maintained over the years, significant regrowth of cattails can be held back for a decade or more, at present rates of sedimentation. To dredge 3 feet of silt from a 10-acre area of cattails is to remove roughly 48,400 cu yd of sediment.

After lake drawdown, fish seining operations could be conducted by the SD GF&P to avoid an extensive winter fish kill and at the same time improve the local fishery. Abundant rough fish (mostly carp and black bullhead) could be removed and disposed of, and any game fish transferred to a nearby lake to be restocked the following spring.

B. Ag Waste Management Systems

Installation of animal waste management systems (AWMS) at the feedlots in the immediate watershed (Spink County) would represent a positive step to reduce nutrient and fecal coliform bacteria transported to Lake Redfield. Approximately eleven (11) AWMS's would be needed to contain most of the feedlot runoff in the immediate lake drainage area. In addition, a number of alternate watering sources should be provided for cattle presently grazing on the lakeshore and near tributary inlets.

C. Best Management Practices on Cropland

Best Management Practices (BMP) should be applied to cropland and pastures where necessary, to reduce nutrient loading to the lake. Minimum tillage practices should be stressed as a preferred method of crop residue management. Fertilizer application rates and timing should be monitored to determine if they contribute to excessive nutrient loading. Landowners need to maintain established Best Management Practices or else any gains in nutrient and sediment reduction will be lost.

D. Shoreline Erosion

Approximately 3,500 feet of Lake Redfield shoreline is in need of some kind of stabilization through planting cover or riprapping.

E. Planned Grazing Systems

Planned grazing systems should be applied on 5,000 to 10,000 acres of native range in the Spink County watershed to improve range conditions.

F. Manure Spreading Practices

Surface manure spreading on croplands should be limited to 100 to 300 feet away from the banks of tributaries and 300 feet from the lakeshore. Injection and incorporation of farm manure on land should be limited to 50 feet from streams and 100 feet from lakeshores. Manure spreading should not be conducted during frozen ground periods. Manure should not be stored near lakeshores or tributaries at any time.

G. Tree Planting

To stabilize watershed soils and reduce wind erosion, tree planting needs to be carried out to create needed shelter belts and to repair existing windbreaks.

H. Conservation Reserve Program

Up to 11,700 acres of eroding crop and rangeland in the Lake Redfield drainage in Spink County may be eligible for protection (permanent grass cover) under the CRP program. Present CRP signups in the local drainage total 5,700 acres according to the Spink County Conservation District. For each individual tract appropriate Best Management Practices (BMP) should be applied as needed.

I. Septic Tank Systems

The septic tank systems of three residences at the Shar-Winn Estates may require upgrading and possibly one system in the vicinity of the lake. Septic tank systems of lakeside residences and those near lake tributaries should be monitored periodically due to the advanced age of many of those wastewater facilities.

J. Tributary Site 3

Due to the disproportionately high contribution of phosphorus, nitrogen, and fecal coliform bacteria from the northern tributary (site 3), this stream and its small drainage basin should be given priority in a further investigation to determine the source(s) of pollutants entering the lake.

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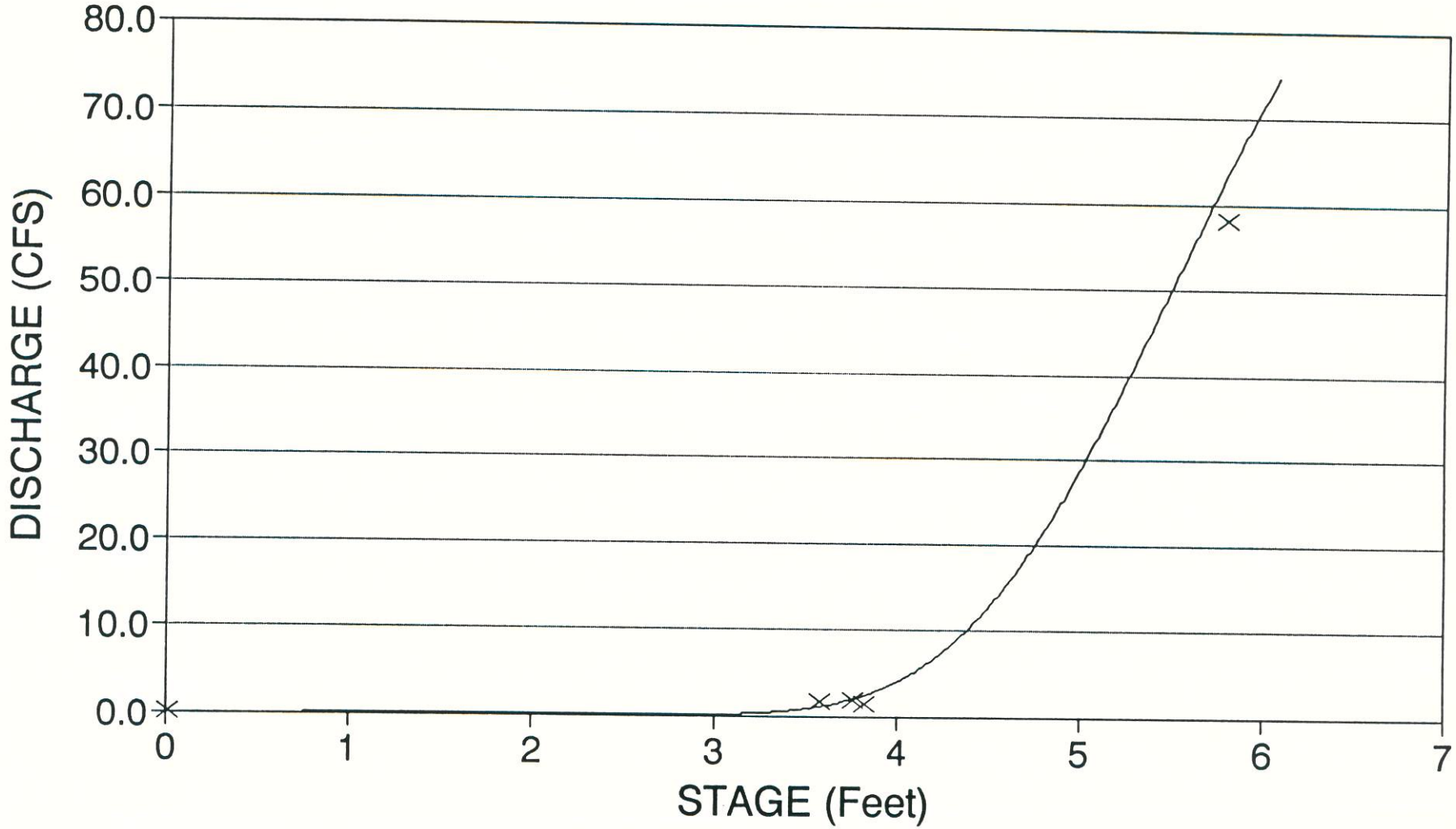
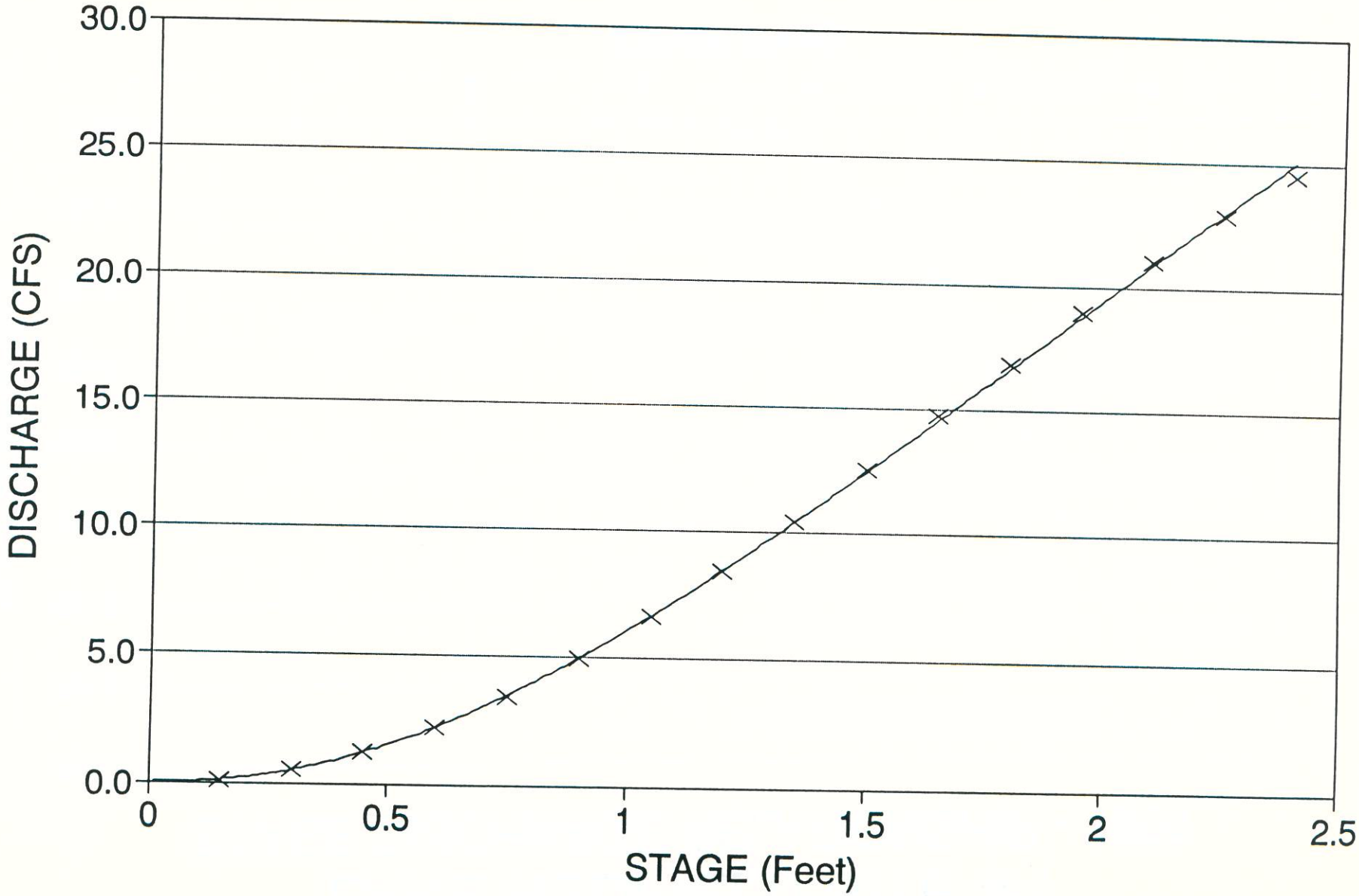
APPENDIX A
Stream Flow and Loading Data

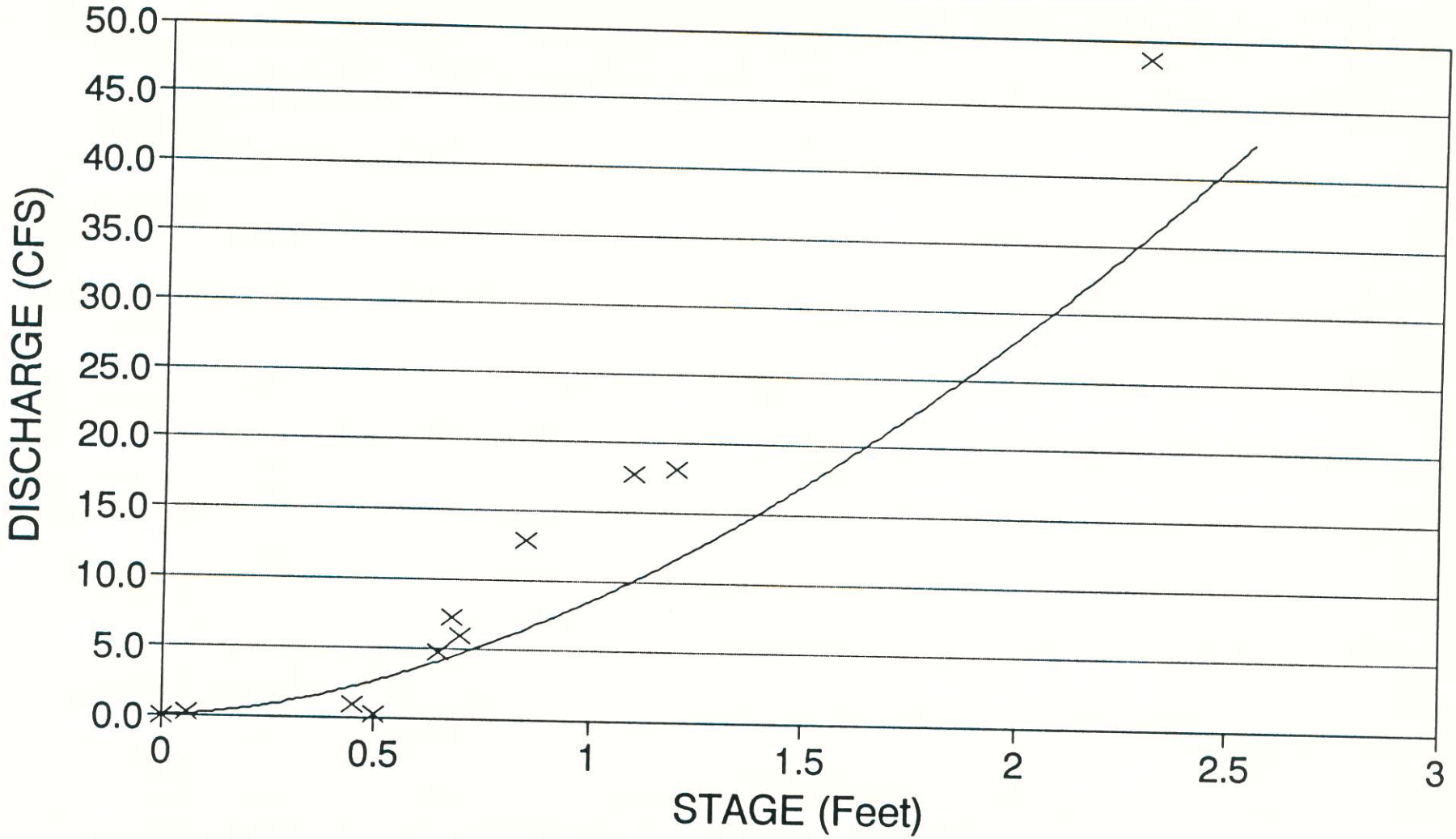
LAKE REDFIELD SITE #1
STAGE DISCHARGE RELATIONSHIP - 1991



LAKE REDFIELD SITE #2
DISCHARGE USING MANNINGS EQUATION



LAKE REDFIELD SITE #3
STAGE DISCHARGE RELATIONSHIP - 1991



LAKE REDFIELD SITE #4
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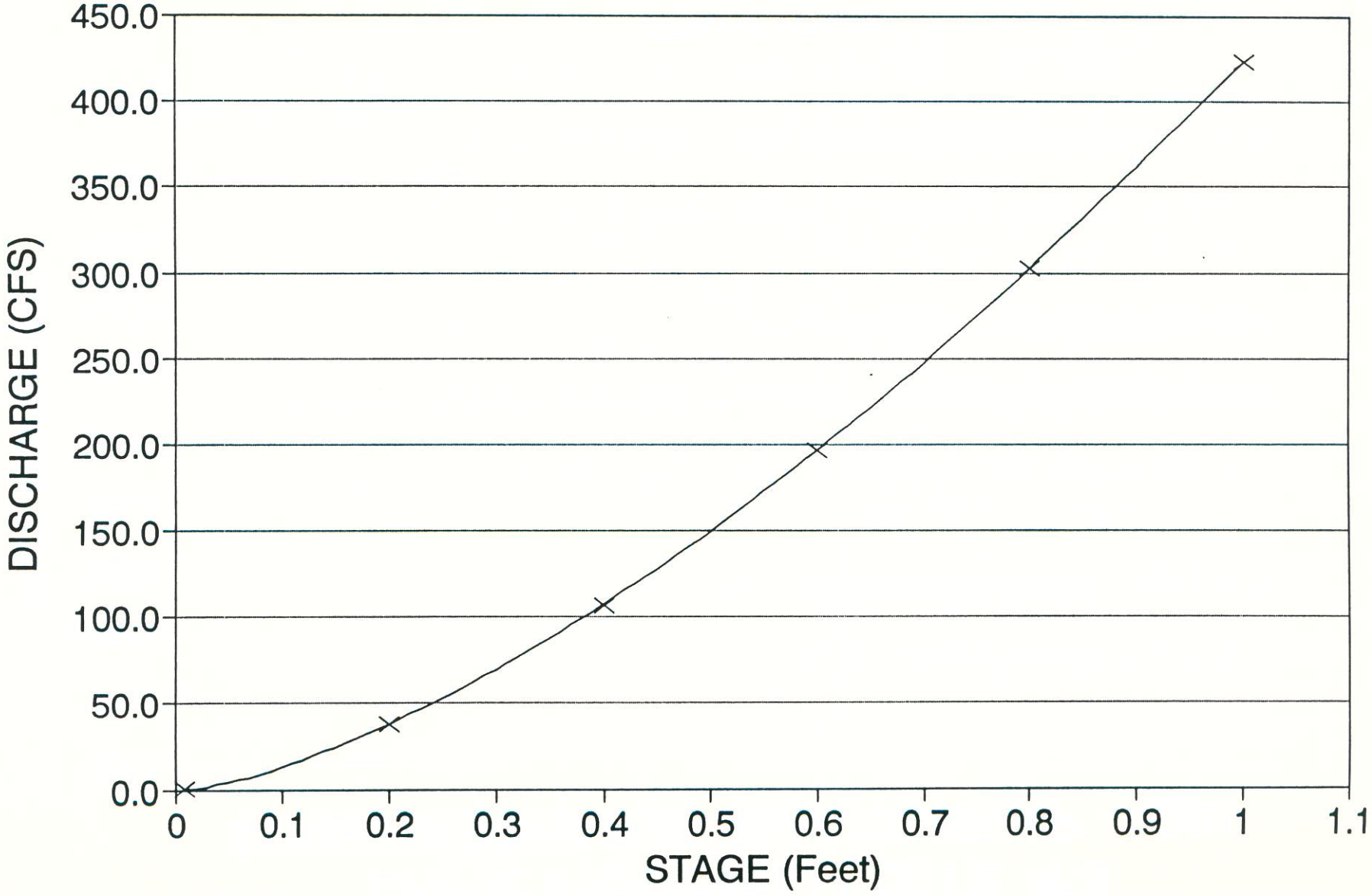


SITE IDENTIFICATION: RL-1

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
15-Apr-91	1300	5.80	63.65	155,723,739	45,160	201,974	200,728	7,163	4,049	3,114	3.11	1.52	15.57	291.20	60.73	34.26
16-Apr-91		5.69	59.06	144,502,738	43,495	212,491	205,049	5,925	4,480	1,445	2.89	1.40	14.45	261.55	54.19	23.12
17-Apr-91		5.59	54.34	132,958,509	40,021	195,515	188,668	5,451	4,122	1,330	2.66	1.29	13.30	240.65	49.86	21.27
18-Apr-91		5.48	49.56	121,256,473	36,498	178,308	172,063	4,972	3,759	1,213	2.43	1.18	12.13	219.47	45.47	19.40
19-Apr-91		5.38	44.78	109,562,488	32,978	161,112	155,469	4,492	3,396	1,096	2.19	1.06	10.96	198.31	41.09	17.53
20-Apr-91		5.27	40.07	98,038,143	29,509	144,165	139,116	4,020	3,039	980	1.96	0.95	9.80	177.45	36.76	15.69
21-Apr-91		5.17	35.49	86,836,100	26,138	127,692	123,220	3,560	2,692	868	1.74	0.84	8.68	157.17	32.56	13.89
22-Apr-91		5.06	31.10	76,095,697	22,905	111,899	107,980	3,120	2,359	761	1.52	0.74	7.61	137.73	28.54	12.18
23-Apr-91		4.96	26.95	65,939,024	19,848	96,963	93,567	2,703	2,044	659	1.32	0.64	6.59	119.35	24.73	10.55
24-Apr-91		4.85	23.08	56,467,681	16,997	83,036	80,128	2,315	1,750	565	1.13	0.55	5.65	102.21	21.18	9.03
25-Apr-91		4.74	19.52	47,760,378	14,376	70,232	67,772	1,958	1,481	478	0.96	0.46	4.78	86.45	17.91	7.64
26-Apr-91		4.64	16.30	39,871,506	12,001	58,631	56,578	1,635	1,236	399	0.80	0.39	3.99	72.17	14.95	6.38
27-Apr-91		4.53	13.42	32,830,765	9,882	48,278	46,587	1,346	1,018	328	0.66	0.32	3.28	59.42	12.31	5.25
28-Apr-91		4.43	10.89	26,643,850	8,020	39,180	37,808	1,092	826	266	0.53	0.26	2.66	48.23	9.99	4.26
29-Apr-91		4.32	8.70	21,294,152	6,410	31,313	30,216	873	660	213	0.43	0.21	2.13	38.54	7.99	3.41
30-Apr-91		4.22	6.84	16,745,345	5,040	24,624	23,762	687	519	167	0.33	0.16	1.67	30.31	6.28	2.68
01-May-91		4.11	5.29	12,944,691	3,896	19,035	18,369	531	401	129	0.26	0.13	1.29	23.43	4.85	2.07
02-May-91		4.00	4.02	9,826,844	2,958	14,450	13,944	403	305	98	0.20	0.10	0.98	17.79	3.69	1.57
03-May-91		3.90	3.00	7,334,809	2,208	10,786	10,408	301	227	73	0.15	0.07	0.73	13.28	2.75	1.17
04-May-91		4.00	3.96	9,700,174	2,920	14,264	13,765	398	301	97	0.19	0.09	0.97	17.56	3.64	1.55
05-May-91		3.95	3.46	8,453,747	2,545	12,431	11,996	347	262	85	0.17	0.08	0.85	15.30	3.17	1.35
06-May-91		3.85	2.59	6,334,940	1,907	9,316	8,989	260	196	63	0.13	0.06	0.63	11.47	2.38	1.01
07-May-91	1500	3.80	2.23	5,445,682	1,699	8,953	8,435	196	196	0	0.11	0.05	0.54	9.53	1.96	0.54
08-May-91		3.73	1.79	4,370,559	1,311	6,619	6,178	232	135	96	0.09	0.06	0.44	7.15	2.82	1.18
09-May-91		3.60	1.16	2,828,840	849	4,284	3,999	150	88	62	0.06	0.04	0.28	4.63	1.82	0.76
10-May-91		3.50	0.81	1,974,383	592	2,990	2,791	105	61	43	0.04	0.03	0.20	3.23	1.27	0.53
11-May-91		3.50	0.81	1,974,383	592	2,990	2,791	105	61	43	0.04	0.03	0.20	3.23	1.27	0.53
12-May-91		3.44	0.64	1,573,696	472	2,383	2,224	83	49	35	0.03	0.02	0.16	2.57	1.02	0.42
13-May-91		3.45	0.67	1,635,300	491	2,477	2,311	87	51	36	0.03	0.02	0.16	2.67	1.05	0.44
14-May-91		3.46	0.69	1,698,908	510	2,573	2,401	90	53	37	0.03	0.02	0.17	2.78	1.10	0.46
15-May-91		3.51	0.84	2,048,769	615	3,103	2,896	109	64	45	0.04	0.03	0.20	3.35	1.32	0.55
16-May-91		3.55	0.97	2,369,969	711	3,589	3,350	126	73	52	0.05	0.03	0.24	3.87	1.53	0.64
17-May-91		3.67	1.47	3,591,306	1,077	5,439	5,076	190	111	79	0.07	0.05	0.36	5.87	2.32	0.97
18-May-91		3.75	1.90	4,658,626	1,398	7,055	6,585	247	144	102	0.09	0.07	0.47	7.62	3.00	1.26
19-May-91		3.70	1.62	3,965,486	1,190	6,006	5,605	210	123	87	0.08	0.06	0.40	6.48	2.56	1.07
20-May-91		3.65	1.37	3,358,170	1,007	5,086	4,747	178	104	74	0.07	0.05	0.34	5.49	2.17	0.91
21-May-91		3.65	1.37	3,358,170	1,007	5,086	4,747	178	104	74	0.07	0.05	0.34	5.49	2.17	0.91
22-May-91		3.67	1.47	3,591,306	1,077	5,439	5,076	190	111	79	0.07	0.05	0.36	5.87	2.32	0.97

SITE IDENTIFICATION: RL-1

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
23-May-91		3.85	2.59	6,334,940	1,900	9,594	8,954	336	196	139	0.13	0.09	0.63	10.36	4.09	1.71
24-May-91		3.82	2.37	5,788,652	1,737	8,767	8,182	307	179	127	0.12	0.08	0.58	9.46	3.73	1.56
25-May-91		3.80	2.23	5,445,682	1,634	8,247	7,697	289	169	120	0.11	0.08	0.54	8.90	3.51	1.47
26-May-91		3.95	3.46	8,453,747	2,536	12,803	11,949	448	262	186	0.17	0.12	0.85	13.82	5.45	2.28
27-May-91		4.06	4.65	11,375,840	3,413	17,229	16,080	603	353	250	0.23	0.16	1.14	18.60	7.34	3.07
28-May-91		4.05	4.53	11,082,387	3,325	16,784	15,665	587	344	244	0.22	0.16	1.11	18.12	7.15	2.99
29-May-91	1900	4.45	11.41	27,907,902	8,037	38,652	35,666	1,954	726	1,228	0.56	0.51	2.79	42.42	25.95	12.28
30-May-91		4.60	15.21	37,212,303	7,870	34,756	31,872	1,786	856	930	5.58	1.07	3.72	55.07	32.56	19.54
31-May-91		4.63	16.06	39,280,174	8,308	36,688	33,643	1,885	903	982	5.89	1.13	3.93	58.13	34.37	20.62
01-Jun-91		4.60	15.32	37,490,847	7,929	35,016	32,111	1,800	862	937	5.62	1.08	3.75	55.49	32.80	19.68
02-Jun-91		4.65	16.63	40,696,949	8,607	38,011	34,857	1,953	936	1,017	6.10	1.17	4.07	60.23	35.61	21.37
03-Jun-91		4.70	18.14	44,371,623	9,385	41,443	38,004	2,130	1,021	1,109	6.66	1.27	4.44	65.67	38.83	23.30
04-Jun-91		4.75	19.71	48,233,582	10,201	45,050	41,312	2,315	1,109	1,206	7.24	1.38	4.82	71.39	42.20	25.32
05-Jun-91	1715	5.80	63.65	155,723,739	21,023	75,215	67,740	4,049	3,114	934	43.60	6.07	15.57	224.24	127.69	94.99
06-Jun-91		5.73	60.57	148,195,178	22,377	66,614	61,056	5,187	3,408	1,778	33.34	9.29	59.28	240.82	140.79	105.22
07-Jun-91		5.66	57.43	140,495,198	21,215	63,153	57,884	4,917	3,231	1,686	31.61	8.81	56.20	228.30	133.47	99.75
08-Jun-91		5.59	54.23	132,674,141	20,034	59,637	54,662	4,644	3,052	1,592	29.85	8.32	53.07	215.60	126.04	94.20
09-Jun-91		5.51	51.00	124,783,068	18,842	56,090	51,411	4,367	2,870	1,497	28.08	7.82	49.91	202.77	118.54	88.60
10-Jun-91		5.44	47.77	116,873,108	17,648	52,534	48,152	4,091	2,688	1,402	26.30	7.33	46.75	189.92	111.03	82.98
11-Jun-91		5.37	44.55	108,994,802	16,458	48,993	44,906	3,815	2,507	1,308	24.52	6.83	43.60	177.12	103.55	77.39
12-Jun-91		5.30	41.36	101,197,436	15,281	45,488	41,693	3,542	2,328	1,214	22.77	6.35	40.48	164.45	96.14	71.85
13-Jun-91		5.23	38.23	93,528,397	14,123	42,041	38,534	3,273	2,151	1,122	21.04	5.86	37.41	151.98	88.85	66.41
14-Jun-91		5.16	35.16	86,032,540	12,991	38,672	35,445	3,011	1,979	1,032	19.36	5.39	34.41	139.80	81.73	61.08
15-Jun-91		5.09	32.19	78,751,615	11,891	35,399	32,446	2,756	1,811	945	17.72	4.94	31.50	127.97	74.81	55.91
16-Jun-91		5.02	29.32	71,723,723	10,830	32,240	29,550	2,510	1,650	861	16.14	4.50	28.69	116.55	68.14	50.92
17-Jun-91		4.94	26.56	64,982,858	9,812	29,210	26,773	2,274	1,495	780	14.62	4.07	25.99	105.60	61.73	46.14
18-Jun-91		4.87	23.93	58,558,514	8,842	26,322	24,126	2,050	1,347	703	13.18	3.67	23.42	95.16	55.63	41.58
19-Jun-91		4.80	21.45	52,475,381	7,924	23,588	21,620	1,837	1,207	630	11.81	3.29	20.99	85.27	49.85	37.26
20-Jun-91	1730	4.73	19.11	46,753,136	7,808	19,449	18,187	2,057	1,216	842	7.95	4.04	32.73	84.62	50.49	37.87
21-Jun-91		4.66	16.92	41,406,332	8,281	19,709	17,432	2,195	1,035	1,159	3.93	2.17	24.84	71.43	43.27	29.61
22-Jun-91		4.59	14.90	36,444,388	7,289	17,348	15,343	1,932	911	1,020	3.46	1.91	21.87	62.87	38.08	26.06
23-Jun-91		4.52	13.03	31,871,678	6,374	15,171	13,418	1,689	797	892	3.03	1.67	19.12	54.98	33.31	22.79
24-Jun-91		4.45	11.32	27,687,723	5,538	13,179	11,657	1,467	692	775	2.63	1.45	16.61	47.76	28.93	19.80
25-Jun-91		4.37	9.76	23,887,471	4,777	11,370	10,057	1,266	597	669	2.27	1.25	14.33	41.21	24.96	17.08
26-Jun-91		4.30	8.36	20,461,657	4,092	9,740	8,614	1,084	512	573	1.94	1.07	12.28	35.30	21.38	14.63
27-Jun-91		4.23	7.11	17,397,243	3,479	8,281	7,324	922	435	487	1.65	0.91	10.44	30.01	18.18	12.44
28-Jun-91		4.16	6.00	14,677,907	2,936	6,987	6,179	778	367	411	1.39	0.77	8.81	25.32	15.34	10.49
29-Jun-91		4.09	5.02	12,284,581	2,457	5,847	5,172	651	307	344	1.17	0.64	7.37	21.19	12.84	8.78

SITE IDENTIFICATION: RL-1

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
30-Jun-91		4.02	4.17	10,196,013	2,039	4,853	4,293	540	255	285	0.97	0.53	6.12	17.59	10.65	7.29
01-Jul-91		3.95	3.43	8,389,344	1,678	3,993	3,532	445	210	235	0.80	0.44	5.03	14.47	8.77	6.00
02-Jul-91		3.88	2.80	6,840,673	1,368	3,256	2,880	363	171	192	0.65	0.36	4.10	11.80	7.15	4.89
03-Jul-91		3.80	2.23	5,445,682	1,089	2,592	2,293	289	136	152	0.52	0.29	3.27	9.39	5.69	3.89
04-Jul-91	1200	3.80	2.23	5,445,682	1,269	2,919	2,467	338	131	207	0.11	0.10	2.72	8.93	5.50	3.38
05-Jul-91		3.80	2.23	5,445,682	1,329	3,096	2,636	305	109	196	0.11	0.10	2.72	7.90	5.94	4.09
06-Jul-91		3.79	2.16	5,280,362	1,288	3,002	2,556	296	106	190	0.11	0.10	2.64	7.66	5.76	3.96
07-Jul-91	1630	3.80	2.23	5,445,682	1,389	3,273	2,805	272	87	185	0.11	0.10	2.72	6.86	6.37	4.80
08-Jul-91		3.73	1.79	4,370,559	1,302	3,114	2,819	205	70	135	0.28	0.17	2.19	7.12	5.57	4.53
09-Jul-91		3.74	1.84	4,512,747	1,345	3,215	2,911	212	72	140	0.29	0.17	2.26	7.36	5.75	4.67
10-Jul-91		3.71	1.67	4,096,993	1,221	2,919	2,643	193	66	127	0.27	0.16	2.05	6.68	5.22	4.24
11-Jul-91		3.72	1.73	4,231,995	1,261	3,015	2,730	199	68	131	0.28	0.16	2.12	6.90	5.40	4.38
12-Jul-91		3.73	1.79	4,370,559	1,302	3,114	2,819	205	70	135	0.28	0.17	2.19	7.12	5.57	4.53
13-Jul-91		3.69	1.57	3,837,412	1,144	2,734	2,475	180	61	119	0.25	0.15	1.92	6.25	4.89	3.97
14-Jul-91		3.62	1.24	3,031,703	903	2,160	1,955	142	49	94	0.20	0.12	1.52	4.94	3.87	3.14
15-Jul-91		3.60	1.16	2,828,840	843	2,016	1,825	133	45	88	0.18	0.11	1.41	4.61	3.61	2.93
16-Jul-91		3.65	1.37	3,358,170	1,001	2,393	2,166	158	54	104	0.22	0.13	1.68	5.47	4.28	3.48
17-Jul-91		3.67	1.47	3,591,306	1,070	2,559	2,316	169	57	111	0.23	0.14	1.80	5.85	4.58	3.72
18-Jul-91		3.64	1.33	3,246,311	967	2,313	2,094	153	52	101	0.21	0.12	1.62	5.29	4.14	3.36
19-Jul-91		3.64	1.33	3,246,311	967	2,313	2,094	153	52	101	0.21	0.12	1.62	5.29	4.14	3.36
20-Jul-91		3.64	1.33	3,246,311	967	2,313	2,094	153	52	101	0.21	0.12	1.62	5.29	4.14	3.36
21-Jul-91		3.63	1.28	3,137,509	935	2,235	2,024	147	50	97	0.20	0.12	1.57	5.11	4.00	3.25
22-Jul-91		3.60	1.16	2,828,840	843	2,016	1,825	133	45	88	0.18	0.11	1.41	4.61	3.61	2.93
23-Jul-91		3.60	1.16	2,828,840	843	2,016	1,825	133	45	88	0.18	0.11	1.41	4.61	3.61	2.93
24-Jul-91		3.59	1.12	2,731,664	814	1,946	1,762	128	44	85	0.18	0.11	1.37	4.45	3.48	2.83
25-Jul-91		3.53	0.90	2,204,529	657	1,571	1,422	104	35	68	0.14	0.08	1.10	3.59	2.81	2.28
26-Jul-91		3.54	0.93	2,286,012	681	1,629	1,474	107	37	71	0.15	0.09	1.14	3.73	2.91	2.37
27-Jul-91	1130	3.59	1.12	2,731,664	931	2,251	2,117	120	44	76	0.30	0.16	1.37	5.46	3.77	3.25
28-Jul-91		3.61	1.20	2,928,833	996	2,446	2,293	135	50	85	0.19	0.09	1.61	6.36	3.92	3.16
29-Jul-91		3.56	1.00	2,456,456	835	2,051	1,923	113	42	71	0.16	0.08	1.35	5.33	3.29	2.65
30-Jul-91		3.55	0.97	2,369,969	806	1,979	1,856	109	40	69	0.15	0.07	1.30	5.14	3.18	2.56
31-Jul-91		3.58	1.08	2,637,247	897	2,202	2,065	121	45	76	0.17	0.08	1.45	5.72	3.53	2.85
01-Aug-91		3.59	1.12	2,731,664	929	2,281	2,139	126	46	79	0.18	0.08	1.50	5.93	3.66	2.95
02-Aug-91		3.63	1.28	3,137,509	1,067	2,620	2,457	144	53	91	0.20	0.10	1.73	6.81	4.20	3.39
03-Aug-91		3.63	1.28	3,137,509	1,067	2,620	2,457	144	53	91	0.20	0.10	1.73	6.81	4.20	3.39
04-Aug-91		3.59	1.12	2,731,664	929	2,281	2,139	126	46	79	0.18	0.08	1.50	5.93	3.66	2.95
05-Aug-91		3.67	1.47	3,591,306	1,221	2,999	2,812	165	61	104	0.23	0.11	1.98	7.79	4.81	3.88
06-Aug-91	1115	3.82	2.37	5,788,652	1,962	4,897	4,579	278	104	174	0.12	0.01	3.47	13.55	7.53	5.61

SITE IDENTIFICATION: RL-1

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
07-Aug-91		3.76	1.97	4,808,261	1,510	4,041	3,784	224	101	120	0.10	0.05	2.52	9.70	5.64	4.05
08-Aug-91		3.74	1.84	4,512,747	1,417	3,793	3,552	210	95	113	0.09	0.05	2.37	9.10	5.29	3.80
09-Aug-91		3.71	1.67	4,096,993	1,286	3,444	3,224	191	86	102	0.08	0.04	2.15	8.27	4.80	3.45
10-Aug-91		3.67	1.47	3,591,306	1,128	3,018	2,826	167	75	90	0.07	0.04	1.89	7.25	4.21	3.02
11-Aug-91		3.65	1.37	3,358,170	1,054	2,823	2,643	156	71	84	0.07	0.03	1.76	6.78	3.94	2.83
12-Aug-91		3.65	1.37	3,358,170	1,054	2,823	2,643	156	71	84	0.07	0.03	1.76	6.78	3.94	2.83
13-Aug-91		3.65	1.37	3,358,170	1,054	2,823	2,643	156	71	84	0.07	0.03	1.76	6.78	3.94	2.83
14-Aug-91		3.67	1.47	3,591,306	1,128	3,018	2,826	167	75	90	0.07	0.04	1.89	7.25	4.21	3.02
15-Aug-91		3.73	1.79	4,370,559	1,372	3,673	3,440	203	92	109	0.09	0.04	2.29	8.82	5.12	3.68
16-Aug-91		3.72	1.73	4,231,995	1,329	3,557	3,331	197	89	106	0.08	0.04	2.22	8.54	4.96	3.56
17-Aug-91		3.70	1.62	3,965,486	1,245	3,333	3,121	184	83	99	0.08	0.04	2.08	8.00	4.65	3.34
18-Aug-91		3.69	1.57	3,837,412	1,205	3,225	3,020	178	81	96	0.08	0.04	2.01	7.74	4.50	3.23
19-Aug-91		3.65	1.37	3,358,170	1,054	2,823	2,643	156	71	84	0.07	0.03	1.76	6.78	3.94	2.83
20-Aug-91		3.65	1.37	3,358,170	1,054	2,823	2,643	156	71	84	0.07	0.03	1.76	6.78	3.94	2.83
21-Aug-91		3.68	1.52	3,712,706	1,166	3,121	2,922	173	78	93	0.07	0.04	1.95	7.49	4.35	3.13
22-Aug-91		3.63	1.28	3,137,509	985	2,637	2,469	146	66	78	0.06	0.03	1.65	6.33	3.68	2.64
23-Aug-91		3.65	1.37	3,358,170	1,054	2,823	2,643	156	71	84	0.07	0.03	1.76	6.78	3.94	2.83
24-Aug-91		3.55	0.97	2,369,969	744	1,992	1,865	110	50	59	0.05	0.02	1.24	4.78	2.78	2.00
25-Aug-91		3.57	1.04	2,545,530	799	2,140	2,003	118	53	64	0.05	0.03	1.34	5.14	2.98	2.14
26-Aug-91		3.52	0.87	2,125,467	667	1,786	1,673	99	45	53	0.04	0.02	1.12	4.29	2.49	1.79
27-Aug-91		3.51	0.84	2,048,769	643	1,722	1,612	95	43	51	0.04	0.02	1.08	4.13	2.40	1.73
28-Aug-91		3.45	0.67	1,635,300	513	1,374	1,287	76	34	41	0.03	0.02	0.86	3.30	1.92	1.38
29-Aug-91		3.51	0.84	2,048,769	643	1,722	1,612	95	43	51	0.04	0.02	1.08	4.13	2.40	1.73
30-Aug-91		3.51	0.84	2,048,769	643	1,722	1,612	95	43	51	0.04	0.02	1.08	4.13	2.40	1.73
31-Aug-91		3.48	0.75	1,832,336	575	1,540	1,442	85	38	46	0.04	0.02	0.96	3.70	2.15	1.54
01-Sep-91		3.43	0.62	1,514,048	475	1,273	1,192	70	32	38	0.03	0.02	0.79	3.05	1.78	1.27
02-Sep-91		3.37	0.49	1,194,574	375	1,004	940	56	25	30	0.02	0.01	0.63	2.41	1.40	1.01
03-Sep-91		3.43	0.62	1,514,048	475	1,273	1,192	70	32	38	0.03	0.02	0.79	3.05	1.78	1.27
04-Sep-91		3.38	0.51	1,243,476	390	1,045	979	58	26	31	0.02	0.01	0.65	2.51	1.46	1.05
05-Sep-91		3.40	0.55	1,346,357	423	1,132	1,060	63	28	34	0.03	0.01	0.71	2.72	1.58	1.13
06-Sep-91		3.32	0.40	973,719	306	818	766	45	20	24	0.02	0.01	0.51	1.96	1.14	0.82
07-Sep-91		3.31	0.38	933,988	293	785	735	43	20	23	0.02	0.01	0.49	1.88	1.10	0.79
08-Sep-91		3.31	0.38	933,988	293	785	735	43	20	23	0.02	0.01	0.49	1.88	1.10	0.79
09-Sep-91		3.40	0.55	1,346,357	423	1,132	1,060	63	28	34	0.03	0.01	0.71	2.72	1.58	1.13
10-Sep-91		3.39	0.53	1,294,056	406	1,088	1,018	60	27	32	0.03	0.01	0.68	2.61	1.52	1.09
11-Sep-91		3.37	0.49	1,194,574	375	1,004	940	56	25	30	0.02	0.01	0.63	2.41	1.40	1.01
12-Sep-91		3.37	0.49	1,194,574	375	1,004	940	56	25	30	0.02	0.01	0.63	2.41	1.40	1.01
13-Sep-91		3.38	0.51	1,243,476	390	1,045	979	58	26	31	0.02	0.01	0.65	2.51	1.46	1.05

SITE IDENTIFICATION: RL-1

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
14-Sep-91		3.41	0.57	1,400,425	440	1,177	1,102	65	29	35	0.03	0.01	0.74	2.83	1.64	1.18
15-Sep-91		3.35	0.46	1,119,711	352	941	881	52	24	28	0.02	0.01	0.59	2.26	1.31	0.94
16-Sep-91		3.37	0.49	1,194,574	375	1,004	940	56	25	30	0.02	0.01	0.63	2.41	1.40	1.01
17-Sep-91		3.44	0.64	1,573,696	494	1,323	1,238	73	33	39	0.03	0.02	0.83	3.17	1.85	1.33
18-Sep-91		3.40	0.55	1,346,357	423	1,132	1,060	63	28	34	0.03	0.01	0.71	2.72	1.58	1.13
19-Sep-91		3.35	0.45	1,101,629	346	926	867	51	23	28	0.02	0.01	0.58	2.22	1.29	0.93
20-Sep-91		3.27	0.32	788,540	248	663	621	37	17	20	0.02	0.01	0.41	1.59	0.92	0.66
21-Sep-91		3.23	0.27	662,879	208	557	522	31	14	17	0.01	0.01	0.35	1.34	0.78	0.56
22-Sep-91		3.31	0.38	933,988	293	785	735	43	20	23	0.02	0.01	0.49	1.88	1.10	0.79
23-Sep-91		3.32	0.40	973,719	306	818	766	45	20	24	0.02	0.01	0.51	1.96	1.14	0.82
24-Sep-91		3.33	0.41	1,014,876	319	853	799	47	21	25	0.02	0.01	0.53	2.05	1.19	0.85
25-Sep-91		3.39	0.53	1,294,056	406	1,088	1,018	60	27	32	0.03	0.01	0.68	2.61	1.52	1.09
26-Sep-91		3.35	0.45	1,101,629	346	926	867	51	23	28	0.02	0.01	0.58	2.22	1.29	0.93
27-Sep-91		3.33	0.41	1,014,876	319	853	799	47	21	25	0.02	0.01	0.53	2.05	1.19	0.85
28-Sep-91		3.29	0.35	858,644	270	722	676	40	18	21	0.02	0.01	0.45	1.73	1.01	0.72
29-Sep-91		3.30	0.37	895,642	281	753	705	42	19	22	0.02	0.01	0.47	1.81	1.05	0.75
30-Sep-91		3.32	0.40	973,719	306	818	766	45	20	24	0.02	0.01	0.51	1.96	1.14	0.82
01-Oct-91		3.29	0.35	858,644	270	722	676	40	18	21	0.02	0.01	0.45	1.73	1.01	0.72
02-Oct-91		3.31	0.38	933,988	293	785	735	43	20	23	0.02	0.01	0.49	1.88	1.10	0.79
03-Oct-91		3.29	0.35	858,644	270	722	676	40	18	21	0.02	0.01	0.45	1.73	1.01	0.72
04-Oct-91		3.31	0.38	933,988	293	785	735	43	20	23	0.02	0.01	0.49	1.88	1.10	0.79
05-Oct-91		3.32	0.40	973,719	306	818	766	45	20	24	0.02	0.01	0.51	1.96	1.14	0.82
06-Oct-91		3.27	0.32	788,540	248	663	621	37	17	20	0.02	0.01	0.41	1.59	0.92	0.66
07-Oct-91		3.25	0.30	723,380	227	608	569	34	15	18	0.01	0.01	0.38	1.46	0.85	0.61
08-Oct-91		3.28	0.34	822,956	258	692	648	38	17	21	0.02	0.01	0.43	1.66	0.96	0.69
09-Oct-91		3.27	0.32	788,540	248	663	621	37	17	20	0.02	0.01	0.41	1.59	0.92	0.66
10-Oct-91		3.24	0.28	692,564	217	582	545	32	15	17	0.01	0.01	0.36	1.40	0.81	0.58
11-Oct-91		3.28	0.34	822,956	258	692	648	38	17	21	0.02	0.01	0.43	1.66	0.96	0.69
12-Oct-91		3.22	0.26	634,291	199	533	499	29	13	16	0.01	0.01	0.33	1.28	0.74	0.53
13-Oct-91		3.27	0.32	788,540	248	663	621	37	17	20	0.02	0.01	0.41	1.59	0.92	0.66
14-Oct-91		3.25	0.30	723,380	227	608	569	34	15	18	0.01	0.01	0.38	1.46	0.85	0.61
15-Oct-91		3.21	0.25	606,767	191	510	478	28	13	15	0.01	0.01	0.32	1.22	0.71	0.51
16-Oct-91		3.20	0.24	580,275	182	488	457	27	12	15	0.01	0.01	0.30	1.17	0.68	0.49
17-Oct-91		3.25	0.30	723,380	227	608	569	34	15	18	0.01	0.01	0.38	1.46	0.85	0.61
18-Oct-91		3.22	0.26	634,291	199	533	499	29	13	16	0.01	0.01	0.33	1.28	0.74	0.53
19-Oct-91		3.19	0.23	554,783	174	466	437	26	12	14	0.01	0.01	0.29	1.12	0.65	0.47
20-Oct-91		3.17	0.21	506,676	159	426	399	24	11	13	0.01	0.01	0.27	1.02	0.59	0.43
21-Oct-91		3.19	0.23	554,783	174	466	437	26	12	14	0.01	0.01	0.29	1.12	0.65	0.47

SITE IDENTIFICATION: RL-1

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
22-Oct-91		3.19	0.23	554,783	174	466	437	26	12	14	0.01	0.01	0.29	1.12	0.65	0.47
23-Oct-91		3.23	0.27	662,879	208	557	522	31	14	17	0.01	0.01	0.35	1.34	0.78	0.56
24-Oct-91		3.10	0.15	365,484	115	307	288	17	8	9	0.01	0.00	0.19	0.74	0.43	0.31
25-Oct-91		3.05	0.12	286,827	90	241	226	13	6	7	0.01	0.00	0.15	0.58	0.34	0.24
26-Oct-91		3.03	0.11	259,762	82	218	204	12	5	6	0.01	0.00	0.14	0.52	0.30	0.22
27-Oct-91		3.00	0.09	223,343	70	188	176	10	5	6	0.00	0.00	0.12	0.45	0.26	0.19
28-Oct-91		3.00	0.09	223,343	70	188	176	10	5	6	0.00	0.00	0.12	0.45	0.26	0.19
29-Oct-91	MEDIAN	3.00	0.09	223,343	65	186	175	10	5	4	0.00	0.00	0.10	0.38	0.23	0.16
TOTAL LOAD IN KG/YEAR			1,533	3,750,961,245	841,472	3,318,191	3,137,118	152,409	95,883	56,459	461	137	1,052	6,379	2,852	1,910
TOTAL LOAD IN POUNDS/YEAR			3,381	8,270,869,545	1,855,447	7,316,611	6,917,346	336,062	211,422	124,493	1,016	301	2,319	14,066	6,289	4,211
TOTAL LOAD IN TONS/YEAR			1.7	4,135,434.8	927.7	3,658.3	3,458.7	168.0	105.7	62.2	0.5	0.2	1.2	7.0	3.1	2.1

SITE IDENTIFICATION: RL-2

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
14-Apr-91		0.07	0.03	72,339	4	26	23	2	1	1	0.01	0.00	0.01	0.08	0.03	0.03
15-Apr-91		0.21	0.24	589,053	34	208	190	15	11	5	0.04	0.00	0.06	0.66	0.24	0.23
16-Apr-91		0.30	0.51	1,253,336	71	442	404	33	23	10	0.09	0.00	0.13	1.40	0.51	0.49
17-Apr-91		0.35	0.71	1,741,320	99	615	561	45	31	14	0.12	0.00	0.17	1.95	0.71	0.68
18-Apr-91		0.38	0.85	2,074,869	118	732	668	54	37	17	0.15	0.00	0.21	2.32	0.85	0.81
19-Apr-91	1015	0.39	0.90	2,192,796	125	774	706	57	39	18	0.15	0.00	0.22	2.46	0.90	0.86
20-Apr-91		0.39	0.90	2,192,796	368	2,074	1,957	59	42	18	0.10	0.00	0.22	2.73	0.69	0.53
21-Apr-91		0.38	0.85	2,074,869	349	1,963	1,852	56	39	17	0.09	0.00	0.21	2.58	0.65	0.50
22-Apr-91		0.37	0.80	1,960,307	329	1,854	1,750	53	37	16	0.09	0.00	0.20	2.44	0.62	0.47
23-Apr-91		0.37	0.80	1,960,307	329	1,854	1,750	53	37	16	0.09	0.00	0.20	2.44	0.62	0.47
24-Apr-91		0.36	0.76	1,849,121	311	1,749	1,650	50	35	15	0.08	0.00	0.18	2.30	0.58	0.44
25-Apr-91		0.34	0.67	1,636,913	275	1,549	1,461	44	31	13	0.07	0.00	0.16	2.04	0.52	0.39
26-Apr-91		0.37	0.80	1,960,307	329	1,854	1,750	53	37	16	0.09	0.00	0.20	2.44	0.62	0.47
27-Apr-91		0.49	1.45	3,553,816	597	3,362	3,172	96	68	28	0.16	0.00	0.36	4.42	1.12	0.85
28-Apr-91		0.46	1.27	3,111,297	523	2,943	2,777	84	59	25	0.14	0.00	0.31	3.87	0.98	0.75
29-Apr-91		0.45	1.21	2,970,231	499	2,810	2,651	80	56	24	0.13	0.00	0.30	3.70	0.94	0.71
30-Apr-91		0.49	1.45	3,553,816	597	3,362	3,172	96	68	28	0.16	0.00	0.36	4.42	1.12	0.85
01-May-91		0.45	1.21	2,970,231	499	2,810	2,651	80	56	24	0.13	0.00	0.30	3.70	0.94	0.71
02-May-91		0.41	1.00	2,438,692	410	2,307	2,177	66	46	20	0.11	0.00	0.24	3.04	0.77	0.59
03-May-91		0.64	2.53	6,181,348	1,038	5,848	5,517	167	117	49	0.28	0.00	0.62	7.70	1.95	1.48
04-May-91		0.81	4.05	9,910,395	1,665	9,375	8,845	268	188	79	0.45	0.00	0.99	12.34	3.12	2.38
05-May-91		0.75	3.48	8,511,261	1,430	8,052	7,596	230	162	68	0.38	0.00	0.85	10.60	2.68	2.04
06-May-91		0.68	2.86	6,991,610	1,175	6,614	6,240	189	133	56	0.31	0.00	0.70	8.70	2.20	1.68
07-May-91	1330	0.62	2.37	5,792,810	1,616	8,915	8,475	162	116	46	0.12	0.00	0.58	7.94	1.27	0.52
08-May-91		0.59	2.14	5,231,376	1,216	6,835	6,607	136	84	52	0.26	0.01	0.52	7.61	2.43	1.91
09-May-91		0.58	2.06	5,050,040	1,174	6,598	6,378	131	81	51	0.25	0.01	0.51	7.35	2.35	1.84
10-May-91		0.56	1.92	4,696,243	1,092	6,136	5,931	122	75	47	0.23	0.01	0.47	6.83	2.18	1.71
11-May-91		0.53	1.71	4,188,122	974	5,472	5,290	109	67	42	0.21	0.01	0.42	6.09	1.95	1.53
12-May-91		0.49	1.45	3,553,816	826	4,643	4,488	92	57	36	0.18	0.01	0.36	5.17	1.65	1.30
13-May-91		0.48	1.39	3,403,110	791	4,446	4,298	88	54	34	0.17	0.01	0.34	4.95	1.58	1.24
14-May-91		0.43	1.10	2,697,881	627	3,525	3,407	70	43	27	0.13	0.00	0.27	3.93	1.25	0.98
15-May-91		0.44	1.14	2,778,210	646	3,630	3,509	72	44	28	0.14	0.00	0.28	4.04	1.29	1.01
16-May-91		0.45	1.21	2,970,231	691	3,881	3,751	77	48	30	0.15	0.00	0.30	4.32	1.38	1.08
17-May-91		0.45	1.21	2,970,231	691	3,881	3,751	77	48	30	0.15	0.00	0.30	4.32	1.38	1.08
18-May-91		0.46	1.27	3,111,297	723	4,065	3,930	81	50	31	0.16	0.00	0.31	4.53	1.45	1.14
19-May-91		0.45	1.21	2,970,231	691	3,881	3,751	77	48	30	0.15	0.00	0.30	4.32	1.38	1.08
20-May-91		0.45	1.21	2,970,231	691	3,881	3,751	77	48	30	0.15	0.00	0.30	4.32	1.38	1.08
21-May-91		0.43	1.10	2,697,881	627	3,525	3,407	70	43	27	0.13	0.00	0.27	3.93	1.25	0.98
22-May-91		0.49	1.45	3,553,816	826	4,643	4,488	92	57	36	0.18	0.01	0.36	5.17	1.65	1.30
23-May-91		0.60	2.21	5,415,635	1,259	7,076	6,840	141	87	54	0.27	0.01	0.54	7.88	2.52	1.98
24-May-91		0.59	2.14	5,231,376	1,216	6,835	6,607	136	84	52	0.26	0.01	0.52	7.61	2.43	1.91
25-May-91		0.58	2.06	5,050,040	1,174	6,598	6,378	131	81	51	0.25	0.01	0.51	7.35	2.35	1.84
26-May-91		0.60	2.21	5,415,635	1,259	7,076	6,840	141	87	54	0.27	0.01	0.54	7.88	2.52	1.98

SITE IDENTIFICATION: RL-2

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
27-May-91		0.88	4.76	11,646,517	2,708	15,216	14,710	303	186	116	0.58	0.02	1.16	16.95	5.42	4.25
28-May-91		1.11	7.37	18,019,710	4,190	23,543	22,759	469	288	180	0.90	0.03	1.80	26.22	8.38	6.58
29-May-91	1830	1.78	16.36	40,026,807	7,445	42,989	42,548	961	480	480	3.20	0.10	4.00	61.64	28.42	25.62
30-May-91		2.03	19.91	48,700,964	6,502	33,531	32,337	828	365	463	7.31	0.10	4.87	67.94	32.80	28.78
31-May-91		2.27	23.28	56,954,352	7,603	39,213	37,818	968	427	541	8.54	0.12	5.70	79.45	38.36	33.66
01-Jun-91		2.14	21.46	52,501,387	7,009	36,147	34,861	893	394	499	7.88	0.11	5.25	73.24	35.36	31.03
02-Jun-91		2.05	20.19	49,393,556	6,594	34,007	32,797	840	370	469	7.41	0.10	4.94	68.90	33.27	29.19
03-Jun-91		1.92	18.35	44,884,345	5,992	30,903	29,803	763	337	426	6.73	0.09	4.49	62.61	30.23	26.53
04-Jun-91		2.08	20.61	50,431,253	6,733	34,722	33,486	857	378	479	7.56	0.10	5.04	70.35	33.97	29.80
05-Jun-91	1830	2.25	23.00	56,272,695	4,558	17,051	14,912	563	169	394	12.38	0.10	5.63	70.34	35.85	30.50
06-Jun-91		2.14	21.46	52,501,387	5,723	19,242	18,008	683	446	236	7.88	0.09	18.38	75.08	37.98	33.13
07-Jun-91		1.97	19.06	46,620,284	5,082	17,086	15,991	606	396	210	6.99	0.08	16.32	66.67	33.73	29.42
08-Jun-91		1.92	18.35	44,884,345	4,892	16,450	15,395	583	382	202	6.73	0.08	15.71	64.18	32.47	28.32
09-Jun-91		2.08	20.61	50,431,253	5,497	18,483	17,298	656	429	227	7.56	0.09	17.65	72.12	36.49	31.82
10-Jun-91		1.99	19.34	47,314,243	5,157	17,341	16,229	615	402	213	7.10	0.08	16.56	67.66	34.23	29.86
11-Jun-91		1.81	16.79	41,066,231	4,476	15,051	14,086	534	349	185	6.16	0.07	14.37	58.72	29.71	25.91
12-Jun-91		1.65	14.53	35,544,650	3,874	13,027	12,192	462	302	160	5.33	0.06	12.44	50.83	25.72	22.43
13-Jun-91		1.52	12.72	31,122,934	3,392	11,407	10,675	405	265	140	4.67	0.05	10.89	44.51	22.52	19.64
14-Jun-91		1.46	11.90	29,112,574	3,173	10,670	9,986	378	247	131	4.37	0.05	10.19	41.63	21.06	18.37
15-Jun-91		1.34	10.29	25,170,052	2,744	9,225	8,633	327	214	113	3.78	0.04	8.81	35.99	18.21	15.88
16-Jun-91		1.26	9.24	22,613,608	2,465	8,288	7,756	294	192	102	3.39	0.04	7.91	32.34	16.36	14.27
17-Jun-91		1.14	7.73	18,914,854	2,062	6,932	6,488	246	161	85	2.84	0.03	6.62	27.05	13.68	11.94
18-Jun-91		1.04	6.53	15,983,397	1,742	5,858	5,482	208	136	72	2.40	0.03	5.59	22.86	11.56	10.09
19-Jun-91		0.96	5.62	13,755,372	1,499	5,041	4,718	179	117	62	2.06	0.02	4.81	19.67	9.95	8.68
20-Jun-91	1700	0.91	5.08	12,422,464	1,702	5,342	5,230	199	174	25	0.99	0.02	7.45	20.00	10.06	8.94
21-Jun-91		0.85	4.45	10,889,360	1,699	5,303	4,840	283	174	109	0.54	0.03	6.53	15.08	9.20	7.30
22-Jun-91		0.79	3.86	9,434,541	1,472	4,595	4,194	245	151	94	0.47	0.03	5.66	13.07	7.97	6.32
23-Jun-91		0.72	3.21	7,844,598	1,224	3,820	3,487	204	126	78	0.39	0.02	4.71	10.86	6.63	5.26
24-Jun-91		0.67	2.77	6,784,967	1,058	3,304	3,016	176	109	68	0.34	0.02	4.07	9.40	5.73	4.55
25-Jun-91		0.62	2.37	5,792,810	904	2,821	2,575	151	93	58	0.29	0.02	3.48	8.02	4.89	3.88
26-Jun-91		0.57	1.99	4,871,654	760	2,372	2,165	127	78	49	0.24	0.01	2.92	6.75	4.12	3.26
27-Jun-91		0.52	1.65	4,024,870	628	1,960	1,789	105	64	40	0.20	0.01	2.41	5.57	3.40	2.70
28-Jun-91		0.49	1.45	3,553,816	554	1,731	1,580	92	57	36	0.18	0.01	2.13	4.92	3.00	2.38
29-Jun-91		0.48	1.39	3,403,110	531	1,657	1,513	88	54	34	0.17	0.01	2.04	4.71	2.88	2.28
30-Jun-91		0.48	1.39	3,403,110	531	1,657	1,513	88	54	34	0.17	0.01	2.04	4.71	2.88	2.28
01-Jul-91		0.46	1.27	3,111,297	485	1,515	1,383	81	50	31	0.16	0.01	1.87	4.31	2.63	2.08
02-Jul-91		0.41	1.00	2,438,692	380	1,188	1,084	63	39	24	0.12	0.01	1.46	3.38	2.06	1.63
03-Jul-91		0.38	0.85	2,074,869	324	1,010	922	54	33	21	0.10	0.01	1.24	2.87	1.75	1.39
04-Jul-91	1130	0.37	0.80	1,960,307	343	1,066	917	71	35	35	0.04	0.01	1.18	2.27	1.73	1.22
05-Jul-91		0.36	0.76	1,849,121	330	1,004	876	65	22	43	0.05	0.01	1.02	2.38	1.54	1.13
06-Jul-91		0.34	0.67	1,636,913	292	889	775	57	20	38	0.04	0.01	0.90	2.10	1.36	1.00
07-Jul-91	1730	0.34	0.67	1,636,913	298	887	784	56	10	46	0.05	0.01	0.82	2.31	1.29	0.98
08-Jul-91		0.32	0.59	1,438,306	293	793	728	46	13	33	0.04	0.00	0.72	1.93	1.21	1.00

SITE IDENTIFICATION: RL-2

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
09-Jul-91		0.31	0.55	1,344,116	274	741	680	43	12	31	0.03	0.00	0.67	1.81	1.13	0.93
10-Jul-91		0.30	0.51	1,253,336	255	691	634	40	11	29	0.03	0.00	0.63	1.69	1.05	0.87
11-Jul-91		0.29	0.48	1,165,968	237	643	590	37	10	27	0.03	0.00	0.58	1.57	0.98	0.81
12-Jul-91		0.27	0.41	1,001,453	204	552	507	32	9	23	0.03	0.00	0.50	1.35	0.84	0.69
13-Jul-91		0.26	0.38	924,295	188	510	468	30	8	21	0.02	0.00	0.46	1.24	0.78	0.64
14-Jul-91		0.25	0.35	850,526	173	469	430	27	8	20	0.02	0.00	0.43	1.14	0.71	0.59
15-Jul-91		0.23	0.29	713,102	145	393	361	23	6	16	0.02	0.00	0.36	0.96	0.60	0.49
16-Jul-91		0.22	0.27	649,416	132	358	329	21	6	15	0.02	0.00	0.32	0.87	0.55	0.45
17-Jul-91		0.22	0.27	649,416	132	358	329	21	6	15	0.02	0.00	0.32	0.87	0.55	0.45
18-Jul-91		0.20	0.22	531,991	108	293	269	17	5	12	0.01	0.00	0.27	0.72	0.45	0.37
19-Jul-91		0.19	0.20	478,202	97	264	242	15	4	11	0.01	0.00	0.24	0.64	0.40	0.33
20-Jul-91		0.18	0.17	427,655	87	236	216	14	4	10	0.01	0.00	0.21	0.58	0.36	0.30
21-Jul-91		0.18	0.17	427,655	87	236	216	14	4	10	0.01	0.00	0.21	0.58	0.36	0.30
22-Jul-91		0.17	0.16	380,316	77	210	192	12	3	9	0.01	0.00	0.19	0.51	0.32	0.26
23-Jul-91		0.15	0.12	295,098	60	163	149	9	3	7	0.01	0.00	0.15	0.40	0.25	0.20
24-Jul-91		0.13	0.09	222,182	45	123	112	7	2	5	0.01	0.00	0.11	0.30	0.19	0.15
25-Jul-91		0.11	0.07	161,122	33	89	82	5	1	4	0.00	0.00	0.08	0.22	0.14	0.11
26-Jul-91		0.15	0.12	295,098	60	163	149	9	3	7	0.01	0.00	0.15	0.40	0.25	0.20
27-Jul-91	1100	0.17	0.16	380,316	86	213	203	11	5	7	0.01	0.00	0.19	0.49	0.34	0.30
28-Jul-91		0.17	0.16	380,316	89	230	214	11	4	6	0.01	0.00	0.19	0.54	0.36	0.30
29-Jul-91		0.17	0.16	380,316	89	230	214	11	4	6	0.01	0.00	0.19	0.54	0.36	0.30
30-Jul-91		0.16	0.14	336,144	79	203	189	9	4	6	0.01	0.00	0.17	0.47	0.32	0.26
31-Jul-91		0.15	0.12	295,098	69	178	166	8	3	5	0.01	0.00	0.15	0.42	0.28	0.23
01-Aug-91		0.14	0.11	257,128	60	155	145	7	3	4	0.01	0.00	0.13	0.36	0.25	0.20
02-Aug-91	1800	0.17	0.16	380,316	92	246	226	10	4	6	0.01	0.00	0.19	0.59	0.39	0.29
03-Aug-91		0.17	0.16	380,316	89	240	219	12	4	5	0.01	0.00	0.21	0.57	0.33	0.25
04-Aug-91		0.16	0.14	336,144	79	212	193	11	4	5	0.01	0.00	0.18	0.50	0.29	0.22
05-Aug-91		0.18	0.17	427,655	100	270	246	14	5	6	0.01	0.00	0.24	0.64	0.37	0.29
06-Aug-91	1015	0.39	0.90	2,192,796	493	1,349	1,221	83	26	26	0.04	0.00	1.32	3.16	1.54	1.25
07-Aug-91		0.37	0.80	1,960,307	401	1,144	1,042	64	24	24	0.04	0.00	1.08	2.77	1.42	1.15
08-Aug-91		0.37	0.80	1,960,307	401	1,144	1,042	64	24	24	0.04	0.00	1.08	2.77	1.42	1.15
09-Aug-91		0.34	0.67	1,636,913	335	956	870	53	20	20	0.04	0.00	0.90	2.32	1.19	0.96
10-Aug-91		0.32	0.59	1,438,306	294	840	764	47	17	17	0.03	0.00	0.79	2.04	1.04	0.85
11-Aug-91		0.32	0.59	1,438,306	294	840	764	47	17	17	0.03	0.00	0.79	2.04	1.04	0.85
12-Aug-91		0.34	0.67	1,636,913	335	956	870	53	20	20	0.04	0.00	0.90	2.32	1.19	0.96
13-Aug-91		0.32	0.59	1,438,306	294	840	764	47	17	17	0.03	0.00	0.79	2.04	1.04	0.85
14-Aug-91		0.31	0.55	1,344,116	275	785	714	44	16	16	0.03	0.00	0.74	1.90	0.98	0.79
15-Aug-91		0.30	0.51	1,253,336	256	732	666	41	15	15	0.03	0.00	0.69	1.77	0.91	0.74
16-Aug-91		0.29	0.48	1,165,968	238	681	620	38	14	14	0.03	0.00	0.64	1.65	0.85	0.69
17-Aug-91		0.28	0.44	1,082,008	221	632	575	35	13	13	0.02	0.00	0.60	1.53	0.79	0.64
18-Aug-91		0.27	0.41	1,001,453	205	585	532	33	12	12	0.02	0.00	0.55	1.42	0.73	0.59
19-Aug-91		0.27	0.41	1,001,453	205	585	532	33	12	12	0.02	0.00	0.55	1.42	0.73	0.59
20-Aug-91		0.26	0.38	924,295	189	540	491	30	11	11	0.02	0.00	0.51	1.31	0.67	0.54

SITE IDENTIFICATION: RL-2

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
21-Aug-91		0.26	0.38	924,295	189	540	491	30	11	11	0.02	0.00	0.51	1.31	0.67	0.54
22-Aug-91		0.24	0.32	780,133	160	455	415	25	9	9	0.02	0.00	0.43	1.10	0.57	0.46
23-Aug-91		0.23	0.29	713,102	146	416	379	23	9	9	0.02	0.00	0.39	1.01	0.52	0.42
24-Aug-91		0.22	0.27	649,416	133	379	345	21	8	8	0.01	0.00	0.36	0.92	0.47	0.38
25-Aug-91		0.19	0.20	478,202	98	279	254	16	6	6	0.01	0.00	0.26	0.68	0.35	0.28
26-Aug-91		0.17	0.16	380,316	78	222	202	12	5	5	0.01	0.00	0.21	0.54	0.28	0.22
27-Aug-91		0.14	0.11	257,128	53	150	137	8	3	3	0.01	0.00	0.14	0.36	0.19	0.15
28-Aug-91		0.10	0.06	134,874	28	79	72	4	2	2	0.00	0.00	0.07	0.19	0.10	0.08
29-Aug-91		0.09	0.05	111,383	23	65	59	4	1	1	0.00	0.00	0.06	0.16	0.08	0.07
30-Aug-91		0.07	0.03	72,339	15	42	38	2	1	1	0.00	0.00	0.04	0.10	0.05	0.04
31-Aug-91		0.05	0.02	43,283	9	25	23	1	1	1	0.00	0.00	0.02	0.06	0.03	0.03
01-Sep-91		0.03	0.01	23,605	5	14	13	1	0	0	0.00	0.00	0.01	0.03	0.02	0.01
02-Sep-91		0.02	0.01	17,483	4	10	9	1	0	0	0.00	0.00	0.01	0.02	0.01	0.01
03-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
04-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
05-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
06-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
07-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
08-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
09-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
10-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
11-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
12-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
13-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
14-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
15-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
16-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
17-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
18-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
19-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
20-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
21-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
22-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
23-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
24-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
25-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
26-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
27-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
28-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
29-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
30-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
01-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
02-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00

SITE IDENTIFICATION: RL-2

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
03-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
04-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
05-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
06-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
07-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
08-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
09-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
10-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
11-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
12-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
13-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
14-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
15-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
16-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
17-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
18-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
19-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
20-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
21-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
22-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
23-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
24-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
25-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
26-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
27-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
28-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
29-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
30-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
31-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
01-Nov-91	MEDIAN	0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL IN KG/YEAR		484	1,185,322,770	163,506	717,002	681,617	21,224	11,901	9,082	147	2	299	1,663	791	677
	TOTAL IN POUNDS/YEAR				360,531	1,580,990	1,502,965	46,800	26,242	20,025	323	5	660	3,668	1,744	1,493
	TOTAL IN TONS/YEAR				180	790	751	23	13	10	0.16	0.00	0.33	1.83	0.87	0.75

SITE IDENTIFICATION: RL-3

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
08-Apr-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
09-Apr-91		0.03	0.02	50,487	20	77	75	2	1	1	0.00	0.00	0.01	0.08	0.02	0.01
10-Apr-91		0.08	0.11	272,189	108	417	404	12	6	6	0.01	0.00	0.03	0.46	0.10	0.07
09-Nov-60		0.10	0.16	399,332	159	612	593	18	9	9	0.01	0.00	0.04	0.67	0.14	0.10
12-Apr-91		0.27	0.90	2,199,335	873	3,372	3,264	97	48	48	0.07	0.00	0.22	3.69	0.79	0.55
13-Apr-91		0.72	4.85	11,857,192	4,707	18,177	17,596	522	261	261	0.36	0.01	1.19	19.92	4.27	2.96
14-Apr-91		0.74	5.08	12,428,573	4,934	19,053	18,444	547	273	273	0.37	0.01	1.24	20.88	4.47	3.11
15-Apr-91	1045	0.62	3.75	9,171,332	3,641	14,060	13,610	404	202	202	0.28	0.01	0.92	15.41	3.30	2.29
16-Apr-91		0.56	3.15	7,700,225	2,915	11,539	11,119	193	100	92	0.19	0.01	0.77	11.43	2.54	1.50
17-Apr-91		0.54	2.96	7,233,916	2,738	10,840	10,446	181	94	87	0.18	0.01	0.72	10.74	2.39	1.41
18-Apr-91		0.50	2.59	6,338,130	2,399	9,498	9,152	158	82	76	0.16	0.01	0.63	9.41	2.09	1.24
19-Apr-91		0.49	2.50	6,121,955	2,317	9,174	8,840	153	80	73	0.15	0.01	0.61	9.09	2.02	1.19
20-Apr-91		0.50	2.59	6,338,130	2,399	9,498	9,152	158	82	76	0.16	0.01	0.63	9.41	2.09	1.24
21-Apr-91		0.51	2.68	6,557,431	2,482	9,826	9,469	164	85	79	0.16	0.01	0.66	9.74	2.16	1.28
22-Apr-91		0.45	2.16	5,288,872	2,002	7,925	7,637	132	69	63	0.13	0.00	0.53	7.85	1.75	1.03
23-Apr-91		0.47	2.33	5,699,052	2,157	8,540	8,229	142	74	68	0.14	0.01	0.57	8.46	1.88	1.11
24-Apr-91		0.48	2.42	5,908,922	2,237	8,855	8,532	148	77	71	0.15	0.01	0.59	8.77	1.95	1.15
25-Apr-91		0.51	2.68	6,557,431	2,482	9,826	9,469	164	85	79	0.16	0.01	0.66	9.74	2.16	1.28
26-Apr-91		0.53	2.86	7,005,341	2,652	10,498	10,116	175	91	84	0.18	0.01	0.70	10.40	2.31	1.37
27-Apr-91		0.58	3.34	8,178,643	3,096	12,256	11,810	204	106	98	0.20	0.01	0.82	12.15	2.70	1.59
28-Apr-91		0.55	3.05	7,465,549	2,826	11,187	10,780	187	97	90	0.19	0.01	0.75	11.09	2.46	1.46
29-Apr-91		0.50	2.59	6,338,130	2,399	9,498	9,152	158	82	76	0.16	0.01	0.63	9.41	2.09	1.24
30-Apr-91		0.49	2.50	6,121,955	2,317	9,174	8,840	153	80	73	0.15	0.01	0.61	9.09	2.02	1.19
01-May-91		0.48	2.42	5,908,922	2,237	8,855	8,532	148	77	71	0.15	0.01	0.59	8.77	1.95	1.15
02-May-91		0.48	2.42	5,908,922	2,237	8,855	8,532	148	77	71	0.15	0.01	0.59	8.77	1.95	1.15
03-May-91		1.11	10.19	24,939,906	9,440	37,372	36,013	623	324	299	0.62	0.02	2.49	37.04	8.23	4.86
04-May-91		1.26	12.67	31,006,342	11,736	46,463	44,773	775	403	372	0.78	0.03	3.10	46.04	10.23	6.05
05-May-91		0.72	4.85	11,857,192	4,488	17,768	17,122	296	154	142	0.30	0.01	1.19	17.61	3.91	2.31
06-May-91	1330	0.61	3.65	8,918,714	3,211	13,057	12,522	54	36	18	0.18	0.01	0.89	11.51	2.68	1.25
07-May-91		0.59	3.44	8,422,355	1,701	7,130	6,725	168	118	51	0.21	0.01	0.84	8.42	3.79	2.61
08-May-91		0.58	3.34	8,178,643	1,652	6,923	6,531	164	115	49	0.20	0.01	0.82	8.18	3.68	2.54
09-May-91		0.60	3.54	8,669,050	1,751	7,338	6,922	173	121	52	0.22	0.01	0.87	8.67	3.90	2.69
10-May-91		0.61	3.65	8,918,714	1,802	7,550	7,122	178	125	54	0.22	0.01	0.89	8.92	4.01	2.76
11-May-91		0.59	3.44	8,422,355	1,701	7,130	6,725	168	118	51	0.21	0.01	0.84	8.42	3.79	2.61
12-May-91		0.59	3.44	8,422,355	1,701	7,130	6,725	168	118	51	0.21	0.01	0.84	8.42	3.79	2.61
13-May-91		0.57	3.24	7,937,928	1,603	6,719	6,338	159	111	48	0.20	0.01	0.79	7.94	3.57	2.46
14-May-91		0.56	3.15	7,700,225	1,555	6,518	6,149	154	108	46	0.19	0.01	0.77	7.70	3.47	2.39
15-May-91		0.55	3.05	7,465,549	1,508	6,320	5,961	149	105	45	0.19	0.01	0.75	7.47	3.36	2.31

SITE IDENTIFICATION: RL-3

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
16-May-91		0.60	3.54	8,669,050	1,751	7,338	6,922	173	121	52	0.22	0.01	0.87	8.67	3.90	2.69
17-May-91		0.72	4.85	11,857,192	2,395	10,037	9,468	237	166	71	0.30	0.01	1.19	11.86	5.34	3.68
18-May-91		0.62	3.75	9,171,332	1,853	7,764	7,323	183	128	55	0.23	0.01	0.92	9.17	4.13	2.84
19-May-91		0.62	3.75	9,171,332	1,853	7,764	7,323	183	128	55	0.23	0.01	0.92	9.17	4.13	2.84
20-May-91		0.61	3.65	8,918,714	1,802	7,550	7,122	178	125	54	0.22	0.01	0.89	8.92	4.01	2.76
21-May-91		0.58	3.34	8,178,643	1,652	6,923	6,531	164	115	49	0.20	0.01	0.82	8.18	3.68	2.54
22-May-91		0.63	3.85	9,426,893	1,904	7,980	7,527	189	132	57	0.24	0.01	0.94	9.43	4.24	2.92
23-May-91		0.88	6.84	16,737,111	3,381	14,168	13,365	335	234	100	0.42	0.01	1.67	16.74	7.53	5.19
24-May-91		0.70	4.62	11,297,091	2,282	9,563	9,021	226	158	68	0.28	0.01	1.13	11.30	5.08	3.50
25-May-91		0.63	3.85	9,426,893	1,904	7,980	7,527	189	132	57	0.24	0.01	0.94	9.43	4.24	2.92
26-May-91		0.70	4.62	11,297,091	2,282	9,563	9,021	226	158	68	0.28	0.01	1.13	11.30	5.08	3.50
27-May-91		0.79	5.68	13,905,809	2,809	11,771	11,104	278	195	83	0.35	0.01	1.39	13.91	6.26	4.31
28-May-91		0.77	5.44	13,306,603	2,688	11,264	10,625	266	186	80	0.33	0.01	1.33	13.31	5.99	4.13
29-May-91	1645	1.21	11.82	28,923,065	1,273	6,623	5,582	983	694	289	0.87	0.02	2.89	20.54	17.35	13.88
30-May-91		1.46	16.32	39,934,985	1,657	7,827	6,549	958	719	240	1.60	0.02	3.99	33.94	23.36	19.87
31-May-91		1.36	14.45	35,352,825	1,467	6,929	5,798	848	636	212	1.41	0.02	3.54	30.05	20.68	17.59
01-Jun-91		1.37	14.63	35,800,517	1,486	7,017	5,871	859	644	215	1.43	0.02	3.58	30.43	20.94	17.81
02-Jun-91		1.29	13.20	32,285,245	1,340	6,328	5,295	775	581	194	1.29	0.02	3.23	27.44	18.89	16.06
03-Jun-91		1.47	16.52	40,405,980	1,677	7,920	6,627	970	727	242	1.62	0.02	4.04	34.35	23.64	20.10
04-Jun-91		2.14	31.48	77,019,001	3,196	15,096	12,631	1,848	1,386	462	3.08	0.04	7.70	65.47	45.06	38.32
05-Jun-91	1620	2.41	38.61	94,457,683	3,684	15,397	12,752	1,322	1,133	189	4.72	0.02	9.45	93.51	53.84	48.65
06-Jun-91		1.85	24.51	59,974,473	5,338	15,713	14,694	960	780	180	3.30	0.03	20.99	96.26	80.07	75.72
07-Jun-91		1.60	19.10	46,737,113	4,160	12,245	11,451	748	608	140	2.57	0.02	16.36	75.01	62.39	59.01
08-Jun-91		2.03	28.75	70,344,780	6,261	18,430	17,234	1,126	914	211	3.87	0.04	24.62	112.90	93.91	88.81
09-Jun-91		2.53	41.97	102,680,252	9,139	26,902	25,157	1,643	1,335	308	5.65	0.05	35.94	164.80	137.08	129.63
10-Jun-91		2.45	39.72	97,166,657	8,648	25,458	23,806	1,555	1,263	291	5.34	0.05	34.01	155.95	129.72	122.67
11-Jun-91		2.26	34.57	84,585,988	7,528	22,162	20,724	1,353	1,100	254	4.65	0.04	29.61	135.76	112.92	106.79
12-Jun-91		2.09	30.23	73,953,941	6,582	19,376	18,119	1,183	961	222	4.07	0.04	25.88	118.70	98.73	93.37
13-Jun-91		1.99	27.79	67,980,724	6,050	17,811	16,655	1,088	884	204	3.74	0.03	23.79	109.11	90.75	85.83
14-Jun-91		1.87	24.97	61,092,505	5,437	16,006	14,968	977	794	183	3.36	0.03	21.38	98.05	81.56	77.13
15-Jun-91		1.75	22.28	54,514,471	4,852	14,283	13,356	872	709	164	3.00	0.03	19.08	87.50	72.78	68.82
16-Jun-91		1.68	20.77	50,822,841	4,523	13,316	12,452	813	661	152	2.80	0.03	17.79	81.57	67.85	64.16
17-Jun-91		1.57	18.49	45,241,995	4,027	11,853	11,084	724	588	136	2.49	0.02	15.83	72.61	60.40	57.12
18-Jun-91		1.44	15.94	38,999,930	3,471	10,218	9,555	624	507	117	2.14	0.02	13.65	62.59	52.06	49.24
19-Jun-91		1.37	14.63	35,800,517	3,186	9,380	8,771	573	465	107	1.97	0.02	12.53	57.46	47.79	45.20
20-Jun-91	1500	1.30	13.37	32,716,336	4,548	11,811	11,614	589	458	131	1.96	0.03	19.63	72.63	68.70	65.76
21-Jun-91		1.24	12.33	30,165,769	4,917	12,277	11,629	362	271	90	1.66	0.04	18.10	60.48	58.52	55.35
22-Jun-91		1.18	11.32	27,702,279	4,515	11,275	10,679	332	249	83	1.52	0.04	16.62	55.54	53.74	50.83

SITE IDENTIFICATION: RL-3

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
23-Jun-91		0.50	2.59	6,338,130	1,033	2,580	2,443	76	57	19	0.35	0.01	3.80	12.71	12.30	11.63
24-Jun-91		0.25	0.79	1,926,989	314	784	743	23	17	6	0.11	0.00	1.16	3.86	3.74	3.54
25-Jun-91		0.24	0.72	1,758,096	287	716	678	21	16	5	0.10	0.00	1.05	3.52	3.41	3.23
26-Jun-91		0.22	0.65	1,595,726	260	649	615	19	14	5	0.09	0.00	0.96	3.20	3.10	2.93
27-Jun-91		0.21	0.59	1,439,982	235	586	555	17	13	4	0.08	0.00	0.86	2.89	2.79	2.64
28-Jun-91		0.20	0.53	1,290,977	210	525	498	15	12	4	0.07	0.00	0.77	2.59	2.50	2.37
29-Jun-91		0.18	0.47	1,148,834	187	468	443	14	10	3	0.06	0.00	0.69	2.30	2.23	2.11
30-Jun-91		0.17	0.41	1,013,686	165	413	391	12	9	3	0.06	0.00	0.61	2.03	1.97	1.86
01-Jul-91		0.16	0.36	885,678	144	360	341	11	8	3	0.05	0.00	0.53	1.78	1.72	1.63
02-Jul-91		0.15	0.31	764,970	125	311	295	9	7	2	0.04	0.00	0.46	1.53	1.48	1.40
03-Jul-91		0.13	0.27	651,741	106	265	251	8	6	2	0.04	0.00	0.39	1.31	1.26	1.20
04-Jul-91	1015	0.12	0.22	546,191	102	247	227	3	2	1	0.03	0.00	0.33	0.98	0.97	0.91
05-Jul-91		0.11	0.18	448,546	87	207	194	4	3	1	0.02	0.00	0.25	0.78	0.76	0.70
06-Jul-91		0.09	0.15	359,067	69	166	155	3	2	1	0.02	0.00	0.20	0.63	0.61	0.56
07-Jul-91	1530	0.08	0.11	272,189	54	128	122	3	2	1	0.01	0.00	0.14	0.46	0.44	0.39
08-Jul-91		0.08	0.11	272,189	63	165	135	36	11	25	0.01	0.00	0.14	0.39	0.33	0.29
09-Jul-91		0.07	0.09	216,400	50	131	107	29	9	20	0.01	0.00	0.11	0.31	0.26	0.23
10-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
11-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
12-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
13-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
14-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
15-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
16-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
17-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
18-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
19-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
20-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
21-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
22-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
23-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
24-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
25-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
26-Jul-91		0.05	0.05	121,409	28	74	60	16	5	11	0.00	0.00	0.06	0.17	0.15	0.13
27-Jul-91	900	0.05	0.05	121,409	32	90	66	31	9	22	0.00	0.00	0.06	0.14	0.10	0.08
28-Jul-91		0.05	0.05	121,409	33	82	67	18	5	13	0.00	0.00	0.06	0.26	0.11	0.08
29-Jul-91		0.05	0.05	121,409	33	82	67	18	5	13	0.00	0.00	0.06	0.26	0.11	0.08
30-Jul-91		0.05	0.05	121,409	33	82	67	18	5	13	0.00	0.00	0.06	0.26	0.11	0.08

SITE IDENTIFICATION: RL-3

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
31-Jul-91		0.05	0.05	121,409	33	82	67	18	5	13	0.00	0.00	0.06	0.26	0.11	0.08
01-Aug-91		0.05	0.05	121,409	33	82	67	18	5	13	0.00	0.00	0.06	0.26	0.11	0.08
02-Aug-91	1500	0.05	0.05	121,409	33	75	68	5	0	5	0.00	0.00	0.06	0.38	0.13	0.08
03-Aug-91		0.05	0.05	121,409	32	75	66	6	1	3	0.00	0.00	0.07	0.33	0.11	0.08
04-Aug-91		0.05	0.05	121,409	32	75	66	6	1	3	0.00	0.00	0.07	0.33	0.11	0.08
05-Aug-91		0.05	0.05	121,409	32	75	66	6	1	3	0.00	0.00	0.07	0.33	0.11	0.08
06-Aug-91	815	0.82	6.06	14,825,194	3,647	9,192	7,828	890	178	59	0.44	0.01	8.90	34.10	11.96	9.44
07-Aug-91		0.30	1.08	2,635,661	618	1,533	1,339	113	32	11	0.08	0.00	1.45	5.26	2.15	1.69
08-Aug-91		0.20	0.54	1,313,457	308	764	667	56	16	5	0.04	0.00	0.72	2.62	1.07	0.84
09-Aug-91		0.10	0.16	399,332	94	232	203	17	5	2	0.01	0.00	0.22	0.80	0.33	0.26
10-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
11-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
12-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
13-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
14-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
15-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
16-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
17-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
18-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
19-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
20-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
21-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
22-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
23-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
24-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
25-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
26-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
27-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
28-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
29-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
30-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
31-Aug-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
01-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
02-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
03-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
04-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
05-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
06-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08

SITE IDENTIFICATION: RL-3

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
07-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
08-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
09-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
10-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
11-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
12-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
13-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
14-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
15-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
16-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
17-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
18-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
19-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
20-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
21-Sep-91		0.05	0.05	121,409	28	71	62	5	1	0	0.00	0.00	0.07	0.24	0.10	0.08
22-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
23-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
24-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
25-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
26-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
27-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
28-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
29-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
30-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
01-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
02-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
03-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
04-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
05-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
06-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
07-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
08-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
09-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
10-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
11-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
12-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
13-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
14-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00

SITE IDENTIFICATION: RL-3

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
15-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
16-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
17-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
18-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
19-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
20-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
21-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
22-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
23-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
24-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
25-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
26-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
27-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
28-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
29-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
30-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
31-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
01-Nov-91	MEDIAN	0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL IN KG/YEAR		757	1,852,534,605	247,882	885,854	831,931	36,534	25,851	9,764	83	1	476	2,606	1,828	1,656
	TOTAL IN POUNDS/YEAR				546,581	1,953,307	1,834,408	80,557	57,002	21,529	183	3	1,050	5,746	4,030	3,651
	TOTAL IN TONS/YEAR				273	977	917	40	29	11	0.09	0.00	0.53	2.87	2.02	1.83

SITE IDENTIFICATION: RL-4

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
12-Apr-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
13-Apr-91		0.05	4.13	10,102,398	475	3,223	3,192	263	101	162	0.30	0.00	1.01	13.64	5.05	4.85
14-Apr-91		0.13	19.46	47,616,869	2,238	15,190	15,047	1,238	476	762	1.43	0.02	4.76	64.28	23.81	22.86
15-Apr-91	1000	0.15	24.30	59,463,619	2,795	18,969	18,791	1,546	595	951	1.78	0.02	5.95	80.28	29.73	28.54
16-Apr-91		0.13	19.46	47,616,869	2,024	12,476	12,047	762	333	429	1.19	0.02	4.76	48.81	18.57	17.62
17-Apr-91		0.11	14.98	36,637,679	1,557	9,599	9,269	586	256	330	0.92	0.01	3.66	37.55	14.29	13.56
18-Apr-91		0.08	9.00	22,018,990	936	5,769	5,571	352	154	198	0.55	0.01	2.20	22.57	8.59	8.15
19-Apr-91		0.08	9.00	22,018,990	936	5,769	5,571	352	154	198	0.55	0.01	2.20	22.57	8.59	8.15
20-Apr-91		0.08	9.00	22,018,990	936	5,769	5,571	352	154	198	0.55	0.01	2.20	22.57	8.59	8.15
21-Apr-91		0.07	7.24	17,710,865	753	4,640	4,481	283	124	159	0.44	0.01	1.77	18.15	6.91	6.55
22-Apr-91		0.06	5.61	13,726,916	583	3,596	3,473	220	96	124	0.34	0.01	1.37	14.07	5.35	5.08
23-Apr-91		0.06	5.61	13,726,916	583	3,596	3,473	220	96	124	0.34	0.01	1.37	14.07	5.35	5.08
24-Apr-91		0.05	4.13	10,102,398	429	2,647	2,556	162	71	91	0.25	0.00	1.01	10.35	3.94	3.74
25-Apr-91		0.04	2.81	6,883,883	293	1,804	1,742	110	48	62	0.17	0.00	0.69	7.06	2.68	2.55
26-Apr-91		0.04	2.81	6,883,883	293	1,804	1,742	110	48	62	0.17	0.00	0.69	7.06	2.68	2.55
27-Apr-91		0.03	1.69	4,135,790	176	1,084	1,046	66	29	37	0.10	0.00	0.41	4.24	1.61	1.53
28-Apr-91		0.01	0.20	489,320	21	128	124	8	3	4	0.01	0.00	0.05	0.50	0.19	0.18
29-Apr-91		0.02	0.80	1,953,097	83	512	494	31	14	18	0.05	0.00	0.20	2.00	0.76	0.72
30-Apr-91		0.05	4.13	10,102,398	429	2,647	2,556	162	71	91	0.25	0.00	1.01	10.35	3.94	3.74
01-May-91		0.01	0.20	489,320	21	128	124	8	3	4	0.01	0.00	0.05	0.50	0.19	0.18
02-May-91		0.01	0.20	489,320	21	128	124	8	3	4	0.01	0.00	0.05	0.50	0.19	0.18
03-May-91		0.14	21.84	53,436,845	2,271	14,000	13,520	855	374	481	1.34	0.02	5.34	54.77	20.84	19.77
04-May-91		0.13	19.46	47,616,869	2,024	12,476	12,047	762	333	429	1.19	0.02	4.76	48.81	18.57	17.62
05-May-91		0.13	19.46	47,616,869	2,024	12,476	12,047	762	333	429	1.19	0.02	4.76	48.81	18.57	17.62
06-May-91	1730	0.13	19.46	47,616,869	1,809	9,761	9,047	286	190	95	0.95	0.02	4.76	33.33	13.33	12.38
07-May-91		0.10	12.88	31,502,659	5,198	22,713	21,611	504	441	63	1.26	0.09	11.03	30.40	10.71	9.21
08-May-91		0.08	9.00	22,018,990	3,633	15,876	15,105	352	308	44	0.88	0.06	7.71	21.25	7.49	6.44
09-May-91		0.07	7.24	17,710,865	2,922	12,770	12,150	283	248	35	0.71	0.05	6.20	17.09	6.02	5.18
10-May-91		0.06	5.61	13,726,916	2,265	9,897	9,417	220	192	27	0.55	0.04	4.80	13.25	4.67	4.02
11-May-91		0.04	2.81	6,883,883	1,136	4,963	4,722	110	96	14	0.28	0.02	2.41	6.64	2.34	2.01
12-May-91		0.04	2.81	6,883,883	1,136	4,963	4,722	110	96	14	0.28	0.02	2.41	6.64	2.34	2.01
13-May-91		0.03	1.69	4,135,790	682	2,982	2,837	66	58	8	0.17	0.01	1.45	3.99	1.41	1.21
14-May-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
15-May-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
16-May-91		0.04	2.81	6,883,883	1,136	4,963	4,722	110	96	14	0.28	0.02	2.41	6.64	2.34	2.01
17-May-91		0.02	0.80	1,953,097	322	1,408	1,340	31	27	4	0.08	0.01	0.68	1.88	0.66	0.57
18-May-91		0.01	0.20	489,320	81	353	336	8	7	1	0.02	0.00	0.17	0.47	0.17	0.14
19-May-91		0.01	0.20	489,320	81	353	336	8	7	1	0.02	0.00	0.17	0.47	0.17	0.14

SITE IDENTIFICATION: RL-4

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
20-May-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
21-May-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
22-May-91		0.07	7.24	17,710,865	2,922	12,770	12,150	283	248	35	0.71	0.05	6.20	17.09	6.02	5.18
23-May-91		0.06	5.61	13,726,916	2,265	9,897	9,417	220	192	27	0.55	0.04	4.80	13.25	4.67	4.02
24-May-91		0.05	4.13	10,102,398	1,667	7,284	6,930	162	141	20	0.40	0.03	3.54	9.75	3.43	2.95
25-May-91		0.04	2.81	6,883,883	1,136	4,963	4,722	110	96	14	0.28	0.02	2.41	6.64	2.34	2.01
26-May-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
27-May-91		0.01	0.20	489,320	81	353	336	8	7	1	0.02	0.00	0.17	0.47	0.17	0.14
28-May-91		0.10	12.88	31,502,659	5,198	22,713	21,611	504	441	63	1.26	0.09	11.03	30.40	10.71	9.21
29-May-91	1530	0.10	12.88	31,502,659	9,199	38,969	37,236	819	756	63	1.89	0.17	18.90	38.75	12.60	10.24
30-May-91		0.10	12.88	31,502,659	7,828	33,834	32,227	725	662	63	6.62	0.27	11.03	49.46	17.94	14.52
31-May-91		0.07	7.24	17,710,865	4,401	19,021	18,118	407	372	35	3.72	0.15	6.20	27.81	10.09	8.16
01-Jun-91		0.04	2.81	6,883,883	1,711	7,393	7,042	158	145	14	1.45	0.06	2.41	10.81	3.92	3.17
02-Jun-91		0.07	7.24	17,710,865	4,401	19,021	18,118	407	372	35	3.72	0.15	6.20	27.81	10.09	8.16
03-Jun-91		0.18	32.17	78,704,107	19,558	84,528	80,514	1,810	1,653	157	16.53	0.68	27.55	123.57	44.82	36.28
04-Jun-91		0.38	99.29	242,910,647	60,363	260,886	248,498	5,587	5,101	486	51.01	2.09	85.02	381.37	138.34	111.98
05-Jun-91	1845	0.39	103.21	252,522,728	51,767	230,048	218,180	5,050	4,545	505	90.91	3.01	25.25	482.32	186.61	150.76
06-Jun-91		0.27	59.49	145,546,743	26,053	94,824	90,530	5,676	3,639	2,038	37.11	1.15	50.94	240.88	120.73	100.21
07-Jun-91		0.17	29.47	72,104,392	12,907	46,976	44,849	2,812	1,803	1,009	18.39	0.57	25.24	119.33	59.81	49.64
08-Jun-91		0.47	136.37	333,636,371	59,721	217,364	207,522	13,012	8,341	4,671	85.08	2.63	116.77	552.17	276.75	229.71
09-Jun-91		0.72	258.01	631,243,531	112,993	411,255	392,633	24,618	15,781	8,837	160.97	4.97	220.94	1044.71	523.62	434.61
10-Jun-91		0.71	252.66	618,140,223	110,647	402,718	384,483	24,107	15,454	8,654	157.63	4.87	216.35	1023.02	512.75	425.59
11-Jun-91		0.61	201.29	492,463,869	88,151	320,840	306,313	19,206	12,312	6,894	125.58	3.88	172.36	815.03	408.50	339.06
12-Jun-91		0.51	154.05	376,892,170	67,464	245,545	234,427	14,699	9,422	5,276	96.11	2.97	131.91	623.76	312.63	259.49
13-Jun-91		0.47	136.37	333,636,371	59,721	217,364	207,522	13,012	8,341	4,671	85.08	2.63	116.77	552.17	276.75	229.71
14-Jun-91		0.42	115.29	282,073,700	50,491	183,771	175,450	11,001	7,052	3,949	71.93	2.22	98.73	466.83	233.98	194.21
15-Jun-91		0.37	95.41	233,419,916	41,782	152,073	145,187	9,103	5,835	3,268	59.52	1.84	81.70	386.31	193.62	160.71
16-Jun-91		0.32	76.78	187,839,664	33,623	122,378	116,836	7,326	4,696	2,630	47.90	1.48	65.74	310.87	155.81	129.33
17-Jun-91		0.26	56.20	137,506,324	24,614	89,585	85,529	5,363	3,438	1,925	35.06	1.08	48.13	227.57	114.06	94.67
18-Jun-91		0.21	40.69	99,549,593	17,819	64,857	61,920	3,882	2,489	1,394	25.39	0.78	34.84	164.75	82.58	68.54
19-Jun-91		0.18	32.17	78,704,107	14,088	51,276	48,954	3,069	1,968	1,102	20.07	0.62	27.55	130.26	65.29	54.19
20-Jun-91	1530	0.15	24.30	59,463,619	9,098	23,310	22,596	3,449	1,903	1,546	8.92	0.23	35.68	83.25	54.71	46.38
21-Jun-91		0.12	17.17	42,013,417	6,953	17,057	16,007	1,302	714	588	3.57	0.11	25.21	60.71	40.75	31.51
22-Jun-91		0.07	7.24	17,710,865	2,931	7,191	6,748	549	301	248	1.51	0.04	10.63	25.59	17.18	13.28
23-Jun-91		0.04	2.81	6,883,883	1,139	2,795	2,623	213	117	96	0.59	0.02	4.13	9.95	6.68	5.16
24-Jun-91		0.01	0.20	489,320	81	199	186	15	8	7	0.04	0.00	0.29	0.71	0.47	0.37
25-Jun-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
26-Jun-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00

SITE IDENTIFICATION: RL-4

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
27-Jun-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
28-Jun-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
29-Jun-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
30-Jun-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
01-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
02-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
03-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
04-Jul-91	1030	0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
05-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
06-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
07-Jul-91	1430	0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
08-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
09-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
10-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
11-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
12-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
13-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
14-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
15-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
16-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
17-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
18-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
19-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
20-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
21-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
22-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
23-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
24-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
25-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
26-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
27-Jul-91	1015	0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
28-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
29-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
30-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
31-Jul-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
01-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
02-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
03-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00

SITE IDENTIFICATION: RL-4

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
04-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
05-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
06-Aug-91	915	0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
07-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
08-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
09-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
10-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
11-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
12-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
13-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
14-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
15-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
16-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
17-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
18-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
19-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
20-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
21-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
22-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
23-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
24-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
25-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
26-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
27-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
28-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
29-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
30-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
31-Aug-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
01-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
02-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
03-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
04-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
05-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
06-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
07-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
08-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
09-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
10-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00

SITE IDENTIFICATION: RL-4

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
11-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
12-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
13-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
14-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
15-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
16-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
17-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
18-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
19-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
20-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
21-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
22-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
23-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
24-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
25-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
26-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
27-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
28-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
29-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
30-Sep-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
01-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
02-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
03-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
04-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
05-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
06-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
07-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
08-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
09-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
10-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
11-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
12-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
13-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
14-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
15-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
16-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
17-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
18-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00

SITE IDENTIFICATION: RL-4

DAILY LOADS

DATE	TIME	STAGE Feet	DISCHARGE CFS	DISCHARGE LITERS	TALK KG/DAY	TSOL KG/DAY	TDSOL KG/DAY	TSSOL KG/DAY	VOL-SOL KG/DAY	NONVOL KG/DAY	AMMON KG/DAY	UNIONIZE KG/DAY	NO3+2 KG/DAY	TKN KG/DAY	TPO4-P KG/DAY	TDISS-P KG/DAY
19-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
20-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
21-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
22-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
23-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
24-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
25-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
26-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
27-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
28-Oct-91		0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
29-Oct-91	MEDIAN	0.00	0.00	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL IN KG/YEAR		2,278	5,572,337,101	955,074	3,652,490	3,486,365	189,973	123,983	65,990	1,238	39	1,789	8,753	4,169	3,477
	TOTAL IN POUNDS/YEAR				2,105,937	8,053,740	7,687,434	418,892	273,383	145,509	2,730	87	3,945	19,300	9,193	7,666
	TOTAL IN TONS/YEAR				1,053	4,027	3,844	209	137	73	1.37	0.04	1.97	9.65	4.60	3.83

APPENDIX B
Water Quality Data

LAKE REDFIELD 1991-1992 LAKE ASSESSMENT SAMPLING DATA

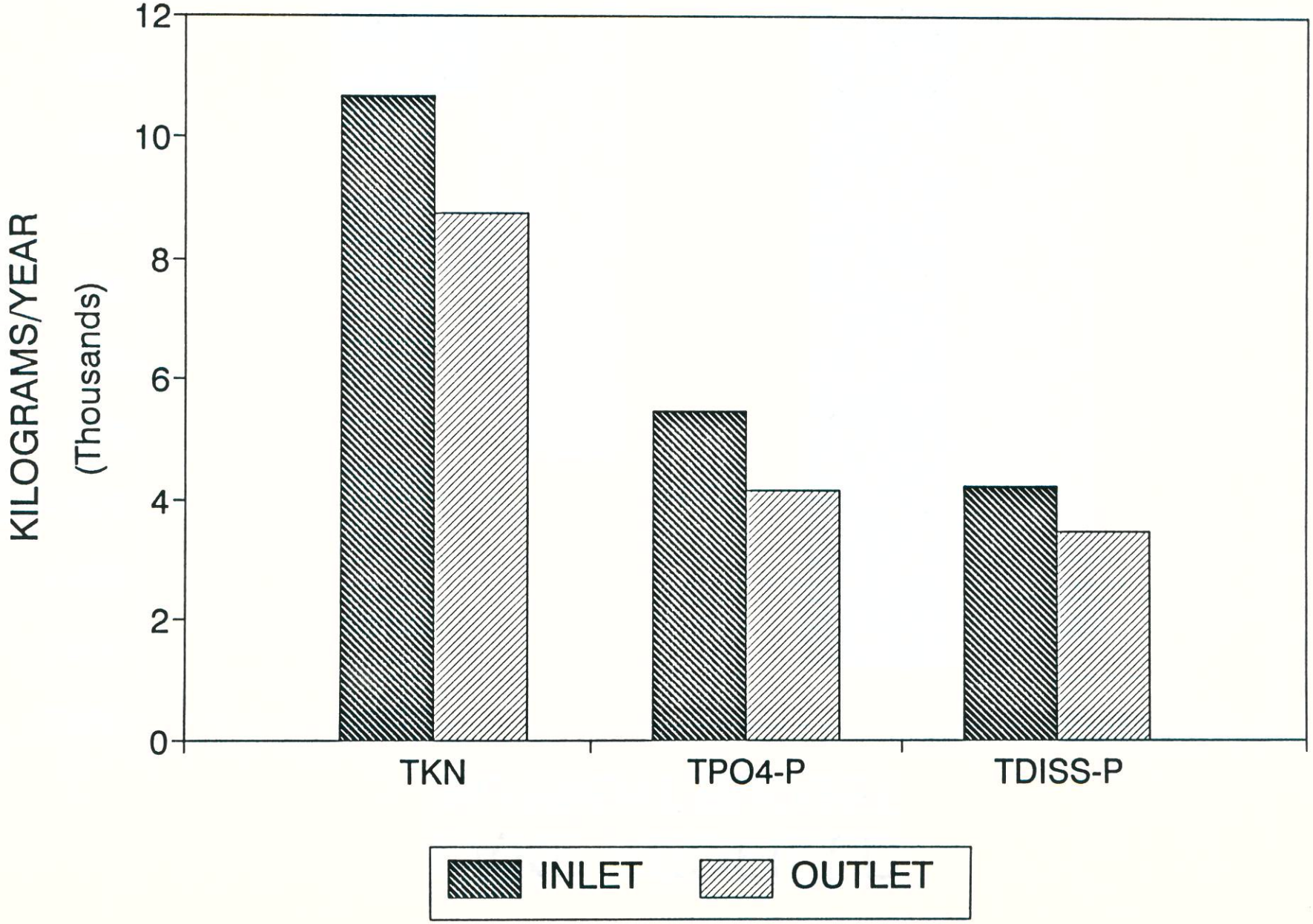
DATE	TIME	SITE	SAMPLE	DPTH (FT)	WTEMP (F)	ATEM (F)	SDSK (FT)	DO	FPH	FECAL	LPH	TALK	TSOL	COND	TDSOL	TSSOL	AMMON	NO3+2	TKN-N	TPO4-P	DISS-P	TSOL-V
4/15/91	1300	1	SGRAB	4.8	36	32		12.9		2	8.9	290	1297	2040	1289	46	0.02	0.10	1.87	0.39	0.22	26
5/7/91	1500	1	SGRAB	1.0	54	57		9.8	8.4	12		312	1644	2550	1549	36	0.02	0.10	1.75	0.36	0.10	36
5/29/91	1900	1	SGRAB		79	73		16.1		1280	8.9	288	1385	2117	1278	70	0.02	0.10	1.52	0.93	0.44	26
6/5/91	1715	1	SGRAB	5.5	68	70		5.2	7.3	350	7.7	135	483	659	435	26	0.28	0.1	1.44	0.82	0.61	20
6/20/91	1730	1	SGRAB		77	79		6.1		50	7.9	167	416	551	389	44	0.17	0.70	1.81	1.08	0.81	26
7/4/91	1200	1	SGRAB	4.0	73	77		9.6			9.0	233	536	721	453	62	0.02	0.50	1.64	1.01	0.62	24
7/7/91	1630	1	SGRAB	3.8	79	72		8.5		40	8.8	255	601	826	515	50	0.02	0.5	1.26	1.17	0.881	16
7/27/91	1130	1	SGRAB		66	68		4.2			8.2	341	824	1183	775	44	0.11	0.5	2	1.38	1.19	16
8/2/91	1700	1	SGRAB		79	81		10.5	7		8.6	351	848	1224	810	32	0.02	0.4	1.6	1.34	1.08	16
8/6/91	1115	1	SGRAB		69	67		14	7.2	330	8.4	339	846	1257	791	48	0.02	0.6	2.34	1.3	0.969	-
4/19/91	1015	2	SGRAB	1.0	36	34		3.4	6.4		7.4	57	353	448	322	26	0.07	0.10	1.12	0.41	0.39	18
5/7/91	1330	2	SGRAB	0.7	46	55		11.7	6.9	2	8.3	279	1539	2310	1463	28	0.02	0.10	1.37	0.22	0.09	20
5/29/91	1830	2	SGRAB	3.0	79	79		5.2		730	7.7	186	1074	1454	1063	24	0.08	0.10	1.54	0.71	0.64	12
6/5/91	1830	2	SGRAB		68	70		1.4	6.2	700	7.3	81	303	374	265	10	0.22	0.1	1.25	0.637	0.542	3
6/20/91	1700	2	SGRAB	1.0	77	84		4.1		40	7.6	137	430	649	421	16	0.08	0.60	1.61	0.81	0.72	14
7/4/91	1130	2	SGRAB	1.0	73	84		11			8.7	175	544	754	468	36	0.02	0.60	1.16	0.88	0.62	18
7/7/91	1730	2	SGRAB	0.4	77	74		7.2		10	8.4	182	542	798	479	34	0.03	0.5	1.41	0.786	0.597	6
7/27/91	1100	2	SGRAB	0.15	71	66		3.8			8	225	561	826	533	30	0.02	0.5	1.28	0.895	0.79	12
8/2/91	1800	2	SGRAB	0.21	79	84		8.6	7		8.4	243	646	942	594	26	0.02	0.5	1.54	1.02	0.766	10
8/6/91	1015	2	SGRAB	0.47	70	64		13.5	7.1	30	8.1	225	615	989	557	38	0.02	0.6	1.44	0.704	0.569	-
4/15/91	1045	3	SGRAB		37	37		10.7		3200	8.5	397	1533	2520	1484	44	0.03	0.10	1.68	0.36	0.25	22
5/6/91	1330	3	SGRAB	6.8	45	48		6.6	6.9	30	8.5	360	1464	2142	1404	6	0.02	0.10	1.29	0.30	0.14	4
5/29/91	1645	3	SGRAB	2.5	75	75		4		12000	7.7	44	229	202	193	34	0.03	0.10	0.71	0.60	0.48	24
6/5/91	1620	3	SGRAB	2.3	66	73		3.8	7.4	1100	7.1	39	163	135	135	14	0.05	0.1	0.99	0.57	0.515	12
6/20/91	1500	3	SGRAB	1.3	75	79		2.3		60	7.4	139	361	426	355	18	0.06	0.60	2.22	2.10	2.01	14
7/4/91	1015	3	SGRAB	0.5	68	77		1.8			8	187	453	556	416	6	0.05	0.60	1.79	1.78	1.66	4
7/7/91	1530	3	SGRAB	0.5	73	70		1.4		900	7.5	200	472	651	448	12	0.04	0.5	1.7	1.6	1.44	8
7/27/91	900	3	SGRAB	0.45	66	64		2.5			7.5	263	740	816	545	252	0.02	0.5	1.14	0.848	0.659	72
8/2/91	1500	3	SGRAB	0.45	73	75		3.4	7.5		7.9	275	614	828	562	42	0.03	0.5	3.16	1.03	0.651	4
8/6/91	815	3	SGRAB		65	64		1.2	7.6	2900	7.6	246	620	877	528	60	0.03	0.6	2.3	0.807	0.637	-

LAKE REDFIELD 1991-1992 LAKE ASSESSMENT SAMPLING DATA

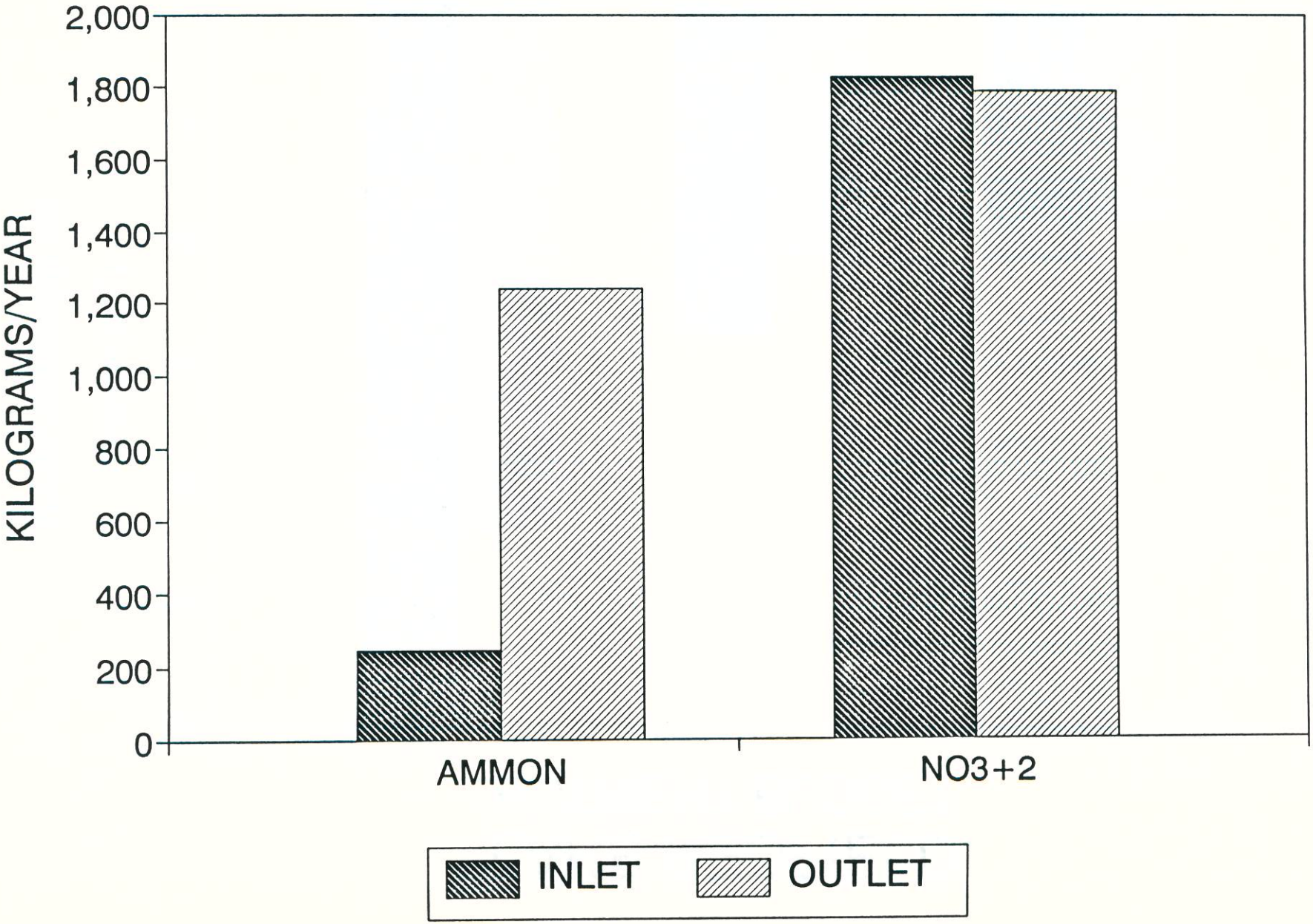
DATE	TIME	SITE	SAMPLE	DPTH	WTEMP	ATEM	SDSK	DO	FPH	FECAL	LPH	TALK	TSOL	COND	TDSOL	TSSOL	AMMON	NO3+2	TKN-N	TPO4-P	DISS-P	TSOL-V
4/15/91	1000	4	SGRAB	1.3	37	39		5.9		250	8.1	47	319	429	316	26	0.03	0.10	1.35	0.50	0.48	10
5/6/91	1730	4	SGRAB	1.0	46	57		11.3	6.9	10	8.1	38	205	214	190	6	0.02	0.10	0.70	0.28	0.26	4
5/29/91	1530	4	SGRAB	0.5	73	77		7.8		280	8.3	292	1237	1803	1182	26	0.06	0.60	1.23	0.40	0.33	24
6/5/91	1845	4	SGRAB		70	72		3.9	5.6	320	7.9	205	911	1520	864	20	0.36	0.1	1.91	0.739	0.597	18
6/20/91	1530	4	SGRAB		75	77		3.7		10	7.7	153	392	546	380	58	0.15	0.60	1.40	0.92	0.78	32
7/4/91	1030	4	SGRAB		73	84		5.7			8.1	178	420	599	382	4	0.02	0.60	1.49	1.02	0.72	2
7/7/91	1430	4	SGRAB		75	70		5.6		140	7.9	187	447	645	395	34	0.02	0.5	1.06	0.983	0.922	16
7/27/91	1015	4	SGRAB		68	64		2.8			7.7	225	484	714	458	18	0.02	0.5	1.34	0.939	0.81	14
8/2/91	1600	4	SGRAB		78	81		3.4	7.5		7.8	228	512	768	478	28	0.02	0.5	1.07	0.888	0.759	6
8/6/91	915	4	SGRAB		69	64		5.1	7.5	270	8.3	228	468	745	457	26	0.03	0.6	1.1	0.814	0.759	-
1/31/91	1245	5	SGRAB(D)	9.3	32	32	1.5	14.4	7.1	10	8.3	528	1960	2808	1915	21	0.35	0.10	2.70	0.58	0.49	11
1/31/91	1245	5	SGRAB	9.3	32	32	1.5	14.4	7.1	10	8.3	537	1983	2783	1906	11	0.36	0.10	2.62	0.63	0.55	11
2/25/91	1100	5	SGRAB	9.7	32	32	1.0	5.1	7	2	7.6	231	894	1394	855	36	0.16	0.10	4.39	1.95	1.63	16
3/25/91	1400	5	SGRAB	10.2	39	61	1.1	12.4	7.8	2	8.3	414	1542	2306	1471	20	0.03	0.10	2.61	0.63	0.53	2
5/24/91	1230	5	SGRAB	10.6	68	73	1.7	7.6			8.4	324	1321	2015	1289	32	0.02	0.10	1.53	0.24	0.16	22
7/16/91	1015	5	SGRAB	10.6	77	82	1.7	6.7		20	8.5	205	434	697	426	14	0.02	0.5	1.42	0.834	0.734	4
7/31/91	945	5	SGBAB	7	51	66	1.8	7.9		10	8.5	229	512	752	500	18	0.02	0.5	1.4	0.881	0.746	6
8/19/91	1030	5	SGRAB	10	73	66	2.4	7		10	8.7	245	507	847	490	16	0.04	0.7	1.43	0.658	0.61	-
9/12/91	1630	5	SGRAB	10	72	81	2.5	10			8.5	274	564	848	555	18	0.06	0.1	1.41	0.759	0.634	10
3/24/92	1110	5	SGRAB	10	46	64	1.8	12.3		2	8.4	320	931	1376	881	10	0.02	0.1	1.54	0.269	0.153	9
1/31/91	1500	6	SGRAB(D)	10.7	32	46	1.2	15	7	10	8.4	440	2047	2860	1967	37	0.21	0.10	2.75	0.56	0.41	22
1/31/91	1500	6	SGRAB	10.7	32	46	1.2	15	7	10	8.4	455	2022	2805	1952	24	0.14	0.10	2.57	0.60	-	10
2/25/91	1400	6	BGRAB	10.9	32	32	1.0	1.7	6.9	2	8.0	558	2073	3009	1996	40	0.24	0.10	2.40	1.15	1.03	32
2/25/91	1345	6	SGRAB	10.9	32	32	1.0	23.4	7	2	8.9	275	1071	1597	1046	22	0.02	0.10	2.24	0.50	0.20	14
3/25/91	1100	6	BGRAB	10.8	39	59	1.2	11.1	8.7	2	8.2	422	1556	2258	1490	20	0.02	0.10	1.68	0.63	0.42	2
3/25/91	1100	6	SGRAB	10.8	39	59	1.2	11.3	8.4	2	8.2	423	1558	2298	1480	20	0.04	0.10	1.84	0.61	0.46	2
5/24/91	1300	6	SGRAB	10.7	70	73	1.7	7.4			8.3	306	1306	1999	1271	30	0.02	0.10	1.65	0.26	0.21	12
5/24/91	1300	6	BGRAB	10.7	68	73	1.7	4.2			8.2	320	1325	1970	1284	36	0.08	0.10	1.30	0.33	0.22	14
7/16/91	915	6	SGRAB	10.9	77	75	1.3	6.6		180	8.5	210	453	707	440	20	0.02	0.50	1.12	0.88	0.70	2
7/16/91	930	6	BGRAB	10.9						160	8.4	211	459	680	439	22	0.02	0.50	1.05	0.86	0.73	2
7/31/91	830	6	SGRAB	10.4	74	66	1.8	7.9		60	8.5	232	514	734	504	20	0.02	0.4	1.35	0.834	0.98	6
8/19/91	900	6	SGRAB	11	73	64	2	6.7	7.5	220	8.8	248	544	826	487	28	0.09	0.6	1.44	0.698	0.644	-
8/19/91	1000	6	BGRAB	11		64	2	7.5		190	8.8	248	527	806	488	30	0.02	0.9	0.9	0.692	0.586	-
9/12/91	1530	6	SGRAB	10.5	73	86	1.7	10.4			8.6	275	589	883	561	24	0.23	0.1	1.7	0.807	0.603	12
9/12/91	1610	6	BGRAB	10.5	70	86		4.5			8.5	277	584	889	554	24	0.07	0.1	1.17	0.732	0.637	4
3/24/92	1200	6	SGRAB	11	46	63	2	12.1		2	8.4	315	922	1386	900	9	0.02	0.1	1.9	0.249	0.149	7
3/24/92	1245	6	BGRAB	11	46	63		12.1		2	8.4	310	920	1365	878	11	0.02	0.1	1.41	0.289	0.149	9

SGRAB = Surface Sample
BGRAB = Bottom Sample
(D) = QA/QC Sample

LAKE REDFIELD
NUTRIENT BUDGET



LAKE REDFIELD
NUTRIENT BUDGET



LAKE REDFIELD
SEDIMENT BUDGET