WOLF CREEK
NUCLEAR OPERATING CORPORATION

Forrest T. Rhodes
Vice President
Engineering & Technical Services

May 1, 1991

ET 91-0070

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Station P1-137
Washington, D. C. 20555

Subject: Docket No. 50-482: Annual Environmental Operating Report

Gentlemen:

Enclosed is the Annual Environmental Operating Report which is being submitted pursuant to Wolf Creek Generating Station (WCGS) Facility Operating License NPF-42, Appendix B. This report covers the operating of Wolf Creek Generating Station for the period of January 1, 1990 to December 31, 1990.

Very truly yours,

Forrest T. Rhodes
Vice President
Engineering & Technical Services

FTR/aem

Enclosure

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Enclosure to ET 91-0070

WOLF CREEK GENERATING STATION

ANNUAL ENVIRONMENTAL OPERATING REPORT

1990

ENVIRONMENTAL MANAGEMENT SECTION

WOLF CREEK NUCLEAR OPERATING CORPORATION

P.O. BOX 411

BURLINGTON, KS 66839

APRIL 1991

WOLF CREEK NUCLEAR OPERATING CORPORATION
WOLF CREEK GENERATING STATION

1990 ANNUAL ENVIRONMENTAL OPERATING REPORT

1.0 INTRODUCTION

Wolf Creek Generating Station (WCGS) has committed to minimizing the impact of facility operation on the environment. The 1990 Annual Environmental Operating Report is being submitted in accordance with the objectives of the Environmental Protection Plan (EPP) as required by Facility Operating License NPF-42. The purpose of this report is to demonstrate that the plant operated during 1990 in an environmentally acceptable manner.

2.0 ENVIRONMENTAL MONITORING

2.1 AQUATIC [EPP Section 2.1]

2.1.1 Impacts of Water Withdrawal on the Neosho River

The owners have contracted with the Kansas Water Resources Board to pump 9.672 billion gallons per calendar year from the tailwaters of the John Redmond Reservoir (JRR) to Wolf Creek Cooling Lake (WCCL). During 1990, 2.583 billion gallons or 27 percent of the contracted allotment were pumped. Auxiliary raw water was pumped at a rate of approximately 1.3 million gallons per day and comprised about 17 percent of the total pumped. The remainder was transferred via the make-up pumps, which operated on July 30 and from October 24 through November 20, 1990.

Measurements taken by the United States Geological Survey indicate that flows in the Neosho River at Burlington were largely unaffected by the pumping conducted on July 30. During the autumn pumping period, however, Neosho River flows decreased by about 6-8 cubic feet per second at the

onset of pumping and increased 8-10 cubic feet per second within 48 hours following the conclusion of pumping. These figures represent approximately one-third to two-thirds of total flow in the Neosho River at that time due to existing low flow conditions. While the reason for this decrease is not known for certain, it is suspected that blockages experienced in the diversion pipe from JRR may have reduced the flow of water to a value less than the 120 cubic feet per second flow rate required by the make-up pumps. Under normal conditions, this diversion pipe is designed to supply all of the water needed by the make-up pumps directly from JRR without affecting river flows. Any deficit resulting from lower-than-normal flows through the diversion pipe would have been balanced by withdrawals from the Neosho River at the Make-up Water Screen House (MUSH). In order to maintain at least a small amount of flow, JRR releases a minimum of 24 cfs and 21 cfs each year during October and November, respectively. Due to the apparent diversion pipe blockage, Wolf Creek's makeup withdrawals inadvertently took a portion of JRR's release, leaving the remainder to provide flow in the river. This situation is still under evaluation to determine the cause of the flow reduction and the need for any changes.

The Final Environmental Statement/Operating License Stage (FES/OLS) postulated that makeup water withdrawal of 41 cfs (average annual predicted makeup requirements) during drought conditions would extend the duration and severity of low-flow conditions below JRR. This, in turn, was expected to reduce riffle habitat which would adversely affect Neosho madtom populations. This combination of circumstances - makeup water withdrawal during very low river flows - occurred during the October 24 through

November 20, 1990 period. While the low flow conditions attributed in part to WCGS' 1990 withdrawals may have had some impact on riffle species such as the Neosho madtom, it would not have been nearly as severe as that documented in the years prior to JRR impoundment. Sampling conducted subsequent to the October/November 1990 withdrawal found Neosho madtoms present in numbers similar to previous years. Based on the follow-up collection data and the short duration of low river flows, this event was judged to have minimal, if any, impact.

2.1.2 Chlorine Discharges to Wolf Creek Cooling Lake

Total residual chlorine (TRC) was postulated in Section 4.2.6.1 of the FES/OLS to range between 0.68 and 1.08 mg/l at the Circulating Water System (CWS) discharge. Three 30-minute doses per day at 411 pounds of chlorine per dose were projected to produce these concentrations. These chlorine doses were expected to cause periodic, appreciable mortality among aquatic organisms in a conservatively estimated 40 acres of the discharge area of WCCL (FES/OLS, Section 5.5.2.2).

Administered by the Kansas Department of Health and Environment (KDHE), the WCGS National Pollutant Discharge Elimination System (NPDES) permit allows TRC to be a maximum of 0.2 mg/l in the circulating water effluent. Chlorine dose duration is limited to two hours per day. In practice, WCGS has fallen well below the NPDES allowable limits. Actual chlorine dosages to the CWS have averaged approximately 56 pounds per day. Compliance with the permit limits for daily maximum TRC and chlorination dose durations was 100 percent. Monitoring during 1990 detected

a daily average TRC concentration of less than 0.1 mg/l, well below the 0.2 mg/l permitted level. In Section 5.5.2.2 of the FES/OLS, the proposed chlorination treatments were not expected to meaningfully affect the overall biological productivity of WCCL. Because the actual monitored values during CWS chlorination were well below the evaluated levels and no fish mortalities attributable to chlorination were observed, permitted chlorine discharges during 1990 were not considered to have had appreciable effects on the cooling lake environment.

During 1990 the implementation of Plant Modification Request (PMR) 2149 initiated a continuous diversion of approximately 18,000 gpm of Service Water System (SWS) flow to the Essential Service Water System (ESW). PMR 2149 was intended to provide microbiologically induced corrosion and sedimentation control. This flow diversion differed from that of previous years when historically they had only occurred in an effort to prevent winter ice formation at the ESW intake.

In order to contrast this operational change with the criteria evaluated by the FES/OLS, two environmental evaluations have been completed. Evaluations 89-6 and 90-1 (detailed later in Section 3.1 of this report) describe the potential for unreviewed environmental impacts. Both evaluations conclude that selected benthic and pelagic organisms will likely experience mortality. More importantly, however, these evaluations determined that the area of impact was predicted to be only 0.1 percent (approximately six acres) of the total cooling lake surface area. Therefore, it was concluded that the significance of this additional chlorine discharge should be negligible to

the WCCL ecosystem and the impacts should be within those considered acceptable in the FES/OLS.

In the EPP, the Nuclear Regulatory Commission (NRC) defers regulation of water quality issues to the WCGS NPDES permit administered by the State of Kansas. In the 1989 permit revision the KDHE established a 1.0 mg/l TRC limit for ESW. Compliance with the ESW TRC limit in 1990 was greater than 97 percent, however values of 1.28 and 1.65 mg/l were recorded on March 18, 1990 and 1.1 and 1.3 on April 4, 1990 and May 1, 1990, respectively. These permit noncompliances were reported to the KDHE and, following correspondence in which WCNOC committed to procedural and operational corrective action, were resolved to the KDHE's satisfaction.

2.1.3 Cold Shock

In the event of a rapid decline in plant power level during winter, fishes attracted to the WCGS heated discharge could experience mortality due to "cold shock", a quick reduction in body temperature. In reference to licensing document evaluations, the WCGS EPP Section 2.1 (c) states, "Cold shock effects on fish due to reactor shutdowns could cause significant mortality to aquatic species in the cooling lake". There were no cold shock mortality events observed during 1990.

2.1.4 Impingement and Entrainment

Impacts of entrainment and impingement were projected to be significant in the WCGS EPP. Condenser mortality for entrained organisms was expected to approach 100%. Because

of this, sampling efforts to monitor entrainment impacts were not required by the NRC and have not been implemented by WCGS. Through casual observations, fish impingement at the WCCL circulating water intake was considered minimal, thus no sampling efforts to monitor impingement impacts have been implemented.

2.1.5 Impacts of Wolf Creek Cooling Lake Discharges to the Neosho River

Cooling lake discharges into the Neosho River are regulated by NPDES permit limitations. Since discharges are sporadic, chiefly from stormwater runoff and infrequent blowdowns, water is sampled on the first day of each discharge and weekly thereafter until the end of each respective discharge. Effluent parameters measured include a flow rate estimate, temperature, pH, TDS, sulfate, and chloride concentration. Discharges are regulated to maintain a zone of passage in the Neosho River for aquatic organisms at the Wolf Creek confluence. Consequently, the flows allowed from WCCL may range from zero to unrestricted, depending upon water quality and temperature similarities with the Neosho River. A maximum of 90°F is allowed in the Neosho River downstream of the mixing zone from Wolf Creek. In 1990, no NPDES violations at the WCCL discharge were observed. At no time did water quality criteria restrict WCCL discharge to the Neosho River. Based on monitoring studies completed, there have been no apparent deleterious effects to Neosho River water quality or phytoplankton biomass due to WCCL discharges.

2.2 TERRESTRIAL [EPP Section 2.2]

2.2.1 Control of Vegetation in the Exclusion Zone

The composition and structure of vegetation in the 453 ha (1120 acre) exclusion zone were selectively controlled to be compatible with the function and security of station facilities. Most areas in the immediate vicinity of the power block have been planted and maintained in a lawn-type condition. Other areas within the exclusion area have been mowed for security and aesthetic purposes.

2.2.2 Vegetation Buffer Zone Surrounding Wolf Creek Cooling Lake

To create a 500 acre buffer zone around WCCL, agricultural production activities were curtailed in 1980 below an approximate elevation of 1095' MSL, eight feet above WCCL normal operating surface water elevation (1087' MSL). This border ranges from approximately 200 to 400 feet adjacent to the lake shoreline. Previously grazed or hayed native tallgrass areas were left undisturbed. Previously cultivated lands were allowed to advance through natural successional stages or native grass stands were reestablished. Land management activities specified in an annual land management plan included controlled burning and native tallgrass seeding to enhance and/or maintain the designated buffer zone with a naturally occurring biotic community.

2.2.3 Herbicide Use for Maintenance of Wolf Creek Generating Station Structures

A soil sterilant was applied on selected gravel areas of WCGS. These include the Protected Area Boundary, various lay-down storage yards, meteorological tower, support building borders, storage tank berms, switchyard, hazardous waste and waste oil storage areas, and on-site railroad

beds. The herbicides applied consisted of 8 pounds of Karmex (EPA Reg. No. 352-247) and 4 to 6 pounds of Oust (EPA Reg. No. 352-401) per 100 gallons of water. Application rates ranged from 20-50 gallons per acre. These herbicides are registered by the Kansas Department of Agriculture. No environmental impacts from herbicide treatment of WCGS facilities were identified.

No herbicides were applied to the transmission right-of-ways associated with WCGS during 1990.

2.2.4 Waterfowl Disease Contingency Plan and Monitoring

A waterfowl disease contingency plan was maintained to provide guidance for station biologists in the event of suspected or actual disease outbreaks. The contingency plan lists appropriate federal and state wildlife agency contacts to be made by WCGS in the event of such problems. During routine wildlife monitoring and surveillance activities taking place over this reporting period, no avian mortality attributable to disease pathogens was identified.

2.2.5 Fog Monitoring Program [EPP Subsection 4.2.1]

Visibility monitoring was initiated in December 1983 and continued through 1987. The purpose of this study was to evaluate the impact of waste heat dissipation from WCCL on fog occurrence along U.S. 75 near New Strawn, Kansas. Upon conclusion of 1987 data collection, it was determined that sufficient information was available to evaluate cooling lake fogging and that all commitments relevant to fog monitoring had been satisfied. Because no problems were

identified by these data, no formal fog monitoring program was conducted during 1990. Through casual observations, Environmental Management personnel did not observe any incidents of man-made fog along U.S. 75 during 1990. In addition, there were no reports of such incidents from individuals or local agencies responsible for traffic safety. Implementation of mitigative actions or further monitoring was not warranted.

2.2.6 Wildlife Monitoring Program [EPP Subsection 4.2.2]

A wildlife monitoring program was initiated to monitor and assess wildlife populations or parameters most likely to be impacted by the operation of WCGS. As outlined in the 1989/1990 annual wildlife study plan, specific objectives of the wildlife monitoring program were to assess waterfowl, waterbird, and bald eagle usage of WCCL. Because these annual monitoring programs target each migration season (autumn through early spring), this EPP reporting period overlaps with part of the 1990/1991 monitoring program. The objectives of this program were the same as for the 1989/1990 season. Wildlife monitoring results are summarized in the attachment to this report.

2.2.7 Land Management Program [EPP Subsection 4.2.3]

Land management activities on all company-owned lands except the 453 ha (1120 acre) WCGS exclusion area were designed to achieve balances between agricultural production and conservation values. An annual management plan was formulated to address needs and propose accepted techniques for land maintenance, soil conservation, and wildlife management. These included construction or repair

of livestock fences and ponds, and the construction or establishment of terraces, waterways, and permanent vegetative covers. A summary of the 1990 Land Management Report appears in the attachment to this report.

3.0 ENVIRONMENTAL PROTECTION PLAN REPORTING REQUIREMENTS

3.1 PLANT DESIGN OR OPERATING CHANGES [EPP Section 3.1]

Proposed plant design and operational changes which have the potential to affect the environment must receive an environmental evaluation prior to implementation. A summary of each PMR or operating change which received an environmental evaluation in 1990 is presented. There were no changes in station design or operation nor were there tests or experiments that involved an unreviewed environmental question during 1990.

Evaluation 90-01: Diversion of SWS Flows Through the ESW During Winter Lake Conditions

Diversion of heated and chlorinated SWS flows through the ESW and discharged to the Ultimate Heat Sink (UHS) during winter lake conditions was considered. This evaluation supplements EPP Evaluation 89-06 which dealt with summer lake conditions. Thus, impacts during year-round conditions were considered. Based on engineering projections, the temperature increase at the UHS discharge (approximately 20 feet under the lake surface) would be raised 15^{o}F. Once this flow reached the surface, it was expected to be only 4.5^{o}F higher than ambient. The conservative projections indicated that little area would be thermally influenced and that the heated plane temperature would quickly be within the variability of natural temperature fluctuations governed by the weather. Because of the small size and low

increase in temperature, this thermal discharge was considered to have minimal impacts due to cold shock mortality in the event the discharge was abruptly stopped to the cooling lake fishery. Projected chlorine levels (0.6 mg/l TRC) were lower that the NPDES permitted level (1.0 mg/l TRC) and the level evaluated in licensing documents (0.68 to 1.08 mg/l TRC) for which impacts were considered acceptable. Based on these main factors, no significant environmental impacts were considered probable.

Evaluation 90-02: ESW Train A Post Loss of Coolant Accident (LOCA) Flow Balancing Test Procedure

The configuration of Train A of the ESW system was changed in accordance with a PMR. Following completion of this modification, a flow balance test was conducted to assure adequate flow to safety-related systems following a loss of coolant accident. Performance of the flow balance test procedure resulted in a 1270 gallons per minute discharge of unchlorinated and unheated water to a storm drain exiting to WCCL. It was determined that discharges related to the flow balance test would not result in any significant adverse environmental impacts.

Evaluation 90-03: ESW Train B Post LOCA Flow Balancing Test Procedure

The evaluation and determination are identical to #90-02, except that this evaluation involved ESW Train B.

Evaluation 90-04: Revision of Operations Procedure for Oil Spills at the MUSH

A revision was made to an Operations procedure (CKL ZL-009, Rev. 4, "Site Shift Log and Readings") to provide that the

Environmental Management Group be contacted in the event of any oil spill occurring at the MUSH. Such notification will allow Environmental Management to perform a reportability determination for oil spills at the MUSH for the purpose of compliance with 40 CFR 110. The proposed procedure revision was evaluated and the added checks that it places on activities at the MUSH are considered to provide additional assurances that these activities are in compliance with environmental requirements.

Evaluation 90-05: Permanent Chemical Treatment of Once Through Cooling Water

Permanent chemical treatment of circulating water, service water and essential service water was evaluated. Limited in-plant heat exchanger chemical treatment was also reviewed. The extension of four previously reviewed trial treatment programs was recommended. Due to the lack of dilution flow, chemical toxicity data indicated the potential for mortality of aquatic life near the UHS discharge. The established commitment to administrative control of the treatment durations and discharge concentrations will minimize the affected area. No significant risk of environmental impacts was apparent.

3.2 NONROUTINE ENVIRONMENTAL REPORTS

3.2.1 Submitted Nonroutine Reports

There were no nonroutine environmental reports involving significant impacts submitted to the NRC during 1990.

3.2.2 Unusual or Important Environmental Event Evaluations

No unusual or important environmental events reportable

under specifications in the EPP were identified during 1990.

3.3 ENVIRONMENTAL NONCOMPLIANCES [EPP Subsection 5.4.1]

At WCGS in 1990, nonradiological environmental noncompliances or noteworthy events were recorded along with the details surrounding them. These included such things as deviations from study plan schedules, use of uncalibrated fish scales, loss of a small amount of mercury from differential pressure gauges, and spills of oil and diesel fuel at various site locations and one off-site location. These noncompliances were evaluated and determined not to be reportable pursuant to EPP criteria.

ATTACHMENT

SUMMARY OF ENVIRONMENTAL INVESTIGATIONS AT WOLF CREEK GENERATING STATION, 1990

Wolf Creek Nuclear Operating Corporation

Environmental Management

Burlington, Kansas

CONTENTS

1. 1990 LAND MANAGEMENT ACTIVITIES

This report is on the implementation of the 1990 Land Management Plan for Wolf Creek Generating Station (WCGS). Unanticipated activities are also presented. This land management program involves, for the most part, agricultural lands around the cooling lake. Landscaped property associated with the power block area, switchyard, and other plant support buildings was not part of this program. Activities presented were designed in part to satisfy Sections 2.2(b) and 4.2.3 of the Environmental Protection Plan, Appendix B of the Facility Operating License. Other general objectives of this plan were to:

a. reduce soil loss on agricultural and "old field" areas
b. maintain or increase agricultural production while enhancing wildlife benefits
c. establish, improve, and/or maintain the native grass areas
d. improve wildlife potential on nonagricultural lands

Company lands are composed of primarily range, cropland, and woodland habitats. These lands were used for various purposes depending on the location and capability of each area. Most were leased for grazing, haying, and crop production. Some were inaccessible, unfenced, or were deemed unsuitable for these purposes. Other areas were left unused to preserve lake shoreline stability, fulfill regulatory requirements, or reserved for their wildlife value.

Grasslands

Grasslands at WCGS consist of grazed rangeland, hay meadows and odd areas left idle primarily for their wildlife value. Also, by not renting the odd areas, the licensing commitment to maintain a 500 acre buffer zone around the cooling lake in a "natural occurring biotic community" was satisfied.

Grasslands leased to local farmers included grazed rangeland totaling 1338 acres and approximately 412 acres of hay meadow. A decrease of 180 acres of grazed rangeland compared to 1989 was a result of this amount of land outside the site boundary being traded for privately held acreage located under and adjacent to Wolf Creek Cooling Lake. Grazing lease options included grazing season length, rotation programs, and stocking rates. Hay lease requirements included cutting and bale removal dates.

Controlled burning on WCGS grasslands was used to discourage woody invasion, decrease less desirable cool season grasses and weeds, and increase prairie vigor and production. Approximately 1066 acres were planned to be burned in 1990. Of these, 764 acres were burned. An additional 19 acres, which were not planned to be burned, were done to facilitate improvement efforts. As a result of on-site judgement, 312 acres were not burned as planned. Unfavorable wind conditions and time constraints were the primary reasons for not burning targeted grassland parcels.

Kansas law requires landowners to control noxious weeds on their property to prevent infestation of neighbor properties. Two species, musk thistle and Johnson grass, have appeared on WCGS grasslands. Musk thistle was sprayed with Tordon 22K during the fall of 1988 by the Coffey County Noxious Weed Department. Mowing and manual removal along fence rows were done in the summer of 1989 and a second spraying by the County was completed in the fall of 1989. Environmental Management sprayed 2,4-D on surviving plants in the spring of 1990. Further manual removal of plants and burning of seed heads was accomplished in June 1990. Repeat treatments may be required, but significant progress in eradicating these problem weeds is apparent.

Johnson grass infestation on WCGS grasslands consisted of scattered small areas around the cooling lake which were sprayed with Roundup herbicide. Both Johnson grass and musk thistle have trouble expanding in well managed rangeland; however, they will always threaten disturbed areas such as old

farmsteads, road ditches, dams, and abandoned cropland if left uncontrolled.

Planned native grass reseeding was not completed during 1990. The wet spring did not allow for the seedbed to be prepared properly. Establishment of native prairie grasses is designed to reduce weeds areas, increase wildlife habitat, and allow for easier control of tree, brush, and noxious weed infestation. Soil erosion will also be checked.

Cropland

Cropland at WCGS consists of those fields left unflooded by the cooling lake. Most are upland areas along the sides of the lake with some bottom land along Wolf Creek upstream from the lake. Approximately 1380 acres were leased to 14 local farmers for crop production: primarily corn, milo, soybeans, and wheat. These are common crops grown in this region. Crops produced were not dictated in the lease agreements, but common conservation practices such as contour farming and limited fall tillage were specified. Perennial legume establishment by interested tenants was encouraged. By requiring or encouraging these practices where practical, soil loss is reduced keeping WCGS cropland production sustainable, maintaining land values, and limiting silt accumulation in the cooling lake. Wildlife also benefit.

As on WCGS grasslands, noxious weed control was necessary on some cropland areas. These are handled primarily through tenant agreements as part of their normal farming practices. However, some areas required attention to insure that widespread infestation along the lake shorelines and odd areas would not occur. Continued control efforts with musk thistle and Johnson grass appeared to be effective, but continued attention may be required.

Highly Erodible Land (HEL) plans are management plans required by the

Agricultural Stabilization and Conservation Service (ASCS). These are the responsibility of the landowners and are required to remain eligible for government agricultural programs. Even though WCGS does not participate in the programs, compliance is necessary to allow tenants to participate as they see fit. Determinations of HEL have been completed by the SCS of most fields in Coffey County, including those at WCGS. Only one field was determined to be HEL and a plan was developed for it by the Soil Conservation Service and approved by the ASCS committee. The requirements in this plan, which were designed to keep soil loss tolerances acceptable, included terrace maintenance, contour farming, crop rotations, and reduced tillage. The first two are common lease requirements on all WCGS fields. The latter two are common practices previously employed or easily done by the tenant. Because soil conservation is a primary objective of this land management program, compliance is not expected to be a problem.

Native grass seeding and wildlife weed strip establishment in cropland areas were designed to increase wildlife food and cover habitat diversity along field borders. These practices devote edge areas of limited crop production value to wildlife habitat. They consist of planted native grasses or natural weed growth in strips adjacent to fences or tree lines. As mentioned earlier, planned native grass seeding was not accomplished during 1990 due to inclement spring weather. Wildlife strips established in previous years were maintained through 1990.

Conclusion

Land management activities during 1990 accomplished program goals to the extent practicable. Fences necessary for continued leasing of company rangeland were completed. The establishment of soil conservation structures progressed on cropland areas. Overall tenant compliance with lease requirements was good. Rent income decreased in 1990 due to poor weather conditions. These, as well as activities on unleased lands, continued to

promote wildlife and soil conservation, increase land values, and ensure regulatory compliance while keeping agricultural production compatible on Wolf Creek lands.

2. 1990 WATER QUALITY MONITORING ACTIVITIES

Environmental monitoring included studies on the Neosho River and Wolf Creek Cooling Lake (WCCL). Objectives accomplished by these studies were:

1. documentation of concentrations of general water quality parameters, aquatic nutrients, organically-derived materials and certain trace metals in the Neosho River and WCCL

2. determination of phytoplankton productivity of the Neosho River and WCCL

Water quality studies in the Neosho River near WCCL have been conducted at locations above and below the Wolf Creek confluence since 1973. Seasonal mean concentrations of most water quality parameters during 1990 were within previously established ranges for the study area and no between-location differences were seen for any of the parameters monitored. The differences in average 1989 values for conductivity, sulfates, chemical oxygen demand (COD) and nitrates which were attributed to drought conditions in 1988 remained similar during 1989, except for COD. The 1989 annual mean for COD rose higher than recorded previously, but still within the range of the previous high observed during 1984. The 1990 COD average fell back to normal levels monitored during most years. Rainfall amounts were high during the spring, but dry conditions prevailed during fall and winter. Average values for river nitrates remained near the bottom of their previous ranges while sulfates fell from levels close to their upper ranges observed during 1979 and 1980 to concentrations present during most other years. Since filling of WCCL began in 1981, flows from Wolf Creek into the Neosho River have been limited to seepage, releases for testing of blowdown procedures, and runoff events. There have been no apparent deleterious effects to water quality in the Neosho River due to operation of WCGS based on available water quality monitoring data.

Water quality studies of WCCL began when the lake was initially filled during 1981. Water quality was greatly influenced by makeup water being pumped from the Neosho River during that year. Between 1982 and 1986, makeup water was generally added only during routine use of the auxiliary raw water pumps and quarterly testing of the makeup water pumps. In 1987, use of makeup water increased to nearly 0.97 billion gallons and this rose to 3.9, 2.9, and 2.6 billion in 1988, 1989, and 1990, respectively. Despite this increase, WCCL water quality has been generally independent from influence of the Neosho River. Concentrations of water quality parameters were very similar among locations in the cooling lake, with the shallower upstream sampling site slightly different in water quality than near the main dam and the station intake. In general, concentrations of dissolved and suspended constituents in 1990 were within ranges established during previous years of cooling lake operation. Exceptions to this were continued increasing trends for magnesium, total dissolved solids (TDS), chlorides, and conductivity. The mild increasing trend for sulfates since 1986 stabilized in 1990. All of these parameters were at their highest levels since lake fill. With drought conditions during much of 1988 and early 1989, WCCL had reduced natural inflows and lower lake level than during previous years. Runoff during 1990 was also limited through most of the year. In combination with forced evaporation due to plant operations, these conditions produced chloride and sulfate concentrations which continued their mild trend of increase or stabilization while TDS and conductivity, which are affected by sulfate levels, also increased up to or slightly above previously observed marks. These same conditions helped maintain turbidity levels in the lake at low levels. The TDS rise was a reversal of the decline seen in 1986 and 1987. In summary, the mild trends observed in the cooling lake chemistry are indicative of limited natural inflows since 1987 compounded by increased forced evaporation due to plant operations.

Surface water temperatures in the cooling lake during spring and summer periods have been warmer than during preoperational years. This was

expected with the plant operating and has been especially evident at the upstream monitoring location. This area receives heated effluent during spring, summer, and fall when southerly winds prevail. Dissolved oxygen data indicated a stratification pattern in 1988 and 1989 with an anoxic hypolimnion forming strongly by August and being dispersed by October. This pattern varied somewhat from that before 1988 when WCCL generally stratified completely by June or July and had mixed, well oxygenated bottom waters by August. During 1990, an anoxic hypolimnion formed in May, disappeared in July, returned in August, and was again oxygenated in September. Based on WCCL's relatively large average depth (21 ft.) and data from other Kansas impoundments, longer periods of vertical stratification for the cooling lake would be expected but have not occurred consistently during preoperational or operational years. Considering data prior to and including 1990, stratification patterns in WCCL appear to be independent of the generating station's intake, warming, and discharge of circulating water.

Phytoplankton chlorophyll a concentrations as indicators of standing crop have been monitored in the Neosho River above and below the confluence with Wolf Creek since 1973. Flow in the study area is controlled by releases from John Redmond Reservoir. In 1990 average Neosho River flows were comparable with normal years. The annual average chlorophyll a concentration was 16.30 mg/m^3 which fell within the previous years' range of averages (3.81-63.88 mg Chl a/m^3). Chlorophyll a monthly and yearly average values above and below the Wolf Creek - Neosho River confluence were similar in 1990 and were similar to those from previous years. Therefore, there is no indication that adverse effects have occurred on Neosho River phytoplankton as a result of plant operation.

Phytoplankton chlorophyll a concentrations in WCCL have been monitored bimonthly since 1981. Previous annual averages ranged from 11.0 mg/m^3 in 1981 to 6.3 mg/m^3 in 1987, but within that span have shown slow oscillations. Means were down during 1982-1984 and up during 1985-1986. Concentrations in 1989 increased to 7.94 mg/m^3 and in 1990 fell slightly to

7.75 mg/m^3. These values fit well within the established range. Locational chlorophyll *a* differences within WCCL in 1990 were similar to the pattern seen previously. The highest levels were at the shallower, upstream area while the lowest concentrations were at the deep, pelagic location. Samples from near the circulating water intake channel fell in-between these two extremes. Overall, chlorophyll *a* concentration as an indicator of phytoplankton standing crop shows WCCL in the mesotrophic range with mild, infrequent fluctuations indicating little or no plant operational impacts.

3. ASIATIC CLAM MONITORING ACTIVITIES
(Corbicula fluminea)

The Asiatic clam (Corbicula fluminea) has been reported to cause biofouling problems in power plant cooling systems. The first report of Corbicula near Wolf Creek Generating Station (WCGS) occurred in August 1986 when immature clams were collected at long-term monitoring sites located on the Neosho River upstream and downstream of the Wolf Creek confluence. To compliment the on-going ecological monitoring program, a discrete survey has been conducted annually to identify the distribution of Corbicula in the vicinity of WCGS. This report presents the findings of the most recent sampling effort, which was conducted during October and November of 1990.

During the Corbicula survey 49 discrete sampling efforts were completed, including 24 efforts in Wolf Creek Cooling Lake (WCCL), and 21 below and 4 above John Redmond Reservoir (JRR) in the Neosho River. Fifteen live clams and 44 isolated valves (unbroken, half-shell, dead) were collected. These included 3 live clams and 12 valves collected below and 9 live and 26 valves collected above the Wolf Creek confluence to the Neosho River. One live and three valves were found at the Burlington city dam while two live and three valves were found further upstream. No Corbicula were found at the WCCL makeup pumps located near the JRR spillway, nor were any found upstream of JRR. Similarly, searches on WCCL yielded no evidence of Corbicula.

The apparent lack of Corbicula upstream of JRR minimizes the potential that it will become established in WCCL. It is generally accepted that, other than man mediated dispersion, downstream drift of the planktonic larval stage is the main factor affecting range extensions. Therefore, before Corbicula could be introduced in WCCL via makeup water, it would have to occur upstream in JRR. Although Corbicula has been found in most substrates, suggested preferred substrates are not prevalent in the Neosho River immediately below or in JRR. This condition should decrease the

likelihood of Corbicula pioneering into WCCL. Thus far, monitoring in the vicinity of WCGS has shown Corbicula far below nuisance levels. Chances that Corbicula will become established in WCCL are limited at this time, but the potential for introduction exists provided the river population remains established. Annual surveys are completed in compliance with department procedures to monitor distribution changes and population trends.

4. 1990 FISHERY MONITORING ACTIVITIES

Fishery monitoring surveys were conducted on Wolf Creek Cooling Lake (WCCL) from April through October 1990. These resulted in the collection of 2,706 individual fish representing 11 families and 30 species. Collection methods used were fyke netting, seining, electrofishing, and gill netting. Data collected were used to describe the fishery, which was subsequently evaluated based on the goal of increased plant reliability through reduced gizzard shad impingement. Catch data calculated as percent relative abundance for all gears combined showed gizzard shad highest (27.5%) and bluegill next (11.9%). This shad percentage represents an increase of 24% from 1989, and is the highest to date. Predators came next with white bass (10.2%), walleye (7.6%), and largemouth bass (6.1%) maintaining high numbers. When total biomass of all species in the standardized effort is considered, walleye were highest at 16.7 percent, followed by channel catfish (15.5%), wiper (13.9%), common carp (9.1%), largemouth bass (8.6%), white bass (7.6%), white crappie (7.2%), and smallmouth bass (5.7%). Considering a life expectancy of five to seven years and that the age of the dominant wiper year class was eight in 1989, it was surprising that natural mortality didn't reduce their number further. The decline in 1990 may be signaling this. Gizzard shad biomass from 1989 to 1990 dropped from 4.4 to 3.9 percent. Shad biomass has tended to vary slightly from year to year but rarely rises above five percent.

Growth and body condition data using Proportional and Relative Stock Density (PSD, RSD), relative weight (Wr), and condition factor (K_{TL}) continue to show large average sizes, slowing growth of early predator year classes, and low to moderate condition for Wolf Creek predators. Wiper growth continues, but at rates which are more modest and variable than in its earliest years. Growth of largemouth bass, crappie, white bass, and walleye continues at moderate rates. For all Wolf Creek predators, average sizes are large and the proportion of mature fish (quality size and larger) versus smaller

immature fish (stock size) is also large, leading to very high PSD's. At the same time, condition of these predators is generally lower than the averages from other Kansas impoundments. In contrast, both gizzard shad PSD and Wr values are close to the top of reservoirs surveyed in Kansas. While these qualities in shad have been shown to be optimal for production of a good prey base, few young-of-the-year gizzard shad in WCCL remain through their first winter. Little or no survival of the last four year classes of gizzard shad indicate that the combination of predation pressure and winterkill are adequate to control expansion of the WCCL shad population. Thus, no impingement problems have been experienced so far. The sportfish/roughfish ratio in Wolf Creek is very high when compared with other reservoirs in the midsection of the U.S. The unusually low number of gizzard shad and unusually high number of predators in WCCL meant that predator condition was low, but more importantly, so were impingement rates.

5. WILDLIFE MONITORING ACTIVITIES
October 1989 through March 1990

The general objectives of the program were to document and assess any trends or impacts that may be due from station operation to migrating or wintering populations of waterbirds, waterfowl, and threatened or endangered species. Of the latter category, bald eagles (Haliaeetus leucocephalus) are of primary concern. Use of Wolf Creek Cooling Lake (WCCL) may expose birds to transmission line collision mortality or to disease outbreaks. Damage to local agricultural crops by large waterfowl concentrations using WCCL is also a concern. To document and assess such occurrences or increased potential for such, specific objectives of the program were to monitor how many and where waterbirds, waterfowl, and threatened and endangered species used WCCL during the winter migration season and compare these to the norm observed since station operation began.

Thirty-one species of waterbirds and waterfowl were observed with Franklin's gull and mallard being most abundant. Mallard usage has normally been comparatively high. Increased numbers of mallards, Canada geese and snow geese were attracted to the ice-free water. During operational winters, the heated effluent provided previously unavailable open water habitat on WCCL. This, in combination with seclusion and close, abundant food supplies, kept wintering birds on WCCL longer than during preoperational seasons. Significant ($p \leq 0.05$) preferences for areas of WCCL providing these habitats were found. No disease or crop depredation problems were observed. No significant transmission line collision events nor the increased potential for such were observed.

The bald eagle, an endangered species, was a common winter resident. During the first two operational winters (1985-1986 and 1986-1987), bald eagle usage of WCCL declined from preoperational levels. The heated effluent from continuous station operation was responsible for the decline because it

reduced the quantity of winter-stressed fish, an important eagle food source. Also, the normally prevalent thawing and refreezing of the surface waters exposing winter-killed fish were absent because of mild weather, further discouraging eagle usage. However, because the plant operated intermittently through much of the 1987-1988 winter, the quantity and to a greater extent the availability of these fish were increased. Colder than normal weather during February played a role in increasing forage availability on WCCL during the 1988-1989 survey period as well. These factors attracted and held larger numbers of eagles than observed previously. The mild winter of 1989-1990 reflected usage observed during the first two operational winters. It was shown that since operation began, more of the area eagles were found on WCCL when air temperatures declined. No such relationship was present before station operation. No transmission line collision mortalities nor increased potential for such were observed.

October through December 1990

This synopsis provides a summary of WCCL bird usage data collected from October through December 1990 as part of the 1990/1991 Operational Wildlife Monitoring Program. These data are not presented in the report summarized above. Except for a lack of surveys during September, the Wolf Creek Generating Station (WCGS) monitoring schedule matched that used by local wildlife agencies monitoring other Kansas reservoirs. This schedule will allow station biologists to determine if changes from previously characterized patterns justify increased monitoring or mitigative action. Formal transmission line collision surveys were discontinued because enough information had been collected to characterize the mortality caused by the lines and to show it to be insignificant. Special attention was given to both state and federally listed threatened and endangered wildlife species occurring in the vicinity of WCGS.

A total of 32 waterfowl and waterbird species were observed on six ground counts during the fall and early winter of 1990. The most abundant species

were the Franklin's gull, mallard, and American coot, which comprised 41, 27, and 12 percent of the total, respectively. This is similar to the fall monitoring completed during past monitoring seasons. Apparent factors influencing usage of WCCL continue to include relatively clear water, seclusion, wind protected coves, concentrations of aquatic weed growth, and availability of agricultural fields. The vast numbers of Franklin's gulls were most likely attracted to WCCL because of its close proximity to the Coffey County landfill. Some winter wheat fields on WCGS lands may have experienced crop damage; however, these were fairly localized and widespread depredation events were not present. No disease problems were present among waterfowl concentrations on WCCL during the fall and early winter of 1990, nor were usage pattern changes apparent that increased transmission line collision potential.

The bald eagle was the only threatened or endangered species observed using WCCL. As during past studies, the eagles were common winter residents first appearing during early November. The cooling lake was used as a feeding and loafing site primarily, but not to the extent observed on John Redmond Reservoir. No changes in bald eagle usage of WCCL during the fall and early winter of 1990 were identified.