WOLF CREEK
NUCLEAR OPERATING CORPORATION

Matthew W. Sunseri
Vice President Oversight

November 17, 2006

WM 06-0046

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Reference: 1) Letter ET 06-0038, dated September 27, 2006, from T. J. Garrett, WCNOC, to USNRC
2) Letter dated November 3, 2006 from V. M. Rodriguez, NRC to T. J. Garrett, WCNOC

Subject: Docket No. 50-482: Supplementary Environmental Information to Support the Application for Renewed Operating License for Wolf Creek Generating Station

Gentlemen:

Reference 1 submitted Wolf Creek Nuclear Operating Corporation's (WCNOC) application for renewal of the operating license for the Wolf Creek Generating Station (WCGS). Through discussions with the NRC on October 31, 2006, it has been determined that additional information is needed to supplement the WCGS environmental report included as Appendix E to the application. Accordingly, this letter supplements the application to include the additional information documented in Reference 2.

Enclosure 1 provides an assessment of the impact of license renewal on the flow of the Neosho River and the related impacts on instream and ecological communities. Assessments on the impact on fish and shellfish resulting from entrainment, impingement and heat shock are provided in enclosures 2 through 4 respectively.

WCNOC understands this information is necessary to complete the acceptance review of the application.

As a separate issue, WCNOC has discovered two typographical errors. These errors have been corrected and replacement pages have been included as enclosure 5.

A121

This letter contains no commitments. If you have any questions concerning this matter, please contact me at (620) 364-4008, or Mr. Kevin Moles, Manager Regulatory Affairs at (620) 364-4126.

Sincerely,

M W Sunseri

Matthew W. Sunseri

MWS/rlt

Attachment: I. Oath

Enclosures:
1. An Assessment of the Potential Impacts on the Flow of the Neosho River
2. An Assessment of the Potential Impacts on Fish and Shellfish Resources from Entrainment
3. An Assessment of the Potential Impacts on Fish and Shellfish Resources from Impingement
4. An Assessment of the Potential Impacts on Fish and Shellfish Resources from Heat Shock
5. Corrections

cc: J. N. Donohew (NRC), w/a, w/e
B. S. Mallett (NRC), w/a, w/e
G. B. Miller (NRC), w/a, w/e
V. M. Rodriguez (NRC) w/a, w/e
Senior Resident Inspector (NRC), w/a, w/e

STATE OF KANSAS)
) SS
COUNTY OF COFFEY)

Matthew W. Sunseri, of lawful age, being first duly sworn upon oath says that he is Vice President Oversight of Wolf Creek Nuclear Operating Corporation; that he has read the foregoing document and knows the contents thereof; that he has executed the same for and on behalf of said Corporation with full power and authority to do so; and that the facts therein stated are true and correct to the best of his knowledge, information and belief.

By M W Sunseri
Matthew W. Sunseri
Vice President Oversight

SUBSCRIBED and sworn to before me this 17th day of Nov, 2006.

RHONDA L. TIEMEYER
MY COMMISSION EXPIRES
January 11, 2010
NOTARY PUBLIC OFFICIAL SEAL STATE OF KANSAS

Rhonda L. Tiemeyer
Notary Public

Expiration Date 1-11-2010

An Assessment of the Potential Impacts on the Flow of the Neosho River Related to the Operating License Renewal for Wolf Creek Generating Station.

(Supplement to Appendix E Section 4.1 to Wolf Creek Generating Station Environmental Report Operating License Renewal Stage)

**An Assessment of the Potential Impacts
on the
Flow of the Neosho River**

**Related to the Operating License Renewal
for
Wolf Creek Generating Station, Unit No. 1**

INTRODUCTION

This is an assessment demonstrating that potential water use impacts to the Neosho River during the license renewal period of Wolf Creek Generating Station (WCGS) operation will be no greater than or less than identified during original licensing evaluations. This assessment is in support of discussion presented in the Environmental Report – Operating License Renewal Stage (ER-OLRS, Section 4.1). Considered during this assessment are conclusions presented during original licensing, available literature and research since original licensing, water withdrawal permits from the State of Kansas, and operational experience since WCGS operation began.

Description of the Neosho River Basin

The instream biota within the Neosho River has been described and is characterized in the ER-OLRS, Section 2.2. Most of the riparian habitat along the Neosho River and its tributaries can be described as riparian woodland. Detailed descriptions of the upstream and downstream riparian habitat, and the wildlife present in the area are available in United States Army Corp of Engineers (USACE 2002), Section 3.4. These habitats represent long-term climax vegetation types, and are not expected to change appreciably during the license renewal period.

CONSUMPTIVE WATER USE IMPACTS

Consumptive water use resulting from license renewal is not expected to change appreciably from that evaluated in Final Environmental Statement related to the operation of WCGS (Nuclear Regulatory Commission, NRC 1982). Basically, water stored in the Coffey County Lake (CCL, sometimes referred to as Wolf Creek Cooling Lake) will be subject to evaporation losses, both natural and forced (NRC 1982, Section 5.3). This water will be a loss from the Neosho River system. Total volume of makeup diversion to CCL will be somewhat less, based on the assessment below. As stated in the ER-OLRS (Section 3.4), license renewal at WCGS will not necessitate a large increase in work force, thus indirect demands on the Neosho River system from increased domestic water needs, and any resulting adverse impacts to aquatic and riparian organisms, will not occur.

MAKEUP DIVERSION IMPACTS

The NRC concluded that withdrawal of water for makeup of Coffey County Lake would not cause unacceptable effects on Neosho River biota under normal hydrological conditions (NRC 1982). However, under severe drought conditions, river flow reductions were predicted in effect to extend the duration and severity of low flow conditions, and thus stress aquatic communities of the Neosho River.

To understand makeup withdrawal during normal hydrological conditions, a review of surface water use at WCGS is necessary. The CCL is a 5090-acre lake formed by a dam across Wolf

Creek, an intermittent stream. Natural runoff from the Wolf Creek watershed, and direct precipitation on the CCL is not typically sufficient to maintain the lake at its normal operating level of 1087 feet Mean Sea Level (MSL, NRC 1982). Consequently, rights to makeup water have been obtained from the natural flows of the Neosho River, and water stored in the conservation pool of nearby John Redmond Reservoir (JRR). This makeup water is transferred via a pumping station (Makeup ScreenHouse, MUSH) located on the east bank of the Neosho River immediately downstream of the JRR dam. This water is pumped through underground piping and discharged to CCL approximately 2.5 miles east of the MUSH. Water to be pumped from the conservation storage in JRR is released to the Neosho River through the JRR dam as detailed in the ER-OLRS, Section 4.1.

The State of Kansas regulates the surface water use at WCGS. To summarize, WCGS has been authorized by the State to obtain makeup water via two primary methods. These include water appropriations and a contract for stored water in JRR.

Appropriation Water

Appropriation refers to the use of natural water flows for beneficial use permitted by the Kansas Department of Agriculture, Division of Water Resources (DWR), as provided for in Kansas Statutes Annotated (KSA) 82a-703. At WCGS, three such appropriations apply to CCL water. These are:

1. Water appropriation (file number 20,275) for all natural flows of Wolf Creek upstream of the CCL dam, (State of Kansas 1977a).

2. Water appropriation (file number 14,626) for withdrawal via MUSH of natural flows in the Neosho River at a diversion rate of $\leq$ 55 cubic feet per second (cfs) and a quantity $\leq$ 25,000 acre-feet per calendar year (State of Kansas 1977b).

3. Water appropriation (file number 19,882) for withdrawal via MUSH of natural flows in the Neosho River at a diversion rate of $\leq$ 170 cubic feet per second (cfs) and a quantity $\leq$ 57,300 acre-feet per calendar year (State of Kansas 1977c).

Wolf Creek Flow Appropriation

Impoundment of the natural flows of Wolf Creek, which is a tributary of the Neosho River, is not expected to have measurable impacts to the stream related habitat and riparian ecological communities of the Neosho River. This is due to the creek's small flow contribution to the river. Using the estimated average monthly stream flow (NRC 1982, Table 4.3), the total annual flow for Wolf Creek is approximately 12,985 acre-feet, or 18 cfs. The average annual flow of the Neosho River at Burlington (USGS Station 07182510, 1963 –2004 annual mean), upstream of Wolf Creek, was 1603 cfs, and at Iola (USGS Station 0718300, 1899-2004 annual mean) was 1865 cfs (Putnam and Schneider 2005). Using these estimates, annual flows of Wolf Creek represents 1.1 and 1.0 percent of the Neosho River flows at Burlington and Iola, respectively. Actual percentage of flows would be less than these estimates because only the flows upstream of the CCL dam are impounded, and all flows above elevation 1088 feet MSL will pass over the CCL spillway and flow to the Neosho River. Precipitation inputs to Wolf Creek below the CCL dam will not be impacted.

Neosho River Appropriations

The remaining two appropriations for water are for natural flows in the Neosho River, diverted via MUSH. Makeup water diverted under the conditions in these appropriations is not expected to cause adverse impacts on the instream and riparian ecological communities because of the flow requirements stated within them (State of Kansas 1977b and 1977c). As stated previously, both have maximum diversion rates and annual quantity limits. However, the primary reason that will ensure that makeup withdrawals under these appropriations will not cause adverse impacts are the minimum flows required before diversion is allowed. Both require that withdrawals of natural flows shall be made only at such times and under such conditions that a minimum flow of at least 250 cfs remains in the Neosho River immediately downstream from the intake structure. In practice, makeup withdrawals using these appropriations are only used when greater than 250 cfs, plus the withdrawal volume, as metered at the MUSH, is being discharged from the JRR dam. Due to physical operational limitations, minimum flow typically needs to be 320 cfs or 370 cfs, depending on MUSH pumping status. These conditions are typically during normal or above normal hydrological conditions in the river. The NRC concluded that withdrawal of water for makeup would not cause unacceptable effects on the Neosho River biota under such conditions (NRC 1982).

Minimum desirable stream flows are maintained by the State of Kansas "for instream uses relative to fish, wildlife, water quality, general aesthetics and downstream domestic and senior water rights" (State of Kansas 2006). The minimum desirable steam flow for the Neosho River, as measured at Iola, downstream of the makeup diversion, has been specified by Kansas legislative action as 40 cfs during all months, with 60 cfs in April, and 200 cfs in May and June maintained as spawning flows to be managed if reservoirs (i.e., JRR) are in flood pool (KSA 82a-703c). Thus, the minimum of 250 cfs immediately downstream of the MUSH required before use of the allocated river water will ensure that flows will support the instream and riparian habitats along the Neosho River.

There are provisions in Neosho River water appropriations where WCGS can request of the Chief Engineer of the DWR to allow withdrawal during times when flows at the makeup diversion point are less than 250 cfs. Only flows not needed to satisfy vested rights, prior appropriations, and prior applications for permits to appropriate water for beneficial use may be requested. The Chief Engineer may permit such withdrawal to the extent that is found to be in the public interest. However, the Chief Engineer shall withhold from appropriation that amount of water deemed necessary to establish and maintain the desired minimum stream flow (KSA 82a-703a). Thus, such requests for makeup withdrawal will not include flows necessary to maintain a minimum of 40 cfs (greater during fish spawning season if available) at Iola. With these considerations, makeup withdrawals using appropriated water will not cause adverse impacts to the Neosho River instream and riparian habitats.

Contract for Stored Water

In addition to the appropriated natural flows of the Neosho River, a portion of the water stored in the conservation pool of JRR has been contracted for with the Kansas Water Resources Board (KWRB) (State of Kansas 1976), now called the Kansas Water Authority. Basically, this stored contract water can only be accessed for CCL makeup purposes when JRR is at or below its conservation pool level of 1039 feet MSL. At this level, downstream flows are less than 250 cfs criteria used to divert appropriated water, indicating that the Neosho River system would either be in a low flow period, or drought condition. A greater detailed review of this contract is provided in the ER-OLRS, Section 4.1, and in the Final Environmental Statement related to the Operation of WCGS, Section 4.3.1.1 (NRC 1982).

Impact Baseline

The NRC determined that during a severe and prolonged drought, the withdrawal of the stored contract water at 41 cfs, will cause a marked drawdown of water levels within the reservoir and reduced flows in the river would occur. Such conditions would stress aquatic communities, including fish populations (NRC 1982, Section 5.5.2.1). These conclusions were based on hydrologic modeling and makeup diversion during CCL lake operations that were expected during the initial operating license process for WCGS (Sargent and Lundy Engineers 1974; NRC 1975, 1976, and 1982).

Unavailable during environmental impact assessment was actual operational conditions of CCL, and makeup diversion procedural limitations. These considerations will demonstrate that impacts will be less than those forecasted. Consequently, WCGS makeup withdrawal impacts to the Neosho River, and by extension, to the riparian areas of its watershed during the license renewal period will not be likely.

The predicted impacts involve comparing Neosho River stream flows with and without expected makeup withdrawals (NRC 1975, Section 5.2.1, and NRC 1976). The analysis used meteorological conditions present for the period from January 1951 through December 1959. During this period occurred a record drought having a two percent chance of occurrence in any given year, or a one in 50 year drought. Among other factors, the projections accounted for CCL blowdown for water quality management, and sufficient makeup to replace this blowdown.

The results of the NRC (1975) analysis were summarized in Table 5.1, and as amended slightly in NRC (1976) Attachment M. These tables clearly indicate decreased Neosho River flows and modeled JRR capacity from July 1952 through April 1957, the analyzed drought period. Attachment M (NRC 1976) indicated this analysis was for makeup for two reactor units at WCGS. Only one unit is present at WCGS, and only impacts from this unit, which will be correspondingly less, are being addressed in this assessment.

The NRC analysis (NRC 1975, 1976) states that there would be no change in the down-river flow during the worst part of the drought because the JRR water surface would have been below the conservation level. The JRR conservation pool is stored between elevation 1020 and 1039 feet MSL (U. S. Army Corp of Engineers, USACE, 2002), so presumably this would mean that JRR would be below 1020 feet MSL. The conservation pool is where the water contracted from the KWRB is stored. During such conditions, water is released downstream only for the previous water rights and for water quality purposes, which are the same with or without WCGS. This circumstance would have occurred during 42 of the 58 months included in the drought analysis, and are identified in Table 1 attached.

The NRC (1976) analysis concluded that 15 of the 58 drought months in which downstream river flow would be reduced because of WCGS. As shown in Table 1, percent flow diverted was large during some months, with the highest being 95 percent during September 1955. It was also shown that downstream flows would be maintained throughout such drought conditions, thus long term instream and riparian habitats should not be adversely impacted. However, during drought-induced low flows, makeup withdrawal could in effect extend the duration and severity of low flow conditions, and thus may stress aquatic communities. The NRC (1976) concluded that such impacts would be acceptable.

License Renewal Period Impacts

Using the baseline conditions for considering impacts, makeup diversion during the license renewal period is expected to have less potential for harmful impacts to occur to the instream and riparian habitats of the Neosho River. This is based on the following:

(1) State of Kansas administration of water purchase contract (State of Kansas 1976) effectively limits diversion of stored water to a maximum of 70 cfs.

(2) Operations controls limit the maximum MUSH diversion rate to 120 cfs.

(3) The reduction in need for CCL blowdown, and subsequent makeup diversion to maintain water chemistry.

Purchase Contract Limiting Factors

The water purchase contract for water stored in JRR allows a maximum flow rate of 120 cfs, which in reality are two operating MUSH pumps. The maximum design flow of the bypass pipe through which the contract storage water is obtained is approximately 130 cfs (USACE 1996). However, the actual metered flow capacity through the bypass pipe has been approximately 95 cfs. When JRR is not discharging through its spillway, the only method for obtaining the stored water is through the bypass pipe supplying water to the MUSH. In practice, administration of the purchase contract prevents diverting stored makeup via the MUSH at rates greater than can be obtained through the bypass pipe (approximately 95 cfs). By default, this limits MUSH diversion pumping to one pump only, or 70 cfs.

Some of the largest portions of Neosho River flows predicted to be diverted by makeup pumping included times when only stored contract water could have been accessed (Table 1). Considering 40 cfs minimum desirable streamflow at Iola downstream of the diversion point required 40 cfs from JRR, and 70 cfs minimum capability for makeup diversion, 110 cfs would be needed to provide for makeup diversion using the contract conditions. Eleven of 58 evaluated drought months had such flows. Applying 70 cfs as a monthly diversion average to the predicted flows in Table 1 would change the range of percent diverted from 11 to 95 (predicted) to a range of percent diverted from 14 to 62 percent. In addition, essentially those months when the average Neosho River flow was predicted to be less than 110 cfs (Table 1), contract and allocation permitting likely would not have allowed makeup water to be pumped.

Consequently, during low flow or drought conditions, actual access to the stored water would be lower than originally predicted. This would tend to decrease the drawdown rate of JRR during such conditions. In addition, partial recharge of the JRR conservation pool during the assessed drought could not be diverted as quickly as originally modeled, further decreasing the duration and severity of makeup diversion impacts to JRR and the Neosho River.

Design Limiting Factors

At the MUSH, there are three makeup pumps rated at approximately 60 cfs individually, but due to friction losses, design net total flow ranges from approximately 60 cfs with one pump operating to 120 cfs with three pumps operating (WCGS, 2002, Section 3.1.1). In addition, the design flow for the makeup water piping is 120 cfs (Sargent & Lundy Engineers, 1979, Section 3.4.1). Actual operating experience using flow data metered during makeup diversion indicates that one pump will divert approximately 70 cfs, and two pumps will divert approximately 120 cfs. This effectively limits the maximum diversion rate to 120 cfs. Since, as has been established, the maximum rate of diversion of contracted storage water is 70 cfs, two-pump operation (120 cfs) will only be possible using water allowed for in the appropriations (State of Kansas 1977b and 1977c). Consequently, a minimum of 370 cfs discharging from the JRR dam would be necessary to provide for the required 250 cfs downstream plus the 120 cfs diversion rate. During the evaluated 50-year drought, such flows existed only two of 58 months (Table 1). Using the 120 cfs maximum as a monthly average, this would have increased the portion of flow diverted for May 1953 from 11 to 68 percent, but decreased percentage for April from 86 to 24 percent.

It must be clarified that the predicted flow rates in Attachment M (NRC 1976), and by extension in Table 1, were monthly averages, which should be interpreted with caution. Such data summary may tend to mask extremes in high and low flows. They do, however, provide a means to assess general magnitude of effects, which are valuable in evaluating potential impacts that may be expected during the license renewal period.

CCL Blowdown Reductions

Less makeup diversion will be required due to the reduction or absence of the need to replace blowdown water from CCL. During normal operations, increases to total dissolved solids (TDS) due to CCL evaporation was expected, especially during drought conditions (NRC 1982). Expected to be contributing to this was sulfates, a by-product of using sulfuric acid for scale control on condenser tubes. Water treatment processes were also considered as a source of artificial inputs to TDS in CCL. To control TDS buildup, periodic blowdown and subsequent makeup was expected to maintain water chemistry to support operations, and to ensure discharges from CCL would meet water quality standards.

During actual WCGS operations, sulfuric acid addition for condenser scale control was not instituted. Scaling is currently being controlled using agents that contribute considerably less to the TDS constituents to CCL. Physical scale removal with condenser cleaning balls is also being used, which is a method that will not artificially add TDS in CCL. In addition, recent changes in water treatment and condensate polisher regenerations have further reduced, or eliminated WCGS artificial inputs of TDS. Consequently, blowdown for water chemistry control has not been necessary, and the need for such is expected to be similar during the license renewal period. This will reduce makeup diversion accordingly, and further decrease the potential for increasing the duration and severity of drought conditions, and ensure the lack of adverse impacts to the instream and riparian communities of the Neosho River.

BENEFICIAL REGIONAL EFFORTS

There are two important efforts that are currently in process that will beneficially impact long-term water availability and quality in JRR and the Neosho River watershed. These include reallocating water storage space in JRR, and targeted conservation programs in the Neosho River watershed upstream of JRR.

Reallocation of water storage in JRR will in effect raise the conservation pool elevation from 1039 feet MSL to 1041 feet MSL. This will provide for an equitable redistribution of the storage remaining between the flood control and conservation pools due to uneven distribution of sediment. Congress has directed the USACE to conduct the study on this reallocation, and a Supplemental Final Environmental Impact Statement has been completed (USACE 2002). This document is in draft form, and is expected to be completed and implemented in the near future.

Throughout Kansas there are conservation efforts underway to address a variety of water and natural resource concerns on a watershed basis. Examples include water quality, public water supply reservoir protection, flooding issues, and wetland and riparian habitat restoration and protection. A Watershed Restoration and Protection Strategy (WRAPS) is a process engaging watershed stakeholders to identify needs and goals, then create and implement the strategy. Common and innovative watershed conservation practices are a result (Kansas Natural Resources Sub-Cabinet 2006). Currently, there are five such WRAPS at varying degrees of completion upstream of JRR. Three are in the implementation phase, and these are above Marion Reservoir, Council Grove Lake, and in the Eagle Creek watershed, which empties into the Neosho River immediately upstream of JRR (Coffey County Regional WRAPS, Marion Reservoir Water Quality Project, and the Twin Lakes WRAPS). Two WRAPS efforts are in the initial investigation and stakeholder engagement stages. One will include the Neosho River watershed above JRR, and the other the Cottonwood River watershed, the largest tributary to the Neosho River upstream of JRR. WCNOC has participated as an interested stakeholder in these efforts. An important aspect of these WRAPS will be to reduce sediment contribution from land use practices in the watershed, thus reduce sedimentation in JRR, and increase its usable water storage into the future.

These regional efforts will serve to increase the availability in the JRR – Neosho River system, thus ensure the water quantity and quality necessary to support the instream and riparian habitats during periods of severe drought, and during the license renewal period.

CONCLUSION

Because instream flows are not affected, license renewal for WCGS will not cause water use impacts to the Neosho River instream biota and riparian habitats. This is due to the permit and contract criteria governing WCGS use of the makeup water diversion, which effectively limit removals during normal and low flow conditions in the river. Other factors limiting potential water diversion impacts are design limits on makeup pumps, and a reduced need for blowdown from CCL, which necessitates subsequent makeup. In addition, local and regional conservation efforts exist that will improve water quality and quantity through the license renewal period. Therefore, WCNOC concludes that the operational impacts to the flow of the Neosho River over the license renewal term will be SMALL, and not warrant mitigation.

Table 1. Predicted flows used to assess the impacts to the Neosho River from makeup water withdrawal during the initial licensing for Wolf Creek Generating Station. Flow impacts were modeled for a once in 50-year period of record drought determined to be actually experienced from July, 1952 through April, 1957.

Month	Flow (cfs)	1952	1953	1954	1955	1956	1957
January	River flow:		64.7	28.0	24.0	25.7	21.0
	Makeup flow:		49.7	28.0	24.0	25.7	21.0
	Percentflow: diverted		77	0	0	0	0
February	River flow		51.0	26.0	15.0	28.0	21.0
	Makeup flow		36.0	26.0	15.0	28.0	21.0
	Percent flow diverted		70	0	0	0	0
March	River flow		168.6	23.0	27.0	25.8	27.4
	Makeup flow		153.6	23.0	27.0	25.8	27.4
	Percent flow diverted		91	0	0	0	0
April	River flow		96.2	28.0	15.0	15.0	494.7
	Makeup flow		61.5	28.0	15.0	15.0	423.7
	Percent flow diverted		64	0	0	0	86
May	River flow		381.0	15.0	15.0	239.4	End of
	Makeup flow		41.0	15.0	15.0	224.4	drought
	Percent flow diverted		11	0	0	94	
June	River flow		44.0	286.2	180.2	46.4	
	Makeup flow	Start of	44.0	242.2	136.2	46.4	
	Percent flow diverted	drought	0	85	76	0	
July	River flow	(1) 112.8	56.0	54.4	267.7	41.1	
	Makeup flow	(2) 64.6	56.0	54.4	223.7	41.1	
	Percent flow diverted	(1) 57	0	0	84	0	
August	River flow	153.5	60.0	65.1	67.7	55.0	
	Makeup flow	73.8	60.0	65.1	12.7	55.0	
	Percent flow diverted	48	0	0	19	0	
Septembe r	River flow	24.0	40.1	36.3	313.5	36.0	
	Makeup flow	24.0	40.1	36.3	298.5	36.0	
	Percent flow diverted	0	0	0	95	0	
October	River flow	24.0	26.5	30.2	279.8	24.0	
	Makeup flow	24.0	26.5	30.2	86.4	24.0	
	Percent flow diverted	0	0	0	31	0	
November	River flow	15.0	25.3	21.7	24.5	21.0	
	Makeup flow	15.0	25.3	21.7	24.5	21.0	
	Percent flow diverted	0	0	0	0	0	
December	River flow	56.9	27.0	21.5	23.7	21.0	
	Makeup flow	41.9	27.0	25.5	23.7	21.0	
	Percent flow diverted	74	0	0	0	0	

(1) Neosho River flow values and percent that makeup diversion flow comprises of the total river flow below John Redmond Dam were reproduced from modeled forecasts by the NRC (1976) presented in Attachment M.

(2) Makeup flows were derived from the difference between Attachment M river flows without makeup diversion and with makeup diversion.

LITERATURE CITED

Kansas Natural Resources Sub-Cabinet. 2006. Watershed Restoration and Protection Strategy – WRAPS. Brochure accessed on Kansas Department of Health and Environment web site. http://www.kdheks.gov/nps/wraps . Accessed November 8, 2006.

NRC. 1975. Final Environmental Statement related to construction of Wolf Creek Generating Station Unit 1, NUREG-75/096, Docket No. STN 50-482. Office of Nuclear Reactor Regulation, Washington, D.C., October.

NRC. 1976. Supplemental Testimony before the Atomic Safety and Licensing Board. Docket No. STN 50-482, January 6, 1976.

NRC. 1982. Final Environmental Statement related to the operation of Wolf Cree Generating Station, Unit 1, NUREG-0878. Office of Nuclear Reactor Regulation, Washington, D.C., June.

Putnam, J. E., and D. R. Schneider. 2005. Water Resources Data, Kansas, Water Year 2004, Water-Data Report KS-04-1. U. S. Department of the Interior, U. S. Geological Survey.

Sargent and Lundy Engineers. 1974. Cooling Systems Evaluation Wolf Creek Generating Station Units 1 and 2. Report prepared for Kansas Gas and Electric Company, Kansas City Power & Light Company. Report SL-3060.

Sargent and Lundy Engineers. 1979. Design Criteria for Cooling Lake Makeup Water and Blowdown System, DC-WL-01-WC, Rev. 3. Wolf Creek Generating Station, Kansas Gas and Electric Company, Kansas City Power & Light Company.

State of Kansas. 1976. Kansas Water Resources Board, Water Purchase Contract No. 76-2.

State of Kansas. 1977a. Approval of Application and Permit to Proceed, Appropriation of water for Beneficial Use File Number 20,275. Kansas Department of Agriculture, Division of Water Resources. Topeka, Kansas. August.

State of Kansas. 1977b. Approval of Application and Permit to Proceed, Appropriation of water for Beneficial Use File Number 14,626. Kansas Department of Agriculture, Division of Water Resources. Topeka, Kansas. August.

State of Kansas. 1977c. Approval of Application and Permit to Proceed, Appropriation of water for Beneficial Use File Number 19,882. Kansas Department of Agriculture, Division of Water Resources. Topeka, Kansas. August.

State of Kansas. 2006. Kansas Water Office, Kansas Water Plan. Available online at http://www.kwo.org . Accessed November 5, 2006.

USACE, 1996. John Redmond Dam and Reservoir, Neosho River, Kansas, Water Control Manual, Appendix O Part III to Water Control Master. Manual Arkansas River Basin. Department of the Army Tulsa District, Corp of Engineers. Oklahoma. April.

USACE, 2002. Draft Supplement to the Final Environmental Impact Statement Prepared for the : Reallocation of Water Supply Storage Project: John Redmond Lake, Kansas. Volume 1, U. S. Army Corp of Engineers. June.

Wolf Creek Generating Station. 2002. Wolf Creek System Description, Cooling Lake makeup Water and Blowdown System Makeup Water System, FD-WL-02-WC. Rev 6. Internal Document.

An Assessment of the Potential Impacts on Fish and Shellfish Resources from Entrainment.

(Supplement to Appendix E Section 4.2 to Wolf Creek Generating Station Environmental Report Operating License Renewal Stage)

An Assessment of the Impact on Fish and Shellfish Resources from Entrainment

Related to the Operating License Renewal

for

Wolf Creek Generating Station, Unit No. 1

INTRODUCTION

This is an assessment of the impact of license renewal on fish and shellfish entrainment at Wolf Creek Generating Station (WCGS). This evaluation provides supplemental information to support the conclusions in the Environmental Report – Operating License Renewal Stage (ER-OLRS, Section 4.2). This assessment considers conclusions presented during original licensing, correspondence between WCGS and Kansas Department of Health and Environment (KDHE), environmental studies, and operational experience. It is intended to be a NEPA evaluation of impacts associated with entrainment, and not an EPA Phase II 316 (b) determination. WCGS is not required by Phase II 316(b) Final Rule, Exhibit V-1, Performance Standard Requirements, as published in the Federal Register on July 9, 2004, to perform an entrainment determination on a lake or reservoir.

ENTRAINMENT ASSESSMENT

At WCGS, entrainment of fish and shellfish occurs when pumping cooling water from Coffey County Lake (CCL), through WCGS, and back to CCL, and when pumping makeup water from the Neosho River to CCL.

Cooling Water Entrainment

The entrainment impacts to the biota of CCL were evaluated by the NRC (1975, Section 5.5.2.3, and 1982, Section 5.5.2.2), and a conservative assumption was made that the mortality of all organisms entrained would approach 100 percent. Because the water is used for WCGS cooling, primarily thermal shock in the condensers was expected to cause mortality. However stresses associated with mechanical damage, chemical additions, and pressure changes were also expected to contribute to mortality as well.

There were no shellfish species in CCL that would be considered as likely to be entrained at the cooling water intake (KGE 1988). Most species tend to be benthic, and are not susceptible to entrainment. Consequently, this evaluation will focus on fish, primarily in the larval stage.

Entrainment monitoring at the cooling water intake was not required for initial licensing. The NRC relied on the State of Kansas for determination of the need for monitoring on aquatic issues (NRC 1984). The State of Kansas has not required such monitoring, and entrainment will not be required as part of the Phase II 316(b) determination for WCGS. Thus, no entrainment monitoring has been initiated.

However, limited larval fish data has been collected by WCNOC in support of its fishery monitoring efforts to reduce impingement. Insight on the recruitment of important fish species in CCL, including gizzard shad, was considered beneficial. As evaluated by the NRC (1975 and 1982), entrainment was a possible limiting factor, thus samples were collected to provide a rough estimate of magnitude. Sample size was small, but results can be used to support anecdotal analysis.

To determine presence of larval fish in the intake waters, vertical tows with a plankton net were completed from substrate to surface. These efforts were taken monthly from March through August, 2005 to determine approximate peak occurrence. Two to three replicate samples were collected each eight hours over a 24-hour period to ensure any night versus day variation might be detected. The plankton net had a 30 cm diameter opening, and a mesh size of 0.5 mm.

Peak larval fish occurrence could not be statistically ascertained due to the small sample size, but results implied a peak during late May to June, similar to the Neosho River studies (EA 1982 and Wedd 1985). Larval fish sampled included gizzard shad at 1.31, white crappie at 0.47, and freshwater drum at 0.36 per cubic meter. For perspective purposes, annual densities in the Neosho River during 1981 were gizzard shad at 52,950, white crappie at 600, and freshwater drum at 1320 per cubic meter.

In comparison, larval fish densities were much lower upstream of the cooling water intake than was typical in the Neosho River. The monitoring implies that the approach to the cooling water intake was not likely an important spawning or nursery area in CCL, and that WCGS probably was not appreciably removing larval fish from the fishery. This anecdotal data suggests that other influences, such as predation, were likely limiting gizzard shad densities in CCL.

Makeup Water Entrainment [1]

Makeup water to maintain CCL is pumped from the Neosho River to CCL. A detailed description of this process is provided in Section 3.1.2 in the ER–OLRS, and as presented for impingement (Enclosure 3) of this submittal. Fish and drift organisms in the Neosho River cannot be excluded from the makeup intake facility (Makeup Screenhouse, MUSH), and will be subject to entrainment. Consequently, these organisms will be displaced from the river. Entrainment was evaluated by the NRC (1975 and 1982). Discussion of entrainment impacts with the State of Kansas also occurred during the initial certification and discharge permitting process (Kansas Gas and Electric, KGE, 1975).

There were no shellfish species monitored in the Neosho River that would be considered as likely to be entrained at the MUSH (EA 1982). Most species tend to be benthic, and are not susceptible to entrainment. Consequently, this evaluation will focus on fish, primarily in the larval stage.

Larval fish monitoring was extensive in the Neosho river prior to and during initial MUSH operation (Nalco 1976, 1977, 1978, 1979 and 1980, Ecological Analysts 1981 and 1982, and Wedd 1985). In general, larval fish appeared in the Neosho River beginning in April and lasting until July of each year. Peak occurrences were typically during June, and gizzard shad dominated most samples. Catostomids, Cyprinids, and Freshwater drum were also prevalent, consequently, makeup diversion during other times of the year would not likely entrain fish.

Another factor that would minimize some entrainment is that the majority of fish species found in the Neosho River have eggs which are not free-floating and would not likely become entrained. Also, many of the fish were expected to pass through the makeup pumps and piping, and

[1] Water withdrawn from the Neosho River is used to maintain CCL water levels. Because the withdrawals are not for the purposes of cooling, the Neosho River intake is not subject to EPA or Kansas Phase II cooling water intake regulations.

survive in the CCL.[2] This mechanism was credited for gizzard shad, white bass, white crappie, and all rough fish species becoming established in CCL. These species were not initially stocked in CCL by WCGS.

From the larval fish monitoring (Wedd 1985), peak larval densities can approach 54 fish per cubic meter for a short period (approximately two weeks). Many years the peak was lower, ranging from approximately 0.5 to 20 fish per cubic meter. Larval densities throughout the entire monitoring season (late April through July) totaled 5.53 per cubic meter in 1981 (EA 1982). Considering 1981 as a representative year, and the maximum makeup diversion rate of 120 cubic feet per second (3.4 cubic meters per second), then makeup pumping during periods of larval presence could entrain a total of 149.365 million larvae. Gizzard shad would comprise 95.7 percent of this total.

This total was possible during initial CCL filling using Neosho River water. Subsequent fishery monitoring in the river revealed no changes that could be attributed to makeup pumping (EA 1982). Since WCGS operations began, and as is expected during the license renewal period, similar amounts of makeup water typically will not be diverted when larval fish may be present. This is due to normally higher springtime precipitation and higher river flows making makeup diversion not as necessary.

CONCLUSION

In summary, entrained fish would likely suffer near 100 percent mortality as they pass through WCGS. This effect to the environment would be limited to CCL. Limited larval fish monitoring indicates that larval densities appears to be low in the immediate vicinity of the intake, and that no important spawning or nursery areas were impacted by entrainment. Not normally needing to pump makeup water during typical springtime river flows, which corresponds with peak larval fish densities, will limit entrainment impacts. Fish are also expected to survive makeup pumping to CCL. Thus impacts to the CCL and Neosho River fishery from entrainment is expected to be SMALL during the license renewal period.

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[2] Unlike cooling water intakes, the WCGS makeup intake does not subject entrained organisms to thermal stresses

LITERATURE CITED

Ecological Analysts, Inc. 1981. Wolf Creek Generating Station Construction Environmental Monitoring Program, April 1980 – January 1981, EA Report 9107, prepared for Kansas Gas and Electric Company.

Ecological Analysts, Inc. 1982. Wolf Creek Generating Station Construction Environmental Monitoring Program, February 1981 – January 1982, EA Report KGE11, prepared for Kansas Gas and Electric Company.

EA Engineering, Science, and Technology, Inc. 1988. Wolf Creek Generating Station Operational Phase Environmental Monitoring Program, Final Report. Prepared for Wolf Creek Nuclear Operating Corporation, September.

Kansas Gas and Electric Company (KGE). 1975. Letter from M. E. Miller (KGE) to M. Gray (KDHE), KLKAN-039, dated March 7, 1975.

Nalco Environmental Sciences. 1976. Final Report of Preconstruction Environmental Monitoring Program Wolf Creek Generating Station, March 1975 – February 1976, Project No. 5501-06814, prepared for Kansas Gas and Electric Company.

Nalco Environmental Sciences. 1977. Final Report of Construction Environmental Monitoring Program Wolf Creek Generating Station, March 1976 – February 1977, Project No. 5501-07688, prepared for Kansas Gas and Electric Company.

Nalco Environmental Sciences. 1978. Final Report of Construction Environmental Monitoring Program Wolf Creek Generating Station, March 1977 – February 1978, Project No. 5501-08796, prepared for Kansas Gas and Electric Company.

Nalco Environmental Sciences. 1979. Final Report of Construction Environmental Monitoring Program Wolf Creek Generating Station, March 1978 – February 1979, Project No. 8917, prepared for Kansas Gas and Electric Company.

Nalco Environmental Sciences. 1980. Final Report of Construction Environmental Monitoring Program Wolf Creek Generating Station, March 1979 – February 1980, Project No. 9001, prepared for Kansas Gas and Electric Company.

Nuclear Regulatory Commission (NRC). 1975. Final Environmental Statement (FES) for Wolf Creek Generating Station. NUREG-75/096. Docket No. STN 50-482. Office of Nuclear Reactor Regulation, Washington, D.C., October.

NRC. 1982. Final Environmental Statement related to the operation of Wolf Cree Generating Station, Unit 1, NUREG-0878. Office of Nuclear Reactor Regulation, Washington, D.C., June.

NRC. 1984. Wolf Creek Generating Station, Unit No. 1 Environmental Protection Plan, Appendix B to Facility Operating License No NPF-42.

Sargent & Lundy. 1979. Design Criteria for Cooling Lake Makeup water and Blowdown System.

Wedd, G. R. 1985. Observation On Neosho River Larval Fish In Coffey County, Kansas. The Emporia State Research Studies. Vol. XXXXIV, Number 1. Emporia State University. pp 56.

An Assessment of the Potential Impacts on Fish and Shellfish Resources from Impingement Related to the Operating License Renewal For Wolf Creek Generating Station, Unit No, 1.

(Supplement to Appendix E Section 4.3 to Wolf Creek Generating Station Environmental Report Operating License Renewal Stage)

An Assessment of the Impact on Fish and Shellfish Resources from Impingement

Related to the Operating License Renewal For Wolf Creek Generating Station, Unit No, 1

COOLING LAKE ASSESSMENT

INTRODUCTION

This is an assessment of the impact of license renewal on fish and shellfish impingement at Wolf Creek Generating Station (WCGS). In accordance with the Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations at 40 CFR 1502.2, the evaluation that follows is "analytic rather than encyclopedic" and discusses impacts "in proportion to their significance." It is intended to be a NEPA evaluation of impacts associated with impingement rather than a complete 316(b) demonstration compliant with EPA Phase II regulations. A more detailed assessment of impingement is being prepared by WCNOC staff and will be submitted to the Kansas Department of Health and the Environment as part of an NPDES permit renewal application by mid 2008.

Agency Consultations

Exhibit 1 - February 21, 1975, Gray 1975)
In correspondence dated February 21, 1975, from M. W. Gray, Director, Division of Environment, Kansas Department of Health and Environment (KDHE) to M. Miller, Environmental Coordinator, Kansas Gas and Electric Company (KGE), it was the opinion of KDHE that KGE shall not be held responsible for the loss of fish in the lake due to cold shock kill, impingement, or entrainment.

THE PLANT

Cooling Water Source

The Circulating Water System (CWS), Service Water System (SWS), and the Essential Service Water System (ESWS) at WCGS all draw from and discharge to Coffey County Lake (CCL), formerly known as the Wolf Creek Cooling Lake. CCL is located on the WCGS site. A "main" earth dam constructed across Wolf Creek and five saddle dams built along the periphery of the impoundment forms CCL. The main dam is located about seven stream miles from the Wolf Creek and Neosho river confluence. The tops of the dams are at an elevation of 1,100 feet above mean sea level (MSL) to provide sufficient freeboard. Service and auxiliary spillways with ogee crests of 1,088 feet MSL and 1,090.5 feet MSL respectively are provided on the east abutment of the main dam to prevent overtopping of the dams by the probable maximum flood and wind and wave action. The normal operating elevation of the cooling impoundment is 1,087 feet MSL. At this elevation the impoundment has a capacity of 111,280 acre-feet and a surface area of 5,090 acres.

This 5,090-acre reservoir is designed to provide adequate cooling water to the plant during a one-in-fifty-year drought. To maintain the water level in the CCL, it is sometimes necessary to pump makeup water to the CCL from the Neosho River, just below the John Redmond Reservoir dam. Enclosure 1 of this submittal provides additional information concerning makeup water to CCL.

Within the impoundment two baffle dikes and two canals having inverts at 1,070 feet MSL were built to prevent short circuiting of the water flowing from the circulating water discharge to the Circulating Water Intake Structure. The impoundment canals are 215 feet wide with slopes of the canal sides at 1 foot vertical per 3 foot horizontal. The volumetric water rates in these canals are assumed to be 1256 cfs at a water velocity of 0.87 fps when the impoundment water level is at 1087 MSL. WCGS cooling water system configuration is considered a once-through cooling water system. Enclosure 4, Figure 1, provides a simplified drawing of the cooling lake and John Redmond Reservoir System.

Circulating Water System

The Circulating Water Screenhouse (CWSH) is located in the southeast corner of the main plant area on the shore of the cooling lake. The screenhouse contains the major equipment associated with the circulating water system (CWS) and the service water system (SWS).

The CWS operates continuously during power generation, including startup and shutdown. Three one-third capacity motor-driven, vertical, wet-pit circulating water pumps pump the circulating water from the cooling lake to the main condenser. They are designed to operate through the expected range of cooling lake levels. The heated water discharged from the condenser is returned to the cooling lake through a CWS discharge structure. The main circulating water pipes from the circulating water screenhouse to the power block and from the power block to the discharge structure have an inside diameter of 144 inches.

Freeze protection to prevent ice blockage at the circulating water screenhouse is accomplished by a warming line that routes a portion of the circulating water condenser discharge to the inlet of the screenhouse pump bays.

The SWS consists of three one-half capacity service water pumps and one low flow and startup pump, traveling screens and automatic backwash strainers, all located in the screenhouse. During normal plant operation, the SWS supplies cooling water to the turbine plant auxiliary equipment, steam generator blowdown nonregenerative heat exchanger, and CVCS chiller, as well as components served by the ESWS. The service water system is the normal water supply for the Demineralized Water Makeup System.

The circulating water and the service water flow from the cooling impoundment through bar grills (trash racks) into bays where the traveling screens are located. The bar grills are used for removing the larger debris. The CWIS bar grill, located at the inlet of the intake bays, is comprised of 1-inch vertical bars spaced at 3-inch intervals.

There are six traveling screens with two traveling screens per bay. The traveling screens are of a vertical single entry/exit type with a standard 0.375-inch mesh made by Envirex in 1982. Smaller debris is collected on the traveling screens. The traveling water screens are operated as per system operating procedures. The traveling water screens can be rotated and backwashed, manually or automatically, due to differential pressure across the screens. Debris is automatically deposited in a basket for periodic removal by plant personnel.

The plant service water return discharges into the circulating water discharge. This discharge is directed to the station cooling lake. Each service water pump is sized to deliver 25,000 gpm (~58 cfs) of service water at a discharge pressure of approximately 185 feet. Each circulating water pump has a design capacity of 167,000 gpm (~372 cfs) at a corresponding developed total head of 74 feet of water.

The CWIS sump floor is located at an elevation of 1058 feet MSL. A steel plate is provided at the sump inlet of the CWIS as a weather protection device. This steel plate extends downward from the CWIS operating floor (1092 feet MSL) to 1075 feet MSL. The velocities of the circulating water and service water flow downstream of the steel plate are essentially independent of the cooling impoundment water level.

Three pumps provide the design flow rate of approximately 500,000 gallons per minute when lake water temperatures are greater than 50^{O} F. Because condenser cooling is more efficient with colder intake water, only two pumps are operated with a design flow of 365,000 gallons per minute when lake temperatures are below 50^{O} F. At these pumping rates, design flow across the rotating screens at the point of impingement is less than 1.0 fps.

METHODS

Data from impingement surveys conducted monthly at WCGS over the December 2004 through March 2006 period were used for this assessment. A fine-mesh (0.25 inch bar mesh) collection basket was placed in a catch basin to collect all fish washed from traveling screens over a given 24-hour period. The basket was necessary because small fish are able to move through the grate at the base of the catch basin and re-enter the CCL.

Fish were removed from the basket every eight hours and identified, measured, and examined in order to ascertain their condition. Each fish was classified as "live," "recently dead," or "dead" based on its physical condition. All fish categorized as "dead" based on examination were considered dead before they were impinged on the traveling screens. These fish represented natural mortality in CCL. Fish categorized as "recently dead" were assumed to have been alive when impinged, and died in the collection basket as a result of exposure and oxygen deprivation.

Because the traveling screen wash passes though a trash grating (with 1 inch by 3.75 inch openings or 2.54 centimeters by 9.53 centimeters) at the point at which it leaves the Circulating Water Screenhouse (CWSH) and flows into CCL, the following assumptions were employed in extrapolating monthly and annual rates of impingement mortality from basket surveys:

- All fish greater than 100 mm total length (TL), no matter their condition in the collection basket, would die under normal circumstances because they would not likely pass through the openings in the trash grating.

- All fish in the collection basket less than 100 mm TL categorized as "live" or "recently-dead" would, under normal circumstances, return to the CCL and survive.

Table 1 shows how length and condition of fish were used to "bin" fish in order to extrapolate monthly and annual impingement totals based on fish length.

Table 1. Basis for adjusting monthly and annual estimates of impingement samples due to fish length and condition.

Fish Length	Condition	Assumption
> 100 mm TL	Dead	Natural mortality
	Recently dead	Impingement mortality
	Live	Impingement mortality
≤ 100 mm TL	Dead	Natural mortality
	Recently dead	Would have survived
	Live	Would have survived

Fish size and condition were subsequently used to determine if fish would have returned to the reservoir and survived, had the collection basket not been in place. After these adjustments, data from 24-hour basket surveys served as the basis for estimates of monthly and annual impingement mortality rates, and their impact to the CCL environment. To extrapolate monthly and annual impingement rates, the number of fish/shellfish collected over a given 24-hour period was multiplied by the number of days in a month. The monthly totals were summed to calculate annual totals. Because no data were available from April 2005, when the plant was down for re-fueling, the impingement rates for March and May 2005 were evaluated for use as surrogates: the May data was ultimately used because it reflected a much higher rate of impingement, thus was conservative. Similarly, March 2006 data were used for February 2006 extrapolation. For annual impingement rates, only 2005 data were used to capture all four seasons and corresponding lake conditions.

RESULTS

Data

The following overview represents simple gross numbers observed, and is not from data adjusted for non-impingement impact considerations. Consequently, this general review is a conservative assessment only. A total of 420 fish and 104 shellfish (crayfish and *Corbicula, (*Asiatic clam)) were collected in impingement samples at WCNOC over the December 2004 – March 2006 period (Table 2). Five fish species represented 93 percent of all impinged fish: freshwater drum (33 percent of fish collected), white crappie (23 percent), gizzard shad (21 percent), bluegill (11 percent), and channel catfish (6 percent). Smaller numbers of white bass, buffalo, walleye, smallmouth bass, and flathead catfish were also collected, but none of these species comprised more than four percent of the total. Eighty-seven *Corbicula* and 17 crayfish were also collected over the

16-month period. Both operators of power plants and fish and game agencies regard the non-native Corbicula as a nuisance species across the U.S. This species clogs power plant cooling water systems and out-competes and displaces native freshwater mussels. Any *Corbicula* losses at WCGS are regarded as beneficial. The small number of crayfish impinged (approximately one per day) is presumed to be less than the number consumed by a single, actively feeding adult smallmouth bass per day. Because all shellfish were small enough, and were considered hardy, none were considered as impacted by impingement.

Approximately 52 percent of all fish and shellfish impinged were found dead in the collection basket. Gizzard shad, a species known to be fragile and subject to winter kills (Scott and Crossman 1973; Klemesrud 2003; Schoenung 2003), showed the highest mortality rate, 63 percent. Freshwater drum also showed a fairly high rate of mortality, 58 percent. Mortality rates for bluegill, channel catfish, and white crappie were 48 percent, 46 percent, and 31 percent, respectively. Catfish species are exceedingly hardy and able to tolerate low levels of dissolved oxygen (SRAC 1988; Smitherman and Dunham 1993; Pennsylvania Angler & Boater 2001) so it is not surprising that they showed lower rates of mortality.

Analysis

For actual impact, data were adjusted by removing the fish justified as being non-impingement related, the daily (actual) impingement rates of fish in Table 3 yielded estimated monthly impingement rates ranging from 0 to 1,612. A annual total of 957 fish and no shellfish were estimated to have died as a result of being impinged (Table 3). This corresponds to impingement mortality rates of 30.8 percent for finfish and zero percent for shellfish.

The highest rates of impingement were observed in late spring-early summer (May and June) and fall-early winter (November and December). Water temperatures in the 30s and low 40s (°F) were generally associated with higher rates of impingement and impingement mortality for all fish species, but trends were less than clear-cut. The lowest temperature observed over the 16-month period (37.5°F in January 2005) was associated with a fairly low impingement.

Although no statistical tests were performed, there appeared to be no correlation between cooling water withdrawal rates and impingement mortality (Figure 1). Highest impingement rates were often associated with operation of two circulating water pumps; lowest impingement rates were often associated with operation of three circulating water pumps. This suggests that environmental factors influence impingement as much or more than operational factors. These environmental factors include meteorology (frontal movement, specifically air temperature, wind speed, wind direction), water quality (water temperature, dissolved oxygen levels at depth), and biology (distribution and abundance of species that are vulnerable to impingement, such as gizzard shad; overall health of the fish community; size and age composition, as smaller fish are more vulnerable, relatively, than larger fish, which are stronger swimmers).

IMPINGEMENT AT WCGS RELATIVE TO CCL FISHERY

Important Species in CCL

To determine the fishery's susceptibility to WCGS impingement impacts, a review of species present and those considered important for long term recreational and commercial (industrial) value is necessary. Fish species present are common to reservoirs in Kansas (Cross and Collins 1995) and are listed in Table 4. The present fishery reflects WCNOC management efforts to biologically control impingement rates by promoting predator species. This continuing effort was undertaken to minimize impingement impact to the lake environment, and to prevent the economic and operational difficulties that could be caused by excessive impingement, particularly gizzard shad. Problem impingement on intake screens can develop because gizzard shad have difficulty avoiding intake flows when they naturally become weakened, and eventually die, as winter water temperatures fall below approximately 40^{O} F (Bruce NGS 1977, Ontario Hydro 1977, Olmstead and Clugston 1986, White et al 1986).

Predator (game) species that are considered important at WCGS to control impingement include species that are also important for recreational purposes. These include channel catfish, white bass, wiper hybrids, smallmouth bass, largemouth bass, white crappie, and walleye (Tables 5 and 6).

WCNOC's fishery management efforts revolve around eliminating excessive gizzard shad wintertime impingement events that can create operational challenges to the circulating water screens. This effort has been successful with shad densities kept low (Table 7). Still, shad are an important forage species in CCL, and critical for the well being of predators in the lake. Reductions caused by natural predation, or other influences, such as winter die-offs or WCGS impingement, cannot be greater than the population can recover from. Extremely low shad densities would cause subsequent reduction in important predator species (Haines 2000). Consequently gizzard shad are considered an important species in CCL, and potential impacts from impingement must be balanced.

There are no listed threatened or endangered fish species known to be present in CCL, nor are any expected. For the purpose of this evaluation, the commercially important species are considered those important for electricity production at WCGS as explained above. Species used for the commercial food market include buffalo species and common carp. However, there is currently no plans to allow commercial harvest on CCL, thus there should be no impingement impacts expected, and no further assessment will be needed. Additional details on CCL fishery can be found in WCGS's Annual Fishery Monitoring Report and Plans (WCNOC 2006).

Channel Catfish

As previously established, channel catfish are typically hardy, and all but one that were sampled were $\leq$ 100 mm TL, and thus would have returned to CCL alive (Table 3). For assessment purposes on an annual basis (2005 data), adjusted estimates indicate no mortality attributable to WCGS. Thus, impingement impacts to the channel catfish population in CCL were considered inconsequential.

White bass

White bass are common to reservoirs in Kansas, and can be highly productive (Colvin 1993). They are a pelagic (open water) species, highly mobile, and are common in the vicinity of the circulating water intake. This may tend to expose them to impingement. This is reflected by the annual adjusted impingement estimate of 122 (Table 3), and these were all judged to be young-of-year fish.

Based on annual catch frequencies, the white bass population in CCL has remained relatively consistent, with normal fluctuation (Table 7). Extrapolating total white bass densities in CCL to estimate impingement percentage was not possible due to the passive sampling gear used (gill nets). Survival rates for CCL white bass were unavailable, but average survival in regional reservoirs ranged from 21 to 52 percent and averaged 35 percent (Colvin 1993). Growth rates in CCL, as well as regionally (Colvin 1993), indicate that it would take approximately three years for white bass to reach 12 inches (305 mm) TL, which is the current minimum length for recreational harvest. Using average survival of 35 percent, the 122 white bass removed from the CCL population by impingement would be 5.2 fish by the time they are available for harvest. This would be from 0.3 to 1.4 percent of the annual recreational harvest from 1999 through 2005 (Table 5). Because white bass are highly productive, and the small percentage of the fish made unavailable, impingement is judged to not pose a threat to the fishery in CCL.

Wiper Hybrids, Smallmouth bass, and Largemouth Bass

Of the important predator species, there were no wiper hybrids or largemouth bass found in the impingement samples, and only one smallmouth bass observed, which was judged as dead before being impinged (natural mortality). Fishery sampling by WCNOC indicates catch rates for these species to vary (Table 7). The wiper hybrids were hatchery spawned, and their densities were controlled by WCNOC stocking, which was based on shad control needs. As hybrids, they have not reproduced sufficiently to maintain a population. Largemouth bass have experienced a long-term decline typical of aging reservoirs (Kimmel and Groeger 1986, Willis 1986). Because these species were not found in the catch basket, they are not considered to be adversely impacted by impingement.

White Crappie

White crappie is the game fish species with the highest adjusted annual impingement estimate of 185 fish (Table 3). It is an important recreational species, however, because of its current creel limit of only two fish per day, it is not a species sought after for consumption. It is a species important for WCGS, though, because gizzard shad is major forage item (Cross and Collins 1995, Muoneke et al 1992). Most of the crappies impinged were slightly greater than the 100 mm TL used for data adjustment, and were young-of-year fish. O'Brien et al (1984) determined that crappie 80 to 170 mm TL were wholly pelagic. Smaller crappies have also been more often taken in open water than along the shoreline (Grinstead as cited in Carlander 1977). WCNOC observation also indicates such small crappie distribution in CCL. This would tend to explain the higher impingement for white crappie. The fish would be in the deeper, open water similar to that adjacent to the cooling water intake, and thus more susceptible to impingement.

Annual survival rates ranged from 23 to 29 percent for three Kansas reservoirs after length limits were instituted (Mosher 2000), and 46 percent for Lake Carl Blackwell in north-central Oklahoma (Muoneke 1992). Annual survival rates for CCL have not been calculated, however, it is believed to likely be toward the higher range due to relatively larger, longer-lived crappie present. The current length limit before crappies are available for recreational harvest is 14 inches (356 mm) TL, which is restrictive. Average growth rates for CCL crappies indicate that they typically reach the length limit at four years of age. Applying the higher 46 percent survival rate to the adjusted impinged fish yields reductions from 185 after year one, to 85 after year two, to 39 after year three, and to 18 after year four. Accordingly, impingement would cause 18 crappies to be unavailable for recreational harvest. This represents from 2.5 to 9.8 percent of crappies harvested (Table 5). As stated earlier, restrictive creel and length limits suppress harvest rates for CCL crappies. A more applicable impact comparison would be for recreational caught-and-released data, for which 18 impinged fish represents from 0.2 to 0.4 percent of the annual recreational catch (Table 6).

In summary, white crappie was shown to be relatively vulnerable to impingement, and was the game species most impinged. The relative percentage of crappie surviving to sizes available for recreational harvest was higher than other CCL species. However, due to restrictive harvest limits, these percentages may be inflated. Percentages of the recreationally caught-and-released remained low. Consequently, impingement is not expected to adversely impact the CCL fishery, but this species may be more susceptible than other species evaluated.

Walleye

Walleye is an important species both for WCGS operations and recreation. During the entire impingement sampling period, only one was considered impinged, and this extrapolates to 30 walleye per year (Table 3). Catch curve regressions for 2003 and 2004 indicate total annual survival estimates for walleye of 41 and 17 percent, respectively. Averaging these yields a total survival rate of 29 percent. At the current slot limit (18 to 26 inch protected) and at growth rates present in 2003 and 2004, the 30 walleye at 388 mm TL (length of impinged specimen) would remain available for recreational harvest for approximately two years. Applying the 29 percent survival estimate, reductions to the extrapolated 30 impinged walleye would be 21.3 fish the first year, and an additional 6.2 fish the second year. This means that of the 30 impinged walleye, if similar impingement, survival, and growth continued annually, estimated annual loss to the recreational fishery would be 11.2 walleye (8.7 fish remaining after first year, plus 2.5 remaining after second year). This represents <1.0 percent of the recreationally harvest annually (Table 5), and < 0.2 percent of the walleye caught and released by anglers (Table 6). Because a passive gear type (gill nets) was used to monitor walleye in CCL, total lake population density could not be estimated, only relative catch frequency changes (Table 7). Extrapolating these numbers based on one fish impinged is not statistically defensible, but it will provide in this circumstance a relative measure to assess impacts to walleye in CCL. Because the percent removed from the population was very small, there are no impingement impacts expected to the CCL walleye.

Gizzard Shad

Based on adjusted impingement data, gizzard shad represented the largest number of fish impinged on an annual basis (2005 data, Table 3). An adjusted total of 496 were considered impingement mortality during the sampling period. Using 2005 data as representative of annual mortality, the adjusted impingement mortality was 341 gizzard shad.

An estimate of the total gizzard shad estimate from CCL could be derived from mid-summer seine hauls from 1983 through 1997 (Haines 2000). Average density estimates in CCL of similar sized shad over the 1983 through 1997 period were 3.005 million. Mortality attributable to impingement represents 0.01 percent of this average young-of-year population estimate.

Observed length of impinged shad would tend to further reduce any potential impingement influences. Scale aging indicate that the larger adult brood fish achieved first year growth to approximately 200 mm TL, which is above normal growth (Haines 2000). These fish were suspected to have been spawned in the heated discharge from WCGS earlier than normal, and were able to grow sufficiently to not be as susceptible to cold induced mortality (White et al 1986), were too large for predators, and not as susceptible to impingement. All shad in the impingement samples were smaller young-of-year (approximately 100mm TL), and not as likely to survive in CCL to reach reproductive age. Thus, evidence shows that the sizes impinged would not be as likely to contribute on a long-term basis to the CCL fishery.

In summary, gizzard shad is considered one of the most important species in CCL, and had the highest annual (2005) adjusted impingement rates. It was not considered impacted by impingement due to the extremely low percentage removed from the estimated population density. Shad age, growth and size distribution data also imply that the most important shad to the predator fishery were the earlier spawned fish that were able to recruit to reproductive sizes, and were not susceptible to impingement. Therefore, impingement at CCL does not appreciably impact gizzard shad.

Other Species

The remaining species were either considered as rough fish, or were infrequently found in the impingement catch basket. Consequently, these were not considered as recreationally of commercially important species as they relate to CCL and impingement.

IMPINGEMENT AT WCGS COMPARED TO SIMILAR PLANTS

V.C. Summer Station (S.C.)

VC Summer Nuclear Station (VCSNS), in South Carolina, may be the nuclear plant most similar to WCGS in terms of design and cooling system. Both plants are single-unit Westinghouse PWRs with once-through cooling systems that withdraw and discharge to small cooling reservoirs. Coffey County Reservoir, at 5,090 acres, is slightly smaller than Monticello Reservoir (6,500 acres). The 316(b) Demonstration for VCSNS indicated that an estimated 85,000 fish weighing 515 kilograms were impinged annually, which amounted to less than one percent of the reservoir's standing crop (Dames & Moore 1985). Highest rates of impingement were observed in winter, when large numbers of cold-shocked gizzard shad were impinged. More than 80 percent of fish impinged over the 12 months of the study (October 1983 through September 1984) were gizzard shad. Other species commonly impinged were yellow perch, white catfish, bluegill, and channel catfish.

Based on these impingement rates, which were approximately 20 times those seen at WCGS, the Dames & Moore 316(b) Demonstration concluded that "the number of fishes impinged by VCSNS appear sufficiently low so as to have minimal effect on the fish community." In April 1985, the South Carolina Department of Health and Environmental Control determined that the "location, design, construction, and capacity of the VCSNS cooling water intake structure reflects the best technology available for minimizing adverse environmental impact" (SCE&G 2002). This determination has been made a part of all NPDES permits issued since that time.

North Anna Power Station (Va)

North Anna Power Station, a two-unit Westinghouse plant near Mineral, Virginia, uses a once-through condenser cooling system that withdraws from and discharges to Lake Anna, a 9,600 acre cooling reservoir. Virginia Power conducted impingement studies over the 1978-1983 timeframe to characterize impingement and entrainment at the plant. The total number of fish in screen wash samples ranged from 11,063 (1983) to 148,995 (1979) per year, which translated into impingement estimates of 45,591 and 583,530 fish, respectively. Sixty-one percent of fish impinged were gizzard shad, many of which were cold-stressed. Yellow perch (15.8 percent) and black crappie (15.7 percent) were the other species impinged in significant numbers. The authors of the NAPS 316(b) demonstration observed that total impingement and entrainment rates tended to track with abundance of gizzard shad, and declined markedly as the gizzard shad became less numerous in collections.

CONCLUSION

Impingement studies conducted at WCGS over the December 2004 - March 2006 period suggest that impingement rates were very low in both absolute (number of fish) and comparative terms (relative to other nuclear plants of similar design), as was impingement mortality. Impingement was selective for certain species (freshwater drum, white crappie, gizzard shad) and certain size and age classes (small fish that were not aged but were presumed to be young-of-year). More than half of fish impinged were "rough fish" that are not avidly sought by recreational fishermen. The white crappie was the only recreationally important species impinged in significant numbers. Most recreationally important species, including smallmouth bass and walleye, were impinged in very low numbers.

Available data suggests that impingement has had little or no effect on fish populations in Coffey County Lake. Coffey County Lake, with its thriving populations of channel catfish, white crappie, smallmouth bass, walleye and wipers, has become a popular destination for Kansas anglers. Kansas Department of Wildlife and Parks (KDWP) issues annual Fishing Forecasts for public waters in Kansas, which are in effect ratings of public fishing areas. Coffey County Lake received biologists' rating of Excellent for walleye (the only state reservoir to receive this ranking for walleye) and smallmouth bass (the only state reservoir to receive this ranking for smallmouth bass) (KDWP 2004). Channel catfish, white crappie, white bass, and wiper fishing were all rated Good. Therefore, WCNOC concludes that impacts to fish and shellfish in the Coffey County Lake from impingement are SMALL and that mitigative measures are not warranted.

MAKEUP SCREENHOUSE ASSESSMENT (MUSH)

INTRODUCTION

Note: The U. S. Environmental Protection Agency (USEPA) has exempted Kansas Power and Light (KCPL) La Cygne Generating Station (LCGS) makeup water intake structure from the Clean Water Act 316(b) requirements. Kansas Department of Health and Environment (KDHE) has agreed with the USEPA and has also exempted LCGS from making a Phase II 316(b) determination on its intake water structure. KDHE is also considering exempting WCGS MUSH from the Phase II 316(b) determination, as LCGS and WCGS water intake structures are similar in nature.

IMPINGEMENT ASSESSMENT

The Makeup Screenhouse (MUSH) is situated on the east side of the Neosho River downstream of John Redmond Dam (Sargent & Lundy, Design Criteria for Cooling Lake Makeup water and Blowdown System, 1979). The MUSH contains one bar grill, three vertical traveling screens, and three vertical wet-pit pumps, each with a normal operation capacity of 40 to 60 cubic feet per second (cfs). The three pumps in parallel have a maximum capacity of 120 cfs when the river elevation at the pumphouse is at flood stage.

Water for WCGS leaves John Redmond Reservoir via 30-inch supply pipe and flows into the Neosho River. The maximum design flow through the pipe is approximately 130 cfs. The pipe flow is diverted into a channel on the east side of the river where the WCGS's MUSH is located (ER-OLS, Section 4.1). The water level at MUSH is expected to vary as follows:

Low Water Level	1003.5 feet MSL[3]
Normal Water Level (due to the Burlington Dam backwater effect)	1007.5 feet MSL
High Water Level (historic flood)	1032.5 feet MSL

The MUSH is designed to accommodate extreme water level variations.

[3] Mean Sea Level

The MUSH trash bar grills are located at the inlet of the intake bays. They are composed of 1-inch vertical bars spaced at 3-inch intervals (NRC 1975). Each intake bay is approximately 11 feet 2 inches wide. Vertical traveling screens are located in front of each of the three pumps are 10 feet wide. The traveling screen mesh is made of stainless steel wire. The mesh size is 0.375 inch. The screens are backwashed with water drawn from the Neosho River. The screen wash system is activated manually, by a timer or automatically from a high differential pressure switch. The trash collected on the traveling screens is backwashed to a trash basket where it is strained and collected. There are no provisions for returning fish that survive impingement to the Neosho River. However the design intake velocity of less then 0.5 feet per second (fps) at the 1007.5 feet MSL minimizes fish impingement.

As a condition of the Wolf Creek Construction Permit Number CPPR-147, the NRC required Kansas Gas and Electric Company (KGE) to monitor the impingement of fish during the lake-filling phase of construction. The NRC requirement was outlined in Section 6.1.3.2 of the Wolf Creek Generating Station, Unit No. 1 Final Environmental Statement (FES(CP)), NUREG-75/096. KGE completed the study and the results of the study were forwarded to the NRC in March 1982 (Koester 1982).

The one-year impingement study on the MUSH was performed between November 1980 and October 1981 (KGE, 1981). The objective of the study was to document species composition and abundance, size distribution, and seasonality of fish impinged at the MUSH located in the tailwaters of JRR.

Data collected during monitoring at the MUSH reveals a pattern typical of impingement at other facilities. This pattern shows impingement dominated by the major clupeid species present, which was gizzard shad in this study (Edwards et al 1976). Impingement peaked during winter months, and was composed of young-of-year (YOY) fish, with sport fish occurring at low rates.

Throughout the study gizzard shad were the dominant component of impinged fish, comprising over 99 percent of the calculated total. Field observations plus impingement study data supports a hypothesis that during peak impingement, shad were being discharged from JRR in a stressed condition and were unable to avoid the low intake velocities present at the MUSH.

Gizzard shad, along with white bass and freshwater drum, comprised more than 99.9 percent of total impingement. Peak impingement for all three of these taxa occurred during January and February and was predominately YOY fish.

Neither blue sucker (*Cycleptus elongatus*) or Neosho madtom (*Noturus placidus*) individuals were impinged during the study. No impingement of Neosho madtom was expected since this species has not been collected during prolonged monitoring in the area of the MUSH. Additionally, no other rare, threatened or endangered species were impinged at the MUSH during the 1980-1981 study.

The data compiled and circumstances observed during the monitoring period indicate that a worst-case situation was monitored. Low rainfall resulted in discharge rates from JRR, which were low enough to consistently isolate the MUSH intake channel from the Neosho River throughout late 1980 and early 1981. Additionally, the lake filling activities necessitated maximum pumping efforts throughout the study. These factors combined to cause the high impingement observed during the winter months.

Normal rainfall patterns will typically provide more favorable flow conditions and by keeping Coffey County Lake at or near its normal operating level will substantially reduce demands for makeup water. The combination of these circumstances will ameliorate the contributory factors of the observed impingement thereby moderating long-term impingement at the MUSH.

The impingement of larger fish should be quite minimal because the operational intake velocities of approximately 0.5 fps are low in comparison to the stream flows in habitats where most species of fish native to this watershed occur. In the MUSH vicinity, Neosho River flows can typically range from 0.8 to 4.9 fps (Wedd 1985). Consequently, impingement of adult fish is expected to rarely occur and then only when the fish are in a physiologically-weakened condition or are dead and thus cannot avoid even the low current velocities near the MUSH intake.

To limit impingement at the MUSH, WCNOC has procedural guidelines to avoid pumping during the cold winter months (WCNOC 2006, Step 6.11.3). As detailed in Enclosure 1 of this submittal, other MUSH limitations effectively decrease makeup diversion rates, thus decrease flow rates at the screens. This should correspondingly reduce impingement potential.

CONCLUSION

In conclusion, fish impingement due to makeup water diversion has been characterized during worst-case conditions, which was initial Coffey County Lake filling. Makeup pumping during WCGS operation has been less frequent, and has diverted less volume. Administrative guidelines avoid makeup pumping when high fish impingement may be expected. Consequently, makeup water diversion is not expected to adversely impact the Neosho River fish population during the license renewal period. Therefore, WCNOC concludes that impacts to fish and shellfish as a result of the MUSH operation is SMALL and that mitigative measures are not warranted,

Table 2. Total number of fish in impingement samples.

Date	(1) GS	RCS	SBF	CC	FC	WB	BG	SMB	WC	WAE	FWD	*C. f.*	CR *sp.*	Monthly Total	Temp ^{0}F
Dec-04	30	0	3	7	0	8	12	0	27	0	98	2	1	188	38.5
Jan-05	20	1	0	2	0	0	0	0	0	0	0	0	2	25	37.5
Feb-05	0	0	0	1	0	0	0	0	0	0	1	0	1	3	45.2
Mar-05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47.5
Apr-05	0	0	0	0	0	0	0	0	1	0	0	0	0	1	64.9
May-05	0	0	0	0	0	0	1	0	1	0	0	33	1	36	70.2
Jun-05	22	0	0	0	0	0	5	0	0	0	0	20	1	48	81.8
Jul-05	3	0	0	0	0	0	1	0	1	0	2	6	2	15	85.8
Aug-05	2	0	0	0	0	3	0	1	10	0	7	1	2	26	80.7
Sep-05	0	0	0	0	0	0	1	0	1	0	3	15	1	21	79.9
Oct-05	0	0	0	0	0	1	0	0	0	1	1	4	0	7	67.6
Nov-05	1	0	0	1	0	2	26	0	33	1	0	2	0	66	57.8
Dec-05	10	0	3	5	1	2	2	0	19	0	19	0	4	65	40.5
Jan-06	0	0	0	3	0	0	0	0	1	0	1	3	2	10	45.1
Feb-06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42.0
Mar-06	0	0	0	5	0	1	0	0	2	0	4	1	0	13	46.4
2005	88	1	6	24	1	17	48	1	95	2	137	87	17	524	

(1) Fish species abbreviations:

Gizzard Shad	GS	Smallmouth bass	SMB
River carpsucker	RCS	White crappie	WC
Smallmouth buffalo	SBF	Walleye	WAE
Channel catfish	CC	Freshwater drum	FWD
Flathead catfish	FC	*Corbicula fluminea*	*C. f.*
White bass	WB	Crayfish sp.	CR *sp.*
Bluegill	BG		

Table 3. Estimated monthly impingement mortality for WCGS adjusted for fish considered live and likely returned to the lake unharmed.

Date	[1] GS	RCS	SBF	CC	FC	WB	BG	SMB	WC	WAE	FWD	*C. f.*	CR *sp.*	Total
Dec-04	[2] 155	0	93	0	0	186	0	0	62	0	1116	0	0	1612
Jan-05	341	31	0	0	0	0	0	0	0	0	0	0	0	372
Feb-05	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar-05	0	0	0	0	0	0	0	0	0	0	31	0	0	31
Apr-05	0	0	0	0	0	0	0	0	31	0	0	0	0	31
May-05	0	0	0	0	0	0	0	0	31	0	0	0	0	31
Jun-05	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jul-05	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug-05	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep-05	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct-05	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nov-05	0	0	0	0	0	60	0	0	30	30	0	0	0	120
Dec-05	0	0	31	0	0	62	31	0	93	0	155	0	0	372
Jan-06	0	0	0	0	0	0	0	0	31	0	0	0	0	31
Feb-06	0	0	0	31	0	0	0	0	31	0	31	0	0	93
Mar-06	0	0	0	31	0	0	0	0	31	0	31	0	0	93
2005	341	31	31	0	0	122	31	0	185	30	186	0	0	957
ALL	496	31	124	62	0	308	31	0	340	30	1364	0	0	2786

(1) Fish species abbreviations:

Gizzard Shad	GS	Smallmouth bass	SMB
River carpsucker	RCS	White crappie	WC
Smallmouth buffalo	SBF	Walleye	WAE
Channel catfish	CC	Freshwater drum	FWD
Flathead catfish	FC	*Corbicula fluminea*	*C. f.*
White bass	WB	Crayfish sp.	CR sp.
Bluegill	BG		

(2) All fish in impingement samples (Table 2) that were ≤ 100 mm (TL) were considered likely to have returned to the lake alive.

Table 4. Fish species list for CCL.

Common name	Scientific name
Gizzard shad	Dorosoma cepedianum
Common carp	*Cyprinus carpio*
Golden shiner	*Notemigonus crysoleucas*
Ghost shiner	*Notropis buchanani*
Red shiner	*Cyprinella lutrensis*
Fathead minnow	*Pimephales promelas*
River carpsucker	*Carpiodes carpio*
Bigmouth buffalo	*Ictiobus cyprinellus*
Smallmouth buffalo	*Ictiobus bubalus*
Black bullhead	*Ameiurus melas*
Yellow bullhead	*Ameiurus nattalis*
Channel catfish	*Ictalurus punctatus*
Blue catfish	*Ictalurus furcatus*
Flathead catfish	*Pylodictis olivaris*
Blackstripe topminnow	*Fundulus notatus*
Mosquitofish	*Gambusia affinis*
White bass	*Morone chrysops*
Striped bass	*Morone saxatilis*
Wiper hybrid (white bass x striped bass)	*na*
Brook silverside	*Labidesthes sicculus*
Green sunfish	*Lepomis cyanellus*
Longear sunfish	*Lepomis megalotis*
Orange-spotted sunfish	*Lepomis humilis*
Bluegill	*Lepomis macrochirus*
Smallmouth bass	*Micropterus dolomieu*
Largemouth bass	*Micropterus salmoides*
White crappie	*Pomoxis annularis*
Black crappie	*Pomoxis nigromaculatus*
Walleye	*Sander vitreum*
Logperch	*Percina caprodes*
Freshwater drum	*Aplodinotus grunniens*

Table 5. Selected fish species harvested by anglers at Coffey County Lake.

	# Anglers		Chan. catfish	White bass	Wiper hybrid	Smallmouth Bass		LM Bass	Crappie	Walleye		All fish
				>12"	>24"	<13"	>18"	>21"	>14"	>18"		
1999	9008	**No.**	1628	1149	7	356	116	14	725	1669		6007
		#/hour	0.03	0.02	<0.01	0.01	<0.01	<0.01	0.01	0.03		0.13
		#/acre	0.32	0.23	<0.01	0.07	0.02	<0.01	0.14	0.33		1.15
2000	6865	**No.**	2258	859	3	198	20	10	316	533		4366
		#/hour	0.07	0.02	<0.01	0.01	<0.01	<0.01	0.01	0.01		1.13
		#/acre	0.44	0.17	<0.01	0.04	<0.01	<0.01	0.06	0.10		1.35
						<13"	>16"			<18"	>18"	
2001	7449	**No.**	2779	1046	12	126	69	4	415	1609	36	6291
		#/hour	0.08	0.03	<0.01	0.01	<0.01	<0.01	0.01	0.05	<0.01	0.18
		#/acre	0.55	0.21	<0.01	0.02	0.01	<0.01	0.08	0.32	0.01	1.23
2002	4227	**No.**	1161	378	7	85	62	7	184	862	326	3841
		#/hour	0.08	0.02	<0.01	<0.01	<0.01	<0.01	0.01	0.04	0.01	0.18
		#/acre	0.23	0.07	<0.01	0.02	0.01	<0.01	0.04	0.17	0.06	0.83
						<16"	>20"			<18"	>26"	
2003	4751	**No.**	2457	1233	16	364	24	1	234	1244	26	5638
		#/hour	0.10	0.05	<0.01	0.01	<0.01	<0.01	0.01	0.05	<0.01	0.49
		#/acre	0.48	0.24	<0.01	0.07	<0.01	<0.01	0.05	0.24	<0.01	0.93
2004	5674	**No.**	2989	1494	18	371	0	3	386	2327	7	7662
		#/hour	0.10	0.05	<0.01	0.01	0	<0.01	0.01	0.08	<0.01	0.25
		#/acre	0.59	0.29	<0.01	0.07	0	<0.01	0.07	0.46	<0.01	1.51
2005	5287	**No.**	2541	1281	8	303	10	6	325	2441	8	6981
		#/hour	0.09	0.04	<0.01	0.01	<1.01	<0.01	0.01	0.08	<0.01	0.24
		#/acre	0.50	0.25	<0.01	0.06	<0.01	<0.01	0.06	0.48	<0.01	1.37

Table 6. Selected fish species caught and released by anglers at Coffey County Lake.

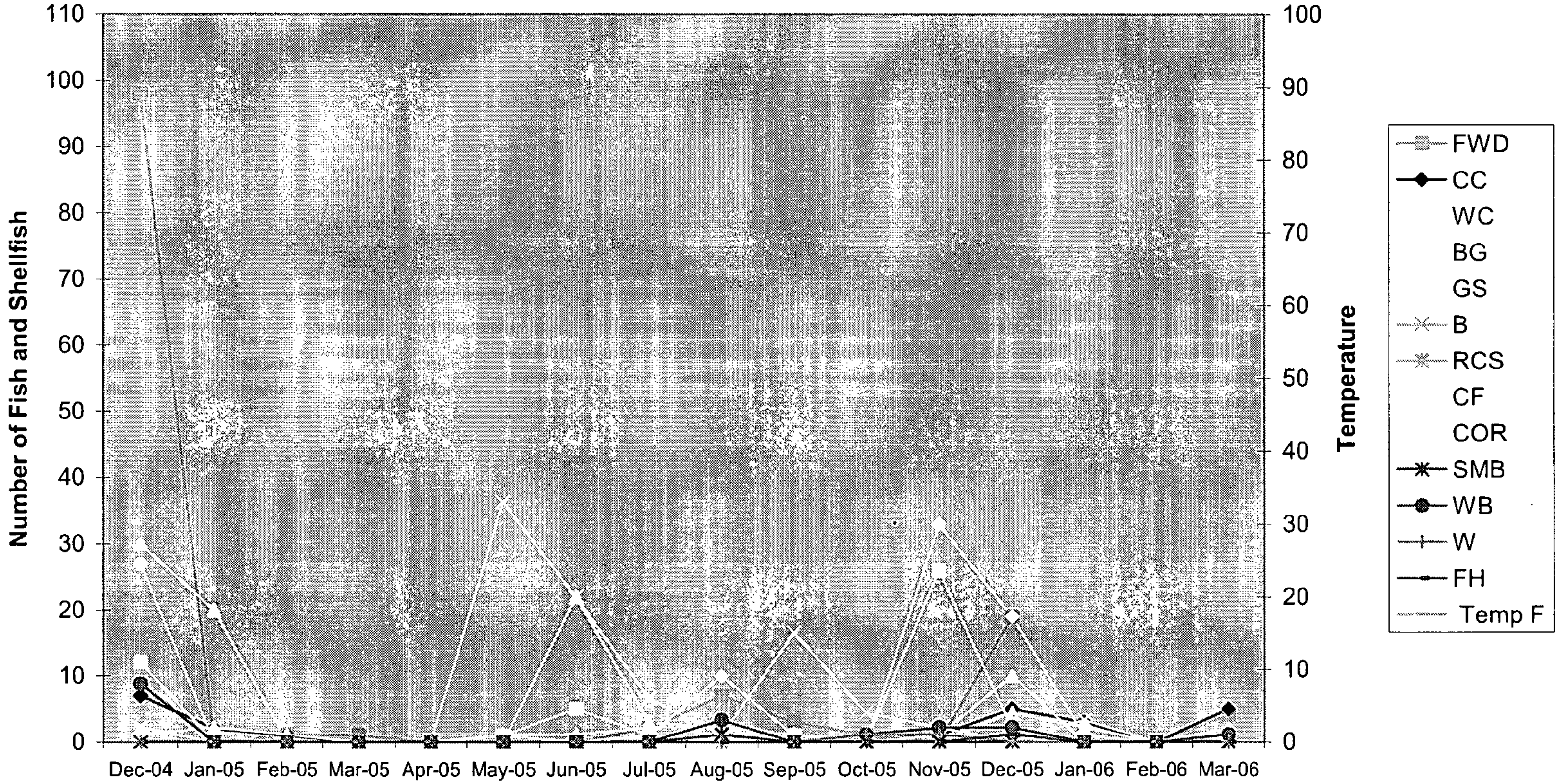
	# Anglers		Chan. catfish	White bass	Wiper hybrid	Smallmouth Bass	LM Bass	Crappie	Walleye	All fish
1999	9008	**No.**	6928	15,171	3503	17,482	3885	7382	31,027	86,464
		#/hour	0.15	0.32	0.07	0.37	0.08	0.15	0.65	1.82
		#/acre	1.36	2.98	0.69	3.43	0.76	1.45	6.10	16.99
2000	6865	**No.**	5191	7838	2267	12,579	4918	5536	21,599	61,102
		#/hour	0.15	0.23	0.07	0.36	0.14	0.16	0.63	1.77
		#/acre	1.02	1.54	0.45	2.47	0.97	1.09	4.24	12.00
2001	7449	**No.**	5623	8777	1810	10,136	4736	7457	20,911	60,417
		#/hour	0.16	0.25	0.05	0.28	0.13	0.21	0.59	1.70
		#/acre	1.10	1.72	0.35	1.99	0.93	1.47	4.11	11.87
2002	4227	**No.**	3949	3623	1649	8097	874	4563	11,785	31,807
		#/hour	0.19	0.17	0.08	0.38	0.04	0.22	0.56	1.65
		#/acre	0.77	0.71	0.32	1.59	0.17	0.90	2.31	6.84
2003	4751	**No.**	6057	8489	6838	8527	3193	5739	6740	45,895
		#/hour	0.25	0.34	0.27	0.35	0.13	0.23	0.27	1.86
		#/acre	1.19	1.67	1.34	1.67	0.63	1.13	1.32	9.02
2004	5674	**No.**	7175	6748	4553	8989	3096	6386	10,016	47,229
		#/hour	0.23	0.22	0.15	0.29	0.10	0.21	0.33	1.55
		#/acre	1.41	1.33	0.89	1.77	0.61	1.25	1.97	9.28
2005	5287	**No.**	10,619	8048	2683	7785	1420	4370	9457	44,629
		#/hour	0.37	0.28	0.09	0.27	0.05	0.15	0.33	1.54
		#/acre	2.09	1.58	0.53	1.53	0.28	0.86	1.86	8.77

Table 7. Catch-per-unit-of-effort (CPUE) of selected fish species in Wolf Creek Lake. Fall gill net, Fyke net, and electrofishing data were not collected in 2001 due to the September 11 events.

	Gizzard Shad	Gizzard Shad (YOY)	White bass	Wiper	Smallmouth Bass	Largemouth Bass	White Crappie	Walleye
1983	(1) 7		(1) 23	(1) 15		(2) 24.5	(3) 0	(1) 4
1984	25		18	11		45.0	6	29
1985	3		6	22		45.3	5	26
1986	32		25	14	(2) 1.3	34.5	5	9
1987	10		18	21	8.5	18.8	12	16
1988	12		28	26	10.5	22.0	9	19
1989	18		17	23	14.8	32.3	4	22
1990	10		34	12	12.0	14.0	5	13
1991	14		45	22	20.5	5.5	4	19
1992	19		17	9	10.8	8.3	6	22
1993	11		52	8	15.0	5.0	5	12
1994	9		61	11	12.5	2.0	4	23
1995	25		29	11	6.3	2.0	5	16
1996	9	(4) 22.9	19	3	10.8	0.3	9	20
1997	19	77.0	60	8	5.5	1.3	4	28
1998	18	39.9	45	6	10.5	1.5	3	16
1999	15	9.9	37	4	11	3.3	6	14
2000	18	29.4	36	13	21.5	3.0	(5) 9	28
2001	-	-	-	-	-	2.0	-	-
2002	11	3.5	32	4	2.0	1.0	6	8
2003	10	1.9	54	9	8.0	2.0	7	14
2004	12	5.5	33	6	34	0.8	-	20
2005	11	0.3	37	4	16	0.0	13	9

(1) Data from fall standard gill netting. Units equal number per gill-net-complement-night ≥ stock size.
(2) Data from spring electrofishing. Units equal number per hour shocked ≥ stock size. Shocking efforts starting in 2004 targeted prime habitats rather than standard locations as completed during prior years.
(3) Data from spring Fyke netting. Units equal number per trap-net-night ≥ stock size.
(4) Data from smallmesh gill net. Units equal number per net complement of one 0.5 and one 0.75 mesh net.
(5) Data beginning in 2000 were from fall Fyke netting. Netting not completed during 2004 due to adverse weather. Units equal number per trap-net-night ≥ stock size.

Figure 1. Total of All Impinged Species



LITERATURE CITED

Bruce Nuclear Generating Station. 1977. Fish Impingement at Bruce Nuclear Generating Station. Ontario Hydro Electric Company. 26 pp.

Carlander, K. D. 1977. Handbook of Freshwater Fishery Biology Volume Two. The Iowa State University Press, Ames, Iowa.

Colvin, M. A. 1993. Ecology and management of white bass: a literature review. Missouri Department of Conservation, Dingell-Johnson project F-1-R-42, Study I-31, Job 1, Final Report.

Cross, F. B. and J. T. Collins. 1995. Fishes In Kansas. second edition. University of Kansas Natural History Museum. 315 pp.

Dames & Moore. 1985. 316(b) Demonstration for the Virgil C. Summer Nuclear Station. Prepared for South Carolina Electric & Gas Company by Dames & Moore, Atlanta, Georgia. March.

Edwards, T. J., W. H. Hunt, L. E. Miller and J. J. Sevic. 1976. An Evaluation of the Impingement of Fishes at Four Duke Power Company Steam-generating Facilities. In Thermal Ecology II. Esch, G. W. and R. W. McFarlane, Editors. Technical Information Center of Energy Research and Development Administration. Pp. 373-380.

Federal Register. July 9, 2004. 40 CFR Parts 9, 122 et al. National Pollutant Discharge Elimination System – Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities; Final Rule.

Haines, D. E. 2000. Biological control of gizzard shad impingement at a nuclear power plant. Environmental Science & Policy 3: S257-S281.

Kansas Department of Health and Environment. 1975. Letter dated February 21, 1975 to M. Miller, Kansas Gas and Electric Company.

Kansas Gas and Electric Company. 1975. Letter KLKAN-039 from M. E. Miller (KGE) to M. Gray of Kansas Department of Health and Environment.

Kansas Gas and Electric Company (KGE). 1981. Makeup Screenhouse Impingement Monitoring Report, 1980-1981. Prepared by Wolf Creek Generating Station Environmental Management Group.

KDWP (Kansas Dept. of Wildlife and Parks). 2004. Kansas Fishing Forecast.

Kimmel, B. L. and A. W. Groeger. 1986. Limnological and Ecological Changes Associated with Reservoir Aging. Pages 103-109 *in* G. E. Hall and M. J Van Den Avyle, editors. Reservoir Fisheries management: Strategies for the 80's. Reservoir Committee, Southern Division American Fisheries Society.

Klemesrud, M. 2003. "Winter stress is causing gizzard shad to die. "From Iowa Outdoors, a publication of Iowa Department of Natural Resources. http://www.iowadnr.com/news/io/03feb25io.pdf.

Mosher, T. D. 2000. Assessment of a 254-mm Minimum Length Limit for Crappie in Three Northeastern Kansas Reservoirs Final Report. Kansas Department of Wildlife and Parks. Federal Aid Project No. FW-9-12 and F-30-R-1.

Muoneke, M. I., C. C. Henry, and O. E. Maughan. 1992. Population structure and food habits of white crappie *Pomoxis annualris* Rafinesque in a turbid Oklahoma reservoir. Journal of Fish Biology. Volume 1 Page 647 – October.

O'Brien W. J., B. Loveless, and D. Wright. 1984. Feeding Ecology of Young White Crappie in a Kansas Reservoir. North American Journal of Fisheries management; 4: p 341-349.

Olmstead, L.L. and J.P. Clugston. 1986. Fishery Management in Cooling Impoundments in Reservoir Fisheries Management, Strategies for the 80's. G. Hall and M. Van Den Avyle ed. American Fisheries Society. Bethesda, MD. 327 pp.

Ontario Hydro. 1977. Winter studies of gizzard shad at Lambto GS-1976-77. Ontario Hydro Research Division Report. No. 77-400-K. 47pp.

Pennsylvania Angler & Boater. 2001. "The Basics of Water Pollution in Pennsylvania." Pennsylvania Angler & Boater Magazine (online), a publication of the Pennsylvania Fish & Available online at http://www.fish.state.pa.us/anglerboater/2001/jf2001/wpollbas.htm.
Schoenung, B. 2003. Fish and Wildlife Research and Management Notes. Indiana Department of Natural Resources, Division of Fish and Wildlife. Available online at http://www.state.in.us/dnr/fishwild/publications/notes/boggs.htm.

Sargent & Lundy. 1979. Design Criteria for Cooling Lake Makeup water and Blowdown System.

Scott, W.B., and E. J. Crossman. 1973. *Freshwater Fishes of Canada*. Bulletin 184, Fisheries Research Board of Canada. Ottawa.

Smitherman, R.O., and R. A. Dunham. 1993. Relationships Among Cultured and Naturally Occurring Populations of Freshwater Catfish in the United States. ***In*** (Collie and McVey, Eds) Proceedings of the Twenty-Second U.S.-Japan Aquaculture Panel Syposium, August 21-22, 1993, Homer, Alaska.

South Carolina Electric & Gas Company. 2002. Appendix E --- Applicant's Environmental Report, Operating License Renewal Stage, Virgil C. Summer Nuclear Station. August.

United States Nuclear Regulatory Commission (NRC). 1975. Final Environmental Statement (FES) for Wolf Creek Generating Station. NUREG-75/096.

Virginia Power. 1985. Impingement and Entrainment Studies for North Anna Power Station, 1978-1983. Prepared by Virginia Power Water Quality Department, Richmond.

WCNOC. 2006. 2005 Fishery Monitoring Report and 2006 Plan. Internal documents.

Wedd, G. R. 1985. Observation On Neosho River Larval Fish In Coffey County, Kansas. The Emporia State Research Studies. Vol. XXXXIV, Number 1. Emporia State University. Pp 56.

Wellborn, T. L. 1988. Channel Catfish: Life History and Biology. Southern Regional Aquaculture Center, Texas A&M University, College Station, Texas. SRAC Publication No. 180.

White, Andrew M., F. D. Moore, N. A. Alldridge, and D. M. Loucks. 1986. The Effects of Natural Winter Stresses on the Mortality of the Eastern Gizzard Shad, Dorosoma cepedianum, in Lake Erie. Environmental Resource Associates, Inc. and John Carrol University, for The Cleveland Electric Illuminating Company and The Ohio Edison Company. 208 pp.

Willis, D. W. 1986. Review of Water Level Management on Kanss Reservoirs. Pages 110-114 *in* G. E. Hall and M. J Van Den Avyle, editors. Reservoir Fisheries management: Strategies for the 80's. Reservoir Committee, Southern Division American Fisheries Society.

Wolf Creek Nuclear Operating Corporation. 2006. Withdrawal of Water from the Neosho Riverand John Redmond Reservoir. AP 26A-006. Revision Number 0A. Internal Procedure.

Exhibit 1

(KAN LK)

State of Kansas . . . ROBERT F. BENNETT, *Governor*

DEPARTMENT OF HEALTH AND ENVIRONMENT

DWIGHT F. METZLER, *Secretary*

Topeka, Kansas 66620

February 21, 1975

~~42297-W~~
42115

Mr. Mike Miller
Environmental Coordinator
Kansas Gas & Electric Company
Post Office Box 208
Wichita, Kansas 67201

Re: Wolf Creek Generating Station

Dear Mr. Miller:

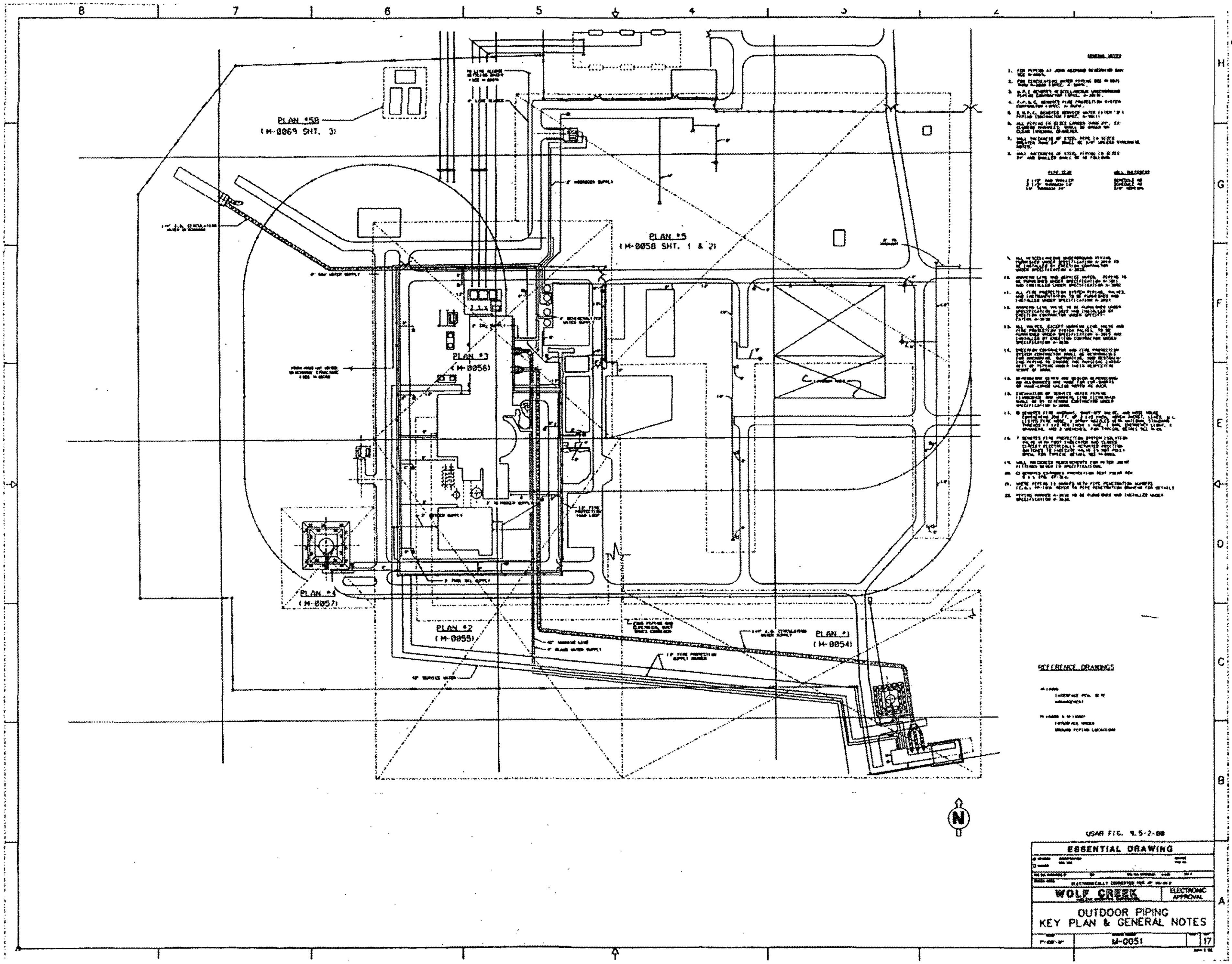
In response to your request for a formal statement by the Kansas Department of Health and Environment on the possible recreational uses of the Wolf Creek facility, the following is offered.

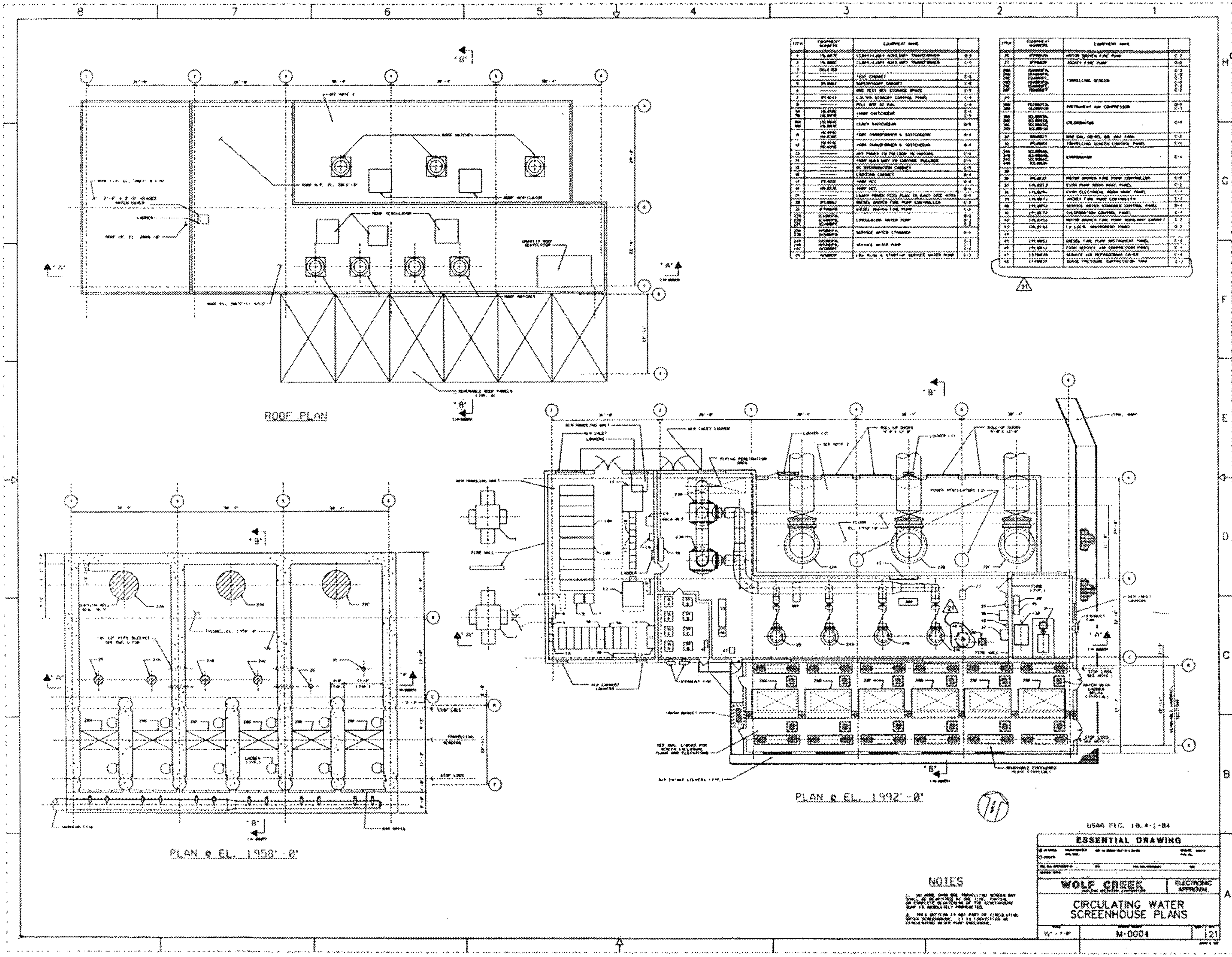
It is the Department's hope that the impounded water and the adjacent land to the lake will be utilized to its fullest extent from the standpoint of providing a public recreational area and/or a fish rearing facility for the Kansas Fish and Game Commission. As stated in the previous meetings concerning the Wolf Creek Generating Station, we are of the opinion that the Kansas Gas and Electric Company controls the impounded water and thus will not be held responsible if its degradation is such that the water becomes unsuitable, as outlined by Regulation 28-16-28 of the Kansas Department of Health and Environment, for body contact sports or fishing. As I have expressed in previous meetings, the water quality of the cooling lake shall be maintained so as to not adversely affect, in the judgement of the Kansas Department of Health and Environment, the ground water. It is also our opinion that the Kansas Gas and Electric Company shall not be held responsible for the loss of fish in the lake due to cold shock kill, impingement, or entrainment.

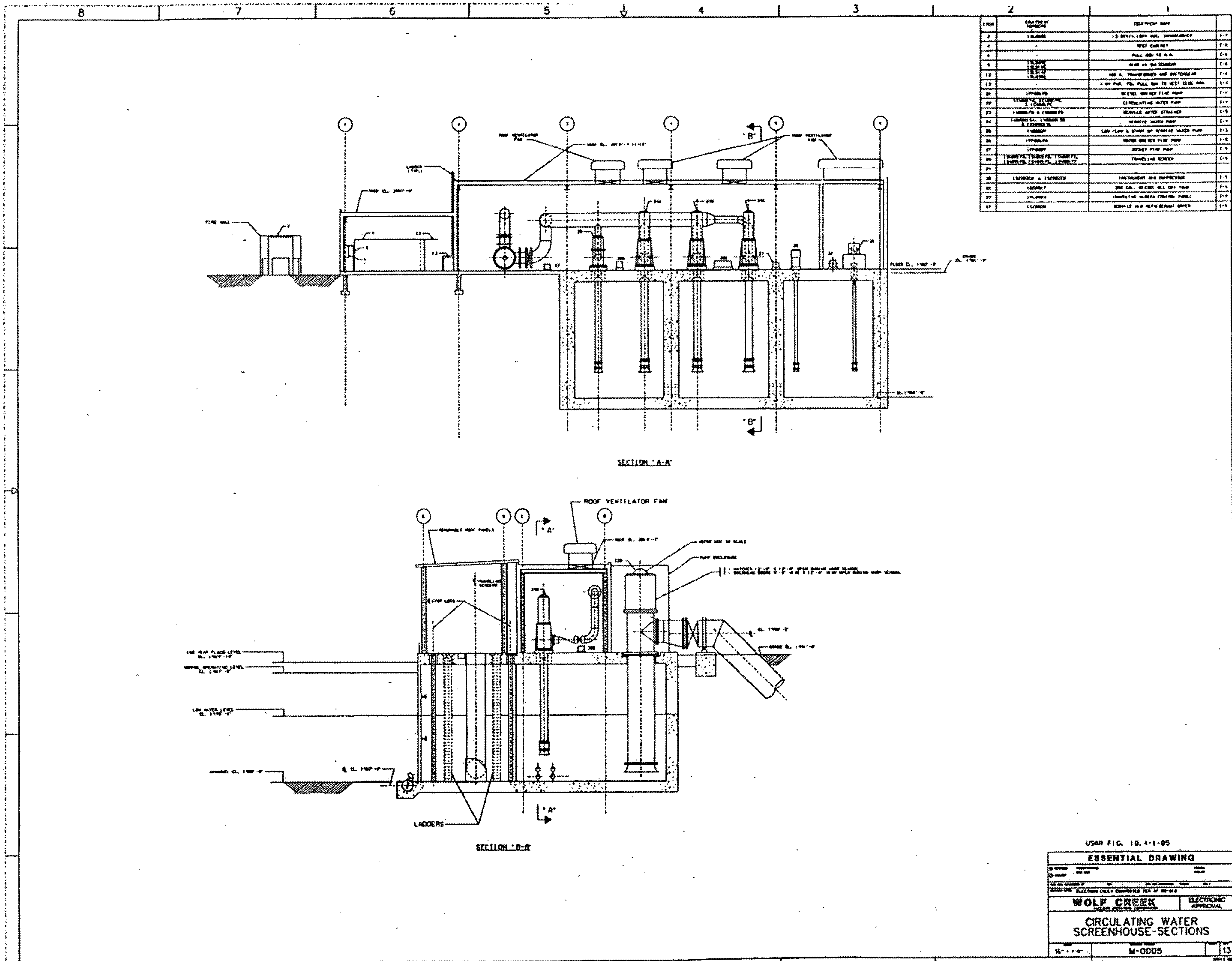
Sincerely yours,

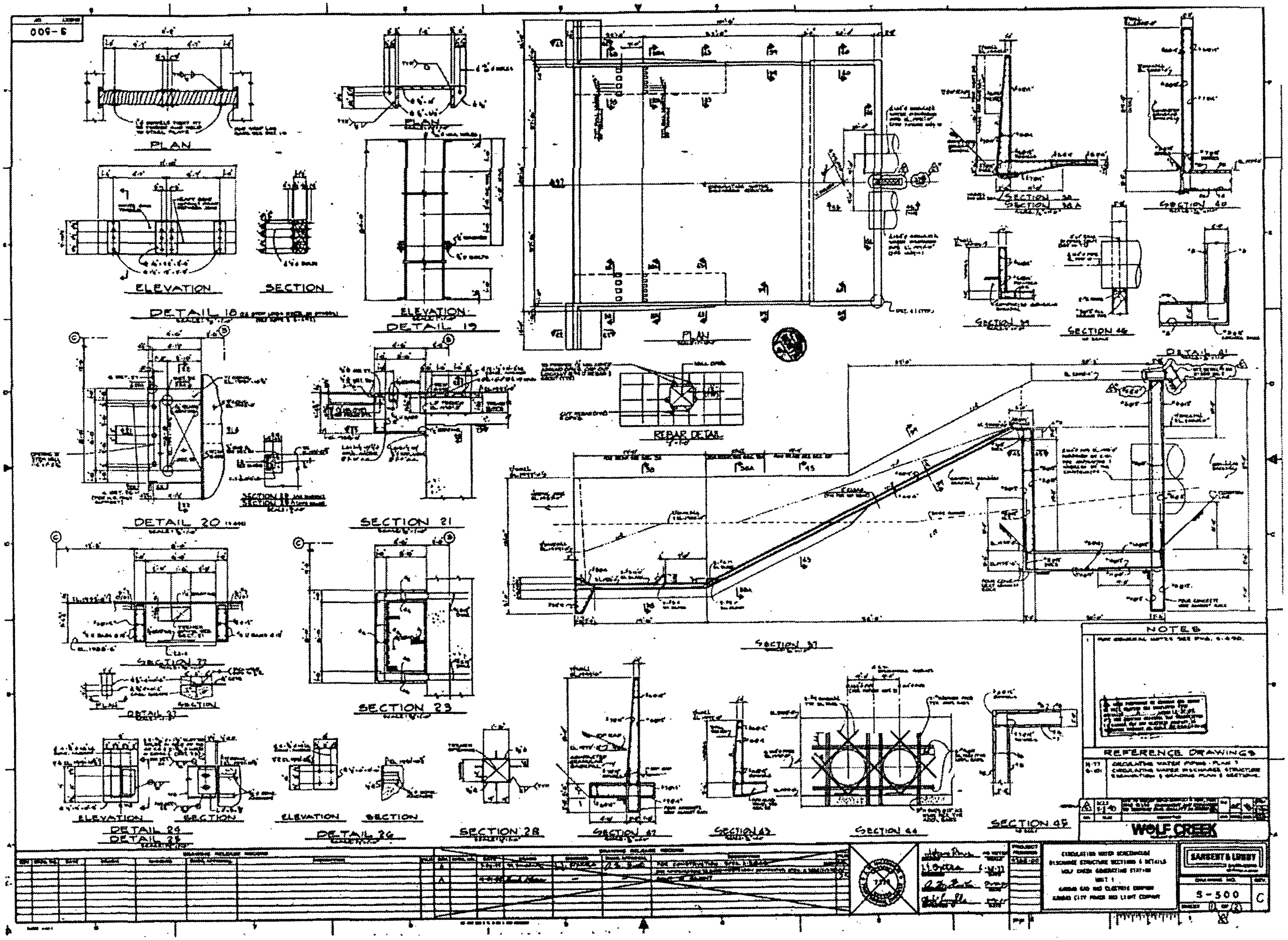
Melville W. Gray, P.E.
Director
Division of Environment

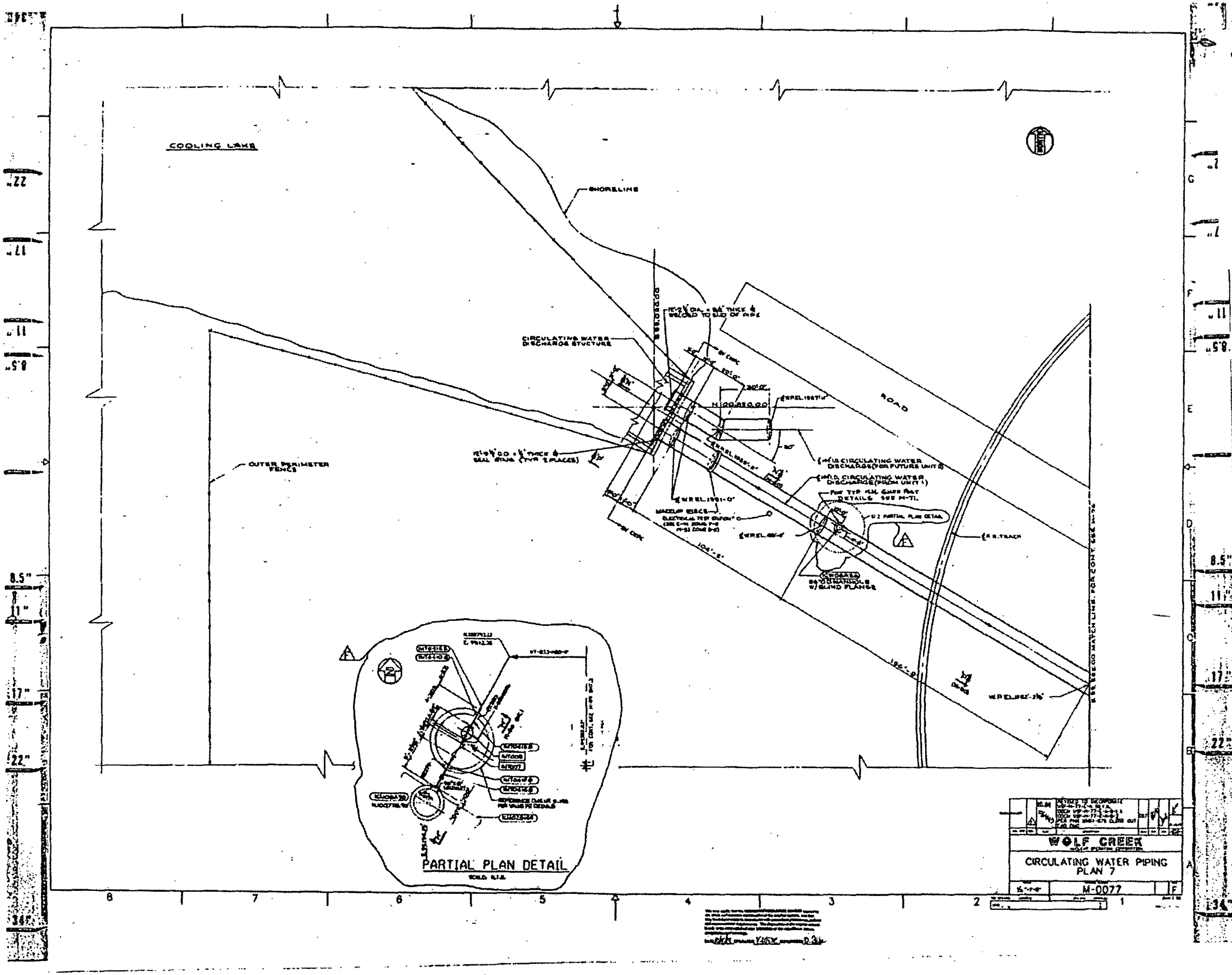
MWG:jac

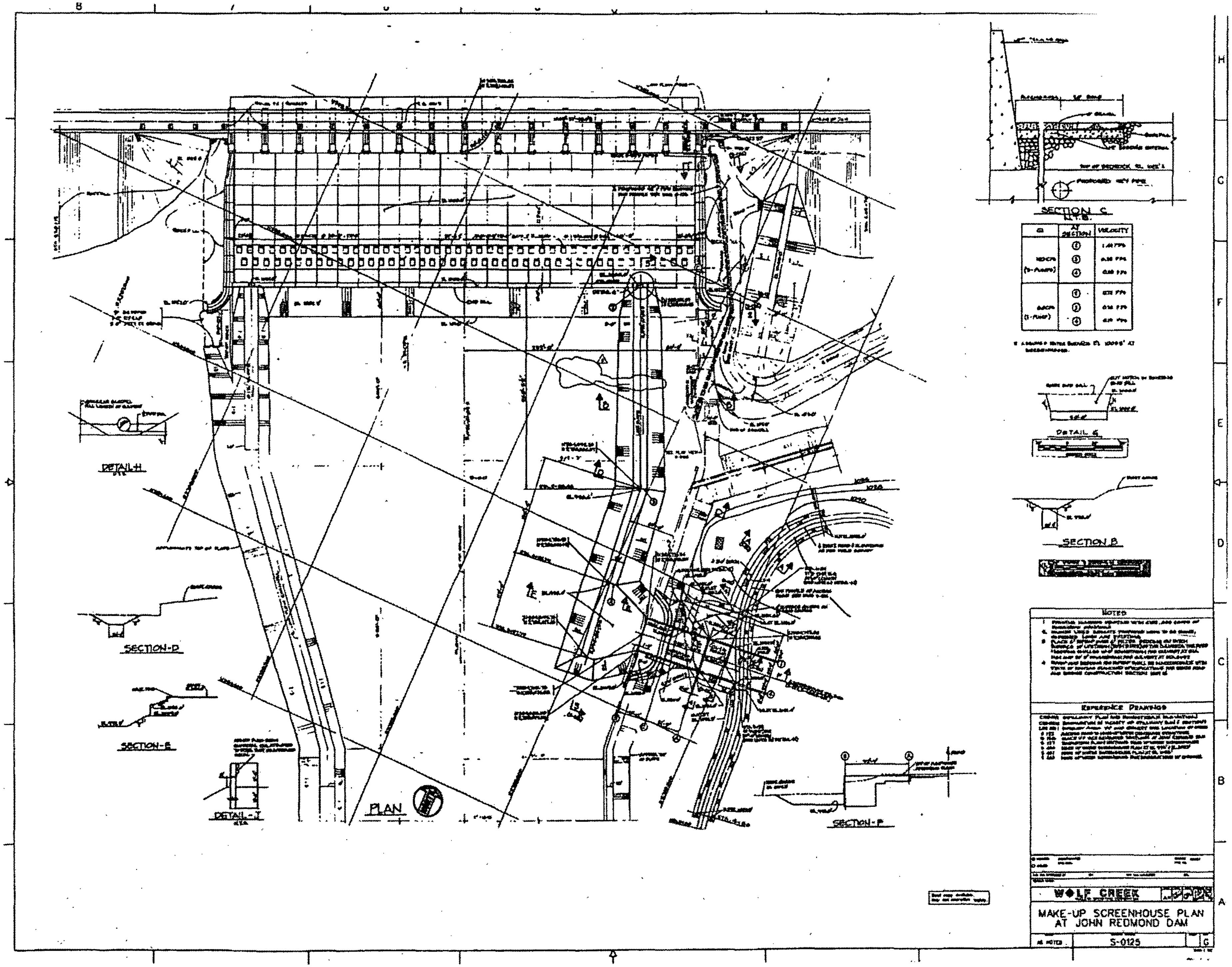

PLAN #5B
(M-0069 SHT. 3)
PLAN #5
(M-0058 SHT. 1 & 2)
PLAN #3
(M-0056)
PLAN #4
(M-0057)
PLAN #2
(M-0055)
PLAN #1
(M-0054)
REFERENCE DRAWINGS
N
USAR FIG. 9.5-2-08
ESSENTIAL DRAWING
WOLF CREEK
ELECTRONIC APPROVAL
OUTDOOR PIPING
KEY PLAN & GENERAL NOTES
M-0051
17


ROOF PLAN
PLAN @ EL. 1958'-0"
PLAN @ EL. 1992'-0"
NOTES
USAR FIG. 10.4-1-04
ESSENTIAL DRAWING
WOLF CREEK
ELECTRONIC APPROVAL
CIRCULATING WATER
SCREENHOUSE PLANS
M-0004
21
Released by Document Services Release Date: 06/23/06


SECTION "A-A"
ROOF VENTILATOR FAN
LADDERS
SECTION "B-B"
USAR FIG. 10.4-1-05
ESSENTIAL DRAWING
WOLF CREEK
ELECTRONIC APPROVAL
CIRCULATING WATER SCREENHOUSE-SECTIONS
M-0005
13


PLAN
ELEVATION
SECTION
DETAIL 18
ELEVATION
DETAIL 19
PLAN
REBAR DETAIL
SECTION 34
SECTION 40
SECTION 46
DETAIL 20
SECTION 21
SECTION 37
NOTES
REFERENCE DRAWINGS
WOLF CREEK
SECTION 22
SECTION 23
ELEVATION
SECTION
DETAIL 24
DETAIL 25
ELEVATION
SECTION
DETAIL 26
SECTION 28
SECTION 47
SECTION 43
SECTION 44
SECTION 45
SARGENT & LUNDY
S-500
C


COOLING LAKE
SHORELINE
CIRCULATING WATER DISCHARGE STRUCTURE
ROAD
OUTER PERIMETER FENCE
PARTIAL PLAN DETAIL
WOLF CREEK
CIRCULATING WATER PIPING PLAN 7
M-0077


SECTION C
N.T.S.
DETAIL-H
DETAIL E
SECTION B
SECTION-D
SECTION-E
DETAIL-J
PLAN
SECTION-F
NOTES
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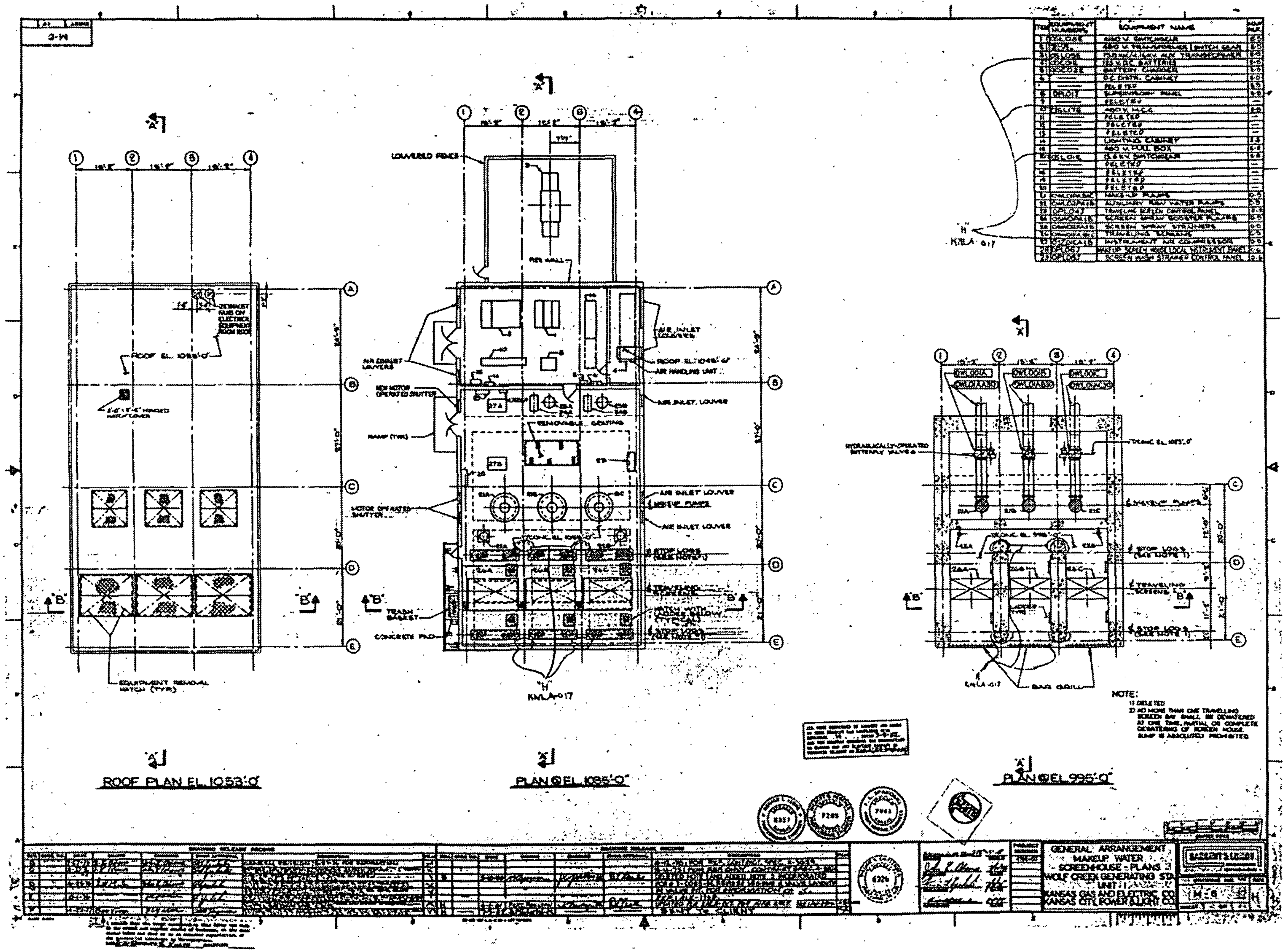
WOLF CREEK
MAKE-UP SCREENHOUSE PLAN
AT JOHN REDMOND DAM
AS NOTED
S-0125
G


EQUIPMENT NAME
LOUVERED FENCE
AIR EXHAUST LOUVERS
AIR INLET LOUVERS
AIR HANDLING UNIT
AIR INLET LOUVER
REMOVABLE GRATING
RAMP (TYP)
MOTOR OPERATED SHUTTER
MAKEUP PUMPS
TRASH BASKET
CONCRETE PAD
TRAVELING SCREENS
STOP LOGS (SEE NOTE 1)
EQUIPMENT REMOVAL HATCH (TYP)
HYDRAULICALLY-OPERATED BUTTERFLY VALVES
BAR GRILL
ROOF PLAN EL. 1053'-0"
PLAN @ EL. 1085'-0"
PLAN @ EL. 995'-0"
NOTE:
1) DELETED
2) NO MORE THAN ONE TRAVELLING SCREEN BAY SHALL BE DEWATERED AT ONE TIME. PARTIAL OR COMPLETE DEWATERING OF SCREEN HOUSE SUMP IS ABSOLUTELY PROHIBITED.
GENERAL ARRANGEMENT MAKEUP WATER SCREENHOUSE - PLANS
WOLF CREEK GENERATING STA
UNIT 1
KANSAS GAS AND ELECTRIC CO
KANSAS CITY POWER & LIGHT CO
BECHTEL
M-1

[illegible]	EQUIPMENT NUMBER	EQUIPMENT NAME	[illegible]
1	[illegible]	480 V. SWITCHGEAR	[illegible]
[illegible]	[illegible]	[illegible] TRANSFORMER	[illegible]
[illegible]	[illegible]	SUPERVISORY PANEL	[illegible]
[illegible]	[illegible]	MAKE UP PUMPS	[illegible]
[illegible]	[illegible]	AUXILIARY RAW WATER PUMP	[illegible]
[illegible]	[illegible]	SCREEN SPRAY BOOSTER PUMP	[illegible]
[illegible]	[illegible]	SCREEN SPRAY STRAINER	[illegible]
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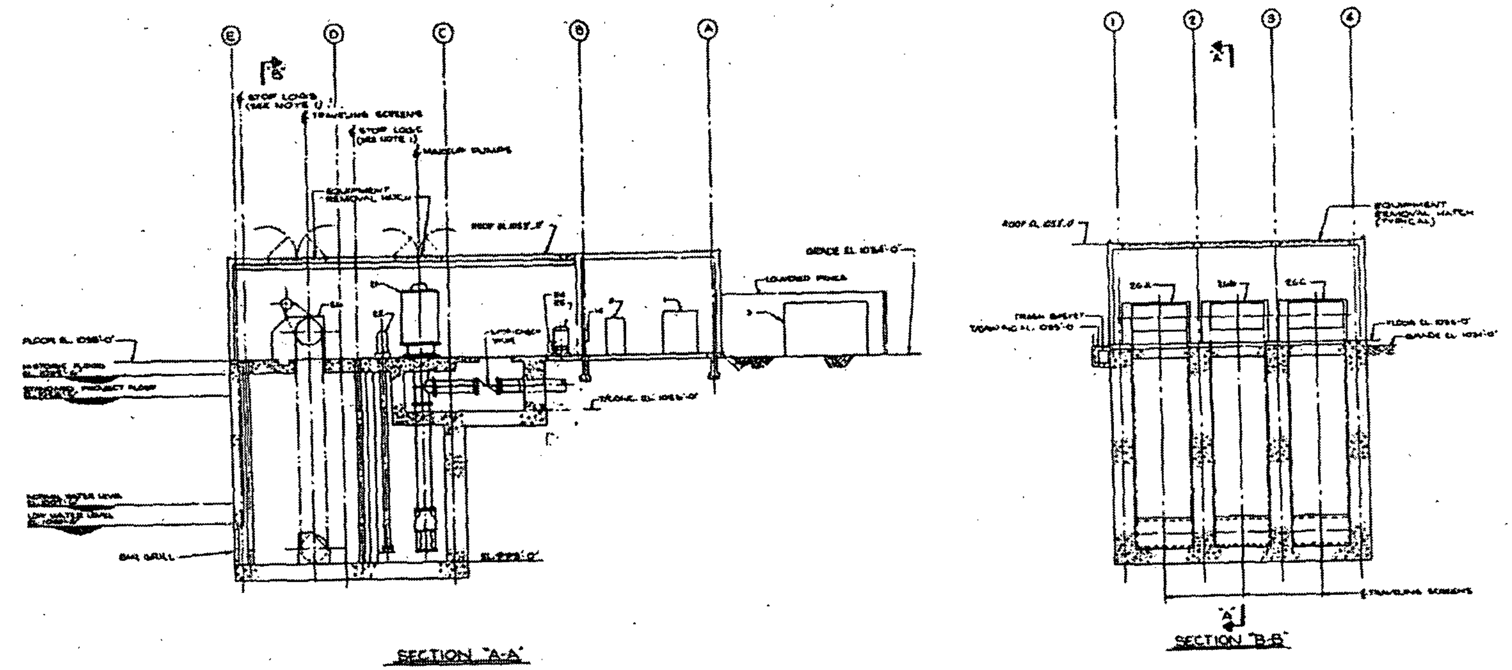
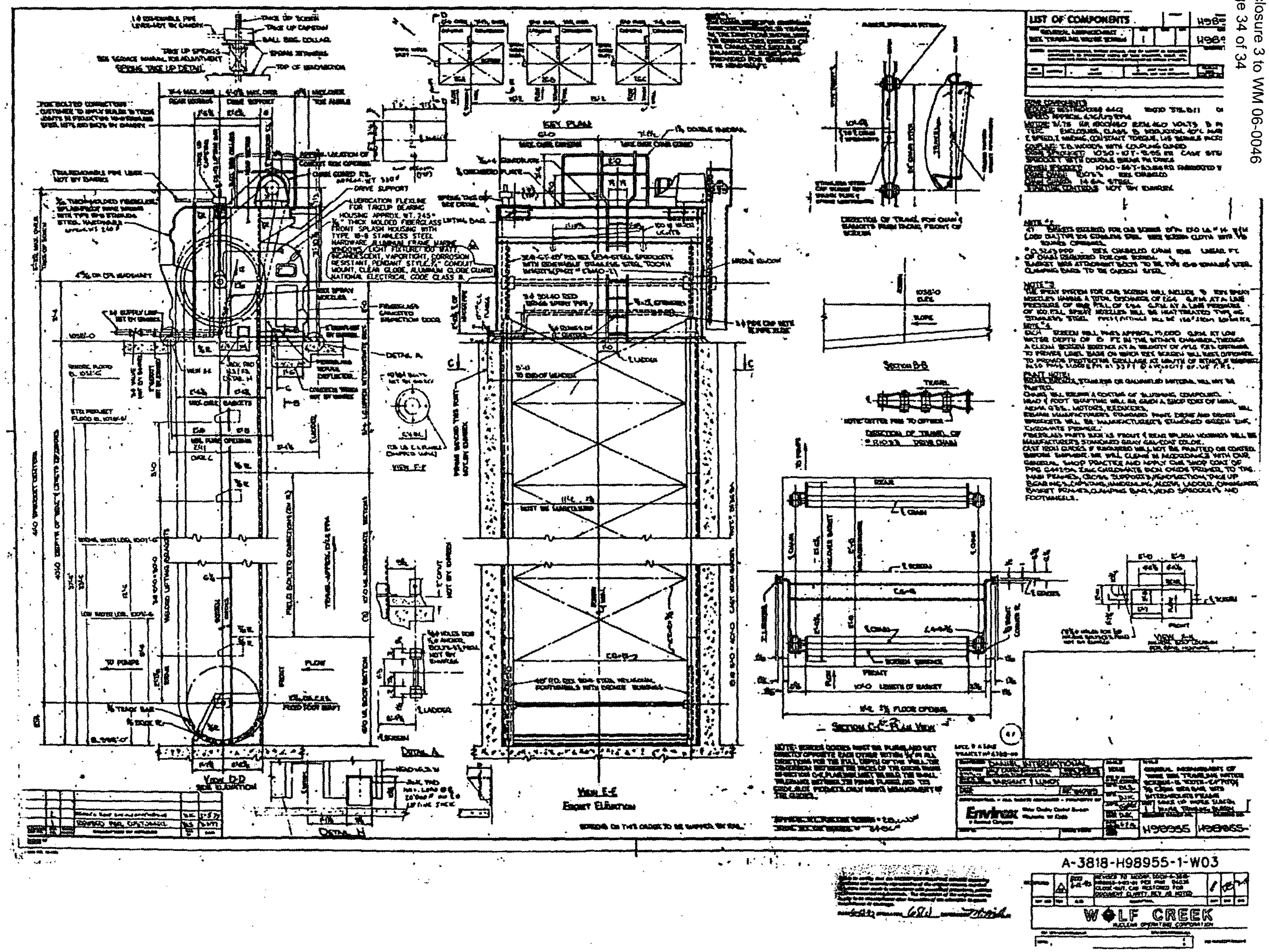


WOLF CREEK

GENERAL ARRANGEMENT
MAKEUP WATER
SCREENHOUSE-SECTIONS

M-0007


LIST OF COMPONENTS
SPRING TAKE UP DETAIL
KEY PLAN
SECTION B-B
VIEW E-E
FRONT ELEVATION
VIEW D-D
SIDE ELEVATION
DETAIL A
DETAIL H
SECTION C-C PLAN VIEW
FRONT
FLOW
TO PUMPS
Envirex
H98955
A-3818-H98955-1-W03
WOLF CREEK
NUCLEAR OPERATING CORPORATION

An Assessment of the Potential Impacts on on Fish and Shellfish Resources from Heat Shock Related to the Operating License Renewal for Wolf Creek Generating Station.

(Supplement to Appendix E Section 4.4 to Wolf Creek Generating Station Environmental Report Operating License Renewal Stage)

An Assessment of the Impact on Fish and Shellfish Resources from Heat Shock

Related to the Operating License Renewal for Wolf Creek Generating Station, Unit No. 1

INTRODUCTION

This is an assessment of the impact on fish and shellfish resources resulting from heat shock. This assessment is in support of discussion presented in the Environmental Report – Operating License Renewal Stage (ER-OLRS, Section 4.4). This assessment considers conclusions presented during original licensing, correspondence between WCGS and the Kansas Department of Health and Environment (KDHE), NPDES permit history, environmental monitoring studies, and operational experience.

NRC made impacts on fish and shellfish resources resulting from heat shock a Category 2 issue, because of continuing concerns about thermal discharge effects and the possible need to modify thermal discharges in the future in response to changing environmental conditions (NRC 1996). Information to be ascertained includes: (1) type of cooling system (whether once-through or cooling pond) and (2) evidence of a Clean Water Act Section 316(a) variance or equivalent state documentation.

As Section 3.1.2 of the ER-OLRS describes, WCGS has a once-through heat dissipation system, but withdraws from and discharges to a cooling pond, Coffey County Lake (CCL). WCGS received Permit No. I-NE07-P002 to discharge under the NPDES, which has been approved by the Administrator of the U.S. Environmental Protection Agency pursuant to Section 402(b) of the Federal Water Pollution Control Act Amendments of 1972 [33 USC 1342 (b)].

Based on the criteria set forth in Section 306 of PL 92-500 and U.S. EPA regulations 40 CFR 423 and information submitted by Kansas Gas and Electric Company, the Kansas Department of Health and Environment (KDHE) determined that the WCGS is exempt from federal thermal standards and that studies pursuant to Section 316(a) of PL 92-500 are not required. However, the WCGS is subject to the Water Quality Criteria for Interstate and Intrastate Waters of Kansas (WCGS 1980). The current WCGS NPDES Permit (No. I-NE07-P002) (see Attachment B of ER-OLRS) does not contain thermal effluent limitations.

Cooling System Operation

The WCGS cooling lake (Coffey County Lake) is a man-made lake formed by the construction of a main dam across Wolf Creek and several saddle dams. The cooling lake provides a continuous supply of cooling water to the WCGS. Figure 1 illustrates the cooling lake, John Redmond Reservoir, Neosho River, and inflows to and outflows from the system (Sargent & Lundy 1976).

Condenser cooling water is withdrawn from CCL through the circulating water intake structure. After passing through the condenser, the warmed water is returned to Coffey County Lake at the circulating water discharge structure (Figure 3-1, ER-OLRS). This structure has a discharge well which overflows into a 40-foot wide apron and then onto the surface of CCL. The heated effluent is discharged from the circulating water discharge structure into an approximately 290-acre cove in CCL (Figure 2). A baffle dike (Baffle Dike B) directs the effluent along a northwesterly path as it leaves the discharge cove to lengthen the flow path through the cooling lake (EA 1985). During the winter, operators may align the circulating water system to direct a fraction of the warmed discharge back to the circulating water intake structure to prevent freezing.

COOLING LAKE ASSESSMENT

Impact Baseline

The WCGS Environmental Report Operating License Stage (ER-OLS) evaluated the effects of released heat from operation of WCGS on aquatic biota in the cooling lake. The ER-OLS concluded that the cooling lake should provide suitable habitat for aquatic biota during operation of WCGS. An area near the immediate discharge zone will be most affected by thermal input since the predicted 1 percentile temperatures during spring, summer, and fall (104.1-116.5 F) will exclude most aquatic organisms. The extent of the area/volume of the cooling lake affected by the thermal input will vary depending on meteorological factors. Thermal stratification in the cooling lake will reduce the volume of the water affected. Unaffected areas (including bays and the area of the cooling lake upstream of the station) will provide suitable habitat and refuge areas when high discharge temperatures exceed different fish species thermal tolerance limits. In general, the released heat is expected to extend the growing season for some organisms and will affect distribution of others (WCGS 1980).

Agency Consultations

November 14, 1974 (Koester 1974)
In a letter to the Kansas State Department of Health and Environment (KDHE), Kansas Gas and Electric Company (KGE) requested that KDHE grant KGE an exception from the requirements as set forth in Section 316(a) of the Federal Water Pollution Control Act. KGE qualified for the exception, based on the “construction” portion thereof as defined in the Act in that, prior to the publication of the proposed regulations, KGE was contractually obligated to purchase facilities, equipment, and land for the site.

Exhibit 1 - December 13, 1974 (Gray 1974)
KDHE responded to the KGE request of November 14, 1974 with a letter granting an exemption from the requirements of 316(a) of PL 92-500.

Exhibit 2 - April 4, 1975 (Koester 1975)
KGE responded to the KDHE letter of December 13, 1974 stating that “because the WCGS is exempt from any limitation on thermal discharge, Kansas Gas and Electric Company is not planning to develop the type of demonstration required by Section 316(a).”

Exhibit 3 - April 10, 1975 (Carlson 1975)
KDHE responded to KGE’s April 4, 1975 letter stating that “...Mr. Gray’s letter, to you dated December 13, 1974, is intended to exempt the Wolf Creek Generating Station from only Federal limitations dealing with the discharge of heat from Steam Electric Generating Point Sources. As we have pointed out in previous meetings, between the Kansas Gas and Electric Company and the Kansas Department of Health and Environment, the exemption from any Federal limitation on the discharge of heat does not in any way exempt or imply that the Wolf Creek Generating station is exempted from the Water Quality Criteria for Interstate and Intrastate Waters of Kansas as outlined in Regulation 28-16-28.”

Monitoring Data

Thermal discharges from electric generating stations elevate water temperature above ambient conditions of the receiving water body. A general assessment of effects of operation of heat dissipation systems was provided in the ER-OLS and in the final environmental statement (FES) prepared by the U.S. Nuclear Regulatory Commission staff. These earlier assessments were prepared before the CCL, (sometimes referred to as Wolf Creek Cooling Lake) fishery was established and were based on predicted water temperature modeled with historical meteorological data and several assumptions related to operation of WCGS and CCL (EA 1985).

In the ER-OLS, the computer model used to calculate the CCL temperature distribution simulated the effects of varying meteorological conditions and plant heated discharge on the surface temperatures and evaporation rates of a lake. The calculated fall and winter temperatures, which were provided in 1 and 50 percentile groups, were used for the ER-OLS assessments. Realistically, the discharge velocity and mixing characteristics of the plume would reduce the absolute temperatures to which fish would be exposed (EA 1985).

Field temperature measurements by KGE in the immediate discharge area during late September and October 1985 were 4 to 7^0 F lower than the condenser outlet temperature. It is not clear in the ER-OLS whether the calculated discharge temperatures are condenser outlet or actual discharge temperatures; however, based on the 18 second travel time through the condensers, the lower discharge temperatures measured by KGE represents rapid cooling as the discharge jet enters the lake. Therefore, assuming the modeled temperatures are at the immediate point of discharge they would represent worst-case conditions because the high jet velocity and apparent rapid cooling would result in fish being exposed to lower absolute temperatures. Additionally, vertical temperature distributions measured in the discharge cove on October 25,1985 exhibited substantial vertical and horizontal heterogeneity. This heterogeneity reduces the amount of warm water available to fish and provides a thermal refuge for fish that may be attracted to the discharge cove for reasons other than the warmer water (e.g., seeking forage and/or flowing water habitat). Vertical stratification in the discharge cove also suggests the ER-OLS modeled temperatures may not be realistic because the model assumed a well-mixed, homogeneous temperature distribution (EA 1985).

The apparent rapid mixing of the discharge and the surface plume discussed reduces the volume of water with maximum discharge temperatures. The vertical and horizontal temperature distribution in the discharge cove should provide thermal refuges for species that may only move into the plume to forage (e.g., striped bass) (EA 1985). Any thermal plume impacts can be considered to be very localized due to the relatively small area (~290 acres) that the discharge cove represents relative to the 5,090 acre CCL. Apparent vertical and horizontal distribution of temperatures in the cove also suggest the area of maximum influence (i.e., plant discharge temperatures) is even smaller.

Thermal behavior of the discharge cove is important to further quantify so that horizontal and vertical temperature distributions throughout the cove can be understood. Data was primarily collected between October 16, 1985 and February 25, 1986. Eighteen locations were sampled throughout the cove for thermal data(Figure 2). Variables such as the delta T, number of circ pumps, wind, and cove morphology were shown to strongly affect this behavior (WCNOC 1987).

Wind plays a large role in discharge cove temperature distribution. A strong south wind greatly lengthens the path of discharged water, which expands the heated area. Conversely, strong north, east, or northeast winds force the discharge current tightly against Baffle Dike B and quickly out of the cove.

The most morphologically important features of the discharge cove are the two arms to the north and the deepwater area in its center (WCNOC 1987). Both are thermally isolated from water movements during normal operations. The two arms extending to the north of the cove are, in the absence of a strong south wind, thermally isolated and near ambient temperature. The deep portion of the cove will remain near ambient temperatures with only the overlying strata being affected by the warmwater discharge during extended periods of normal plant operations. As such, this deepwater area could offer a thermal intergrade.

Thermal impacts to the Fish and Shellfish

The impact on the aquatic biota from the discharge of heated water into CCL was evaluated by the NRC (1975, Section 5.5.2.3) and much of this evaluation remains applicable for WCGS impacts. Lake monitoring revealed surface temperatures similar to those expected (NRC 1975, EA 1988). Considering data prior to and including 1992, stratification patterns in CCL appear to have been independent of WCGS in parts of the lake away from the thermal plume. No stratification, which would have been detrimental to the lake's fishery or productivity, was observed (WCNOC 1993).

As discussed earlier, characteristics of the thermal plume into CCL were more intensively studied during initial operation by WCNOC to determine impacts to the fishery (WCNOC 1987). Vertical and horizontal temperature profiles were assessed in the thermal discharge area of CCL. Vertical transects revealed plume shape and thermal refuges in the discharge cove.

Horizontal temperature profiles showed that the thermal plume remained perched on the surface throughout most of the discharge area. With WCGS at or near full power, the plume depth was typically 10 to12 feet. Water temperatures below that depth often were similar to the cooler WCGS intake area. In effect, this artificial stratification provides a thermal refuge, and a zone of passage for fish within the thermally influence area of CCL.

Fish thermal distribution and preference were determined by electrofishing in the discharge area and correlating fish numbers with water temperatures (WCNOC 1987). As the ambient lake temperatures cooled to below 50^{O} F, fish species moved into the thermal plume, which was about 80^{O} F. This occurred typically during October through March. When ambient temperatures rose above 50^{O} F, fish species left the plume area according to their preferred temperatures.

No fish mortality resulting from heat shock has been observed in the lake. There are no wintering areas or migration routes affected by the heated plume. Because fish avoid the plume at higher temperatures, feeding, spawning, and nursery areas would be unavailable to them during those periods. Substrate types in the discharge cove (~290 acres) include clay and sediment, with rip-rap along Baffle Dike B. These substrate types, and others such as gravel, rock, and aquatic vegetation are prevalent in areas not thermally affected.

During colder periods when fish were attracted to the plume temperatures, many species have used the area. For example, early spawning and greater growth of young-of-year gizzard shad has been suggested as beneficial to important recreational and commercial species in CCL, and thus preventing excessive impingement at the intake screens (Haines 2000). See Enclosure 4.3 for further details.

Conclusion

An area near the immediate discharge zone will be most affected by thermal input. The extent of the area/volume of the cooling lake affected by the thermal input is small relative to the 5,090 acre cooling lake and varies with meteorological factors. Thermal stratification in the cooling lake reduces the volume of the water affected. Unaffected areas (including bays and the area of the cooling lake upstream of the station) will provide suitable habitat and refuge areas when high discharge temperatures exceed different fish species thermal tolerance limits. Acute thermal impacts (e.g., death of immediate disability) are unlikely. Therefore, WCNOC concludes that impacts to fish and shellfish in CCL from heat shock are SMALL and that mitigative measures are not warranted.

NEOSHO RIVER ASSESSMENT

Agency Consultations

The KDHE has determined that "the Water Quality Criteria of the State of Kansas will be enforced in the Neosho River, below the confluence of the Wolf Creek, except for an appropriate mixing zone. The State Water Quality Criteria will not apply to the Wolf Creek, which is unclassified under the State Water Quality Criteria. In general, the effluent limitations to be stipulated in the National Pollutant Discharge Elimination System (NPDES) permit will apply at the point the cooling lake discharges into Wolf Creek (WCGS 1980, Carlson 1976).

WCGS discharges into the Neosho River are regulated by WCGS NPDES permit limitations. Since discharges are sporadic, water is sampled on the first day of each discharge and weekly thereafter. In 1985, the first year of Wolf Creek operation, effluent parameters measured included a flow rate estimate, temperature, pH, TDS, sulfate and chloride concentration. Wolf Creek additions to the Neosho River were regulated to maintain a zone of passage for aquatic organisms at the confluence. Consequently, the flows allowable from Wolf Creek may have ranged from zero to unrestricted, depending upon the similarity between Wolf Creek and the Neosho River water quality and temperature, with a maximum of 90^0 F allowable in the Neosho River downstream of the mixing zone. In 1985, no NPDES violations at the cooling lake discharge were recorded. Also, based on monitoring studies by Ecological Analysts, there had been no apparent deleterious effects to Neosho River water quality on phytoplankton, macroinvertebrate or fish populations (Koester 1986).

Until September 1994, effluent parameters measured included a flow rate estimate, temperature, pH, total dissolved solids, sulfate, and chloride concentration (WCNOC 1995). Discharges of these parameters were regulated to maintain a zone of passage in the Neosho River for aquatic organisms at the Wolf Creek confluence. Consequently, the flows allowed from Coffey County Lake may have ranged from zero to unrestricted, depending upon water quality and temperature similarities with the Neosho River. In September, 1994, a new NPDES permit set discharge limits from the lake for sulfates, chlorides, and pH with no flow restrictions based on the water quality in the Neosho River.

Monitoring Data

The original monitoring program's objectives since plant construction were to satisfy licensing requirements and assess plant impacts. This monitoring began in the Neosho River during 1973 and was initiated in CCL after impoundment to fulfill regulatory commitments (KGE 1981, NRC 1982). The monitoring was to continue through at least two years of plant operation, which was satisfied in 1987. No adverse impacts greater than evaluated in licensing documents were identified (WCNOC 1997). Since 1987, the scope was greatly reduced to target key water quality indicators chosen to either add to baseline data or to reflect long-term operational impacts beyond monitoring commitments. With these objectives being met in 1993, monitoring frequency and scope were further reduced. Frequency was changed to a biennial schedule beginning in 1995 with the program scope focusing on long term trends associated with plant operation. After analyses of 1995 data, it was determined that further water quality monitoring was not necessary and discontinued. Past results have demonstrated that no impacts to the Neosho River have resulted from plant operation.

Conclusion

No NPDES violations at the cooling lake discharge have been observed and at no time did water quality criteria restrict cooling lake discharge to the Neosho River. Based on completed monitoring studies, there have been no apparent deleterious effects to Neosho River water quality or productivity due to cooling lake discharges. Therefore, WCNOC concludes that impacts to fish and shellfish in the Neosho River from heat shock are SMALL and that mitigative measures are not warranted.

REFERENCES

Carlson, D.R. 1975. Sanitary Engineer, Water Pollution and Control, Kansas Department of Health and Environment, Topeka, Kansas, Letter of April 10 to G. Koester, Kansas Gas and Electric Company, Wichita, Kansas.

Carlson, D.R. 1976. Sanitary Engineer, Water Pollution Control, Kansas Department of Health and Environment, Topeka, Kansas, Letter of February 3 to M. Miller, Environmental Coordinator, Kansas Gas and Electric Company, Wichita, Kansas.

EA (Engineering, Science, and Technology, Inc.). 1985. *Assessment of Cold Shock Potential for Six Target Species from the Wolf Creek Cooling Lake.* Prepared for Kansas Gas and Electric Company, Wichita, Kansas.

EA (Engineering, Science, and Technology, Inc.). 1988. *Wolf Creek Generating Station Operational Phase Environmental Monitoring Program, Final Report.* Prepared for Wolf Creek Nuclear Operating Corporation, September.

Gray, M.W. 1974. Director, Division of Environment, Kansas Department of Health and Environment, Topeka, Kansas, Letter of December 13 to G. Koester, Kansas Gas and Electric Company, Wichita, Kansas.

Haines, D. E. 2000. "Biological control of gizzard shad impingement at a nuclear power plant." Environmental Science & Policy 3: S275-S281.

Koester, G.L. 1974. Kansas Gas and Electric, Letter of November 14 to M. Gray, State Department of Health and Environment.

Koester, G.L. 1975. Kansas Gas and Electric, Letter of April 4 to M. Gray, State Department of Health and Environment.

Koester, G.L. 1986. Kansas Gas and Electric, Letter of June 16 to R.D. Martin, U.S. Nuclear Regulatory Commission. *Annual Environmental Operating Report, Revision 1*, KMLNRC 86-111.

Sargent & Lundy. 1976. *Cooling System Operation Wolf Creek Generating Station Unit 1.* Prepared for Kansas Gas and Electric Company and Kansas City Power & Light Company. Report SL-3204, Revised March 26.

WCGS (Wolf Creek Generating Station). 1980. *Wolf Creek Generating Station Unit. No. 1 – Environmental Report, Operating License Stage*

Wolf Creek Nuclear Operating Corporation (WCNOC). 1987. *Evaluation of the Environmental Effects of Higher-than-Postulated Condenser Delta T's*, LI 87-0092, Interoffice correspondence from Brad Loveless to TE: 42072, February 12.

Wolf Creek Nuclear Operating Corporation (WCNOC). 1989. B.D. Withers to U.S. Nuclear Regulatory Commission. *Annual Environmental Operating Report,* WM 89-0116, April 26.

Wolf Creek Nuclear Operating Corporation (WCNOC). 1991. F. T. Rhodes U.S. Nuclear Regulatory Commission. *Annual Environmental Operating Report,* ET 91-0070, May 1.

Wolf Creek Nuclear Operating Corporation (WCNOC). 1992. F. T. Rhodes to U.S. Nuclear Regulatory Commission. *Annual Environmental Operating Report,* ET 92-0093, April 29.

Wolf Creek Nuclear Operating Corporation (WCNOC). 1993. Wolf Creek Generating Station Aquatic Monitoring 1992 Reports and 1993 Plans. Internal document. March 1993.

Wolf Creek Nuclear Operating Corporation (WCNOC). 1995. O.L. Maynard to U.S. Nuclear Regulatory Commission. *Annual Environmental Operating Report,* WO 95-0068, April 20.

Wolf Creek Nuclear Operating Corporation (WCNOC). 1997. C.C. Warren to U.S. Nuclear Regulatory Commission. *Annual Environmental Operating Report,* WO 97-0044, April 18.

Wolf Creek Nuclear Operating Corporation (WCNOC). 2006. *Wolf Creek Generating Station Environmental Report; Operating License Renewal Stage*

Exhibit 1

State of Kansas
DEPARTMENT OF HEALTH & ENVIRONMENT
Topeka, Kansas

RECEIVED
OPERATING
DEC 17 1974

13 December 1974

Mr. Glenn Koester
Kansas Gas & Electric Co.
P.O. Box 208
Wichita, Kansas 67201

Re: Wolf Creek Generating Station

Dear Mr. Koester:

We have received your letter of 14 November 1974 wherein you provided status information on the contractual obligations for the Wolf Creek generating station. Supplemental to the information provided, copies of the actual contractual agreements are desirable for documentation purposes. This request of course excludes any confidential information.

It is our belief that the Wolf Creek generating station has indeed begun construction as defined in Section 306(a) of PL 92-500 and thus we concur with your conclusions. The federal standards of performance for "new sources" of the Electric Power Plant Generating Guidelines published in the Federal Register in October 1974, Volume 39, No. 196, Section 423.13(1) states that such facilities under construction as of the effective date of the above-referenced regulation shall be exempt from the provisions of Section 316(a) of PL 92-500, as construction was begun prior to the effective date. We are therefore exempting you from the requirements of Section 316(a) of PL 92-500.

We appreciate very much your cooperation in this matter.

Very truly yours,

Melville W. Gray, P.E.
Director
Division of Environment

MWG:ht
cc: Ralph Langemeier
South Central District Office

Exhibit 2

42115-W

KANSAS GAS AND ELECTRIC COMPANY
P. O. Box 208 Wichita, Kansas 67201

bcc: Gerald Charnoff
RFoster
RVohs
MHarris
EHall
JOArterburn
RHagan
GBoyer
MMiller ← COPY FOR

42324

April 4, 1975

COPY

Mr. Melville W. Gray, P.E.
Director
Division of Environment
State Department of Health and
Environment
Forbes Air Force Base, Building 740
Topeka, Kansas 66620

Re: Wolf Creek Generating Station

Dear Mr. Gray:

We have received your letter of December 13, 1974, and note your finding that the Wolf Creek Generating Station began construction, as defined in Section 306(a) of PL 92-500 (the Federal Water Pollution Control Act, as amended), of its cooling impoundment system prior to the effective date of 40 CFR §423. We further note your concurrence with our conclusions set forth in my letter to you of November 14, 1974.

Therefore, we are relying on your letter of December 13, 1974, as indicating that, pursuant to Effluent Guidelines and Standards for the Steam Electric Generating Point Source Category promulgated by the United States Environmental Protection Agency on October 8, 1974 (39 F.R. 36186), as corrected (40 F.R. 7095), the Wolf Creek Generating Station is exempt from any limitation on the discharge of heat.

Section 316(a) of the FWPCA contains no effluent limitations. Section 316(a) provides procedures pursuant to which a permittee may obtain the relaxation of a proposed thermal effluent limitation which is more stringent than necessary to insure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made. Because the Wolf Creek Generating Station is exempt from any limitation on thermal discharge, Kansas Gas and Electric Company is not planning to develop the type of demonstration required by Section 316(a).

Sincerely yours,

GLENN L. KOESTER

GLK:bb

Exhibit 3

State of Kansas . . . ROBERT F. BENNETT, Governor

DEPARTMENT OF HEALTH AND ENVIRONMENT

DWIGHT F. METZLER, Secretary

Topeka, Kansas 66620

April 10, 1975

cc: Gerald Charnoff
RFoster
RVohs
MHarris
ESHall
JOArterburn
RHagan
GBoyer
MMiller
...4/11/75.bb

Mr. Glenn L. Koester
Kansas Gas & Electric Company
Post Office Box 208
Wichita, Kansas 67201

Re: Wolf Creek Generating Station

Dear Mr. Koester:

We are in receipt of your letter addressed to Mr. Melville W. Gray, dated April 4, 1975. In your letter the following statement appears.

> "Therefore, we are relying on your letter of December 13, 1974, as indicating that, pursuant to Effluent Guidelines Point Source Category promulgated by the United States Environmental Protection Agency on October 8, 1974, (39 F.R. 36186) as corrected (40 F.R. 7095), the Wolf Creek Generating Station is exempt from any limitation on the discharge of heat."

This statement is essentially correct in that Mr. Gray's letter, to you dated December 13, 1974, is intended to exempt the Wolf Creek Generating Station from only the Federal limitations dealing with the discharge of heat from Steam Electric Generating Point Sources. As we have pointed out in previous meetings, between the Kansas Gas and Electric Company and the Kansas Department of Health and Environment, the exemption from any Federal limitation on the discharge of heat does not in any way exempt or imply that the Wolf Creek Generating Station is exempted from the Water Quality Criteria for Interstate and Intrastate Waters of Kansas as outlined in Regulation 28-16-28. A copy of this regulation is enclosed.

If you have any questions, please contact our office. Telephone number (913) 296-3825.

Sincerely yours,

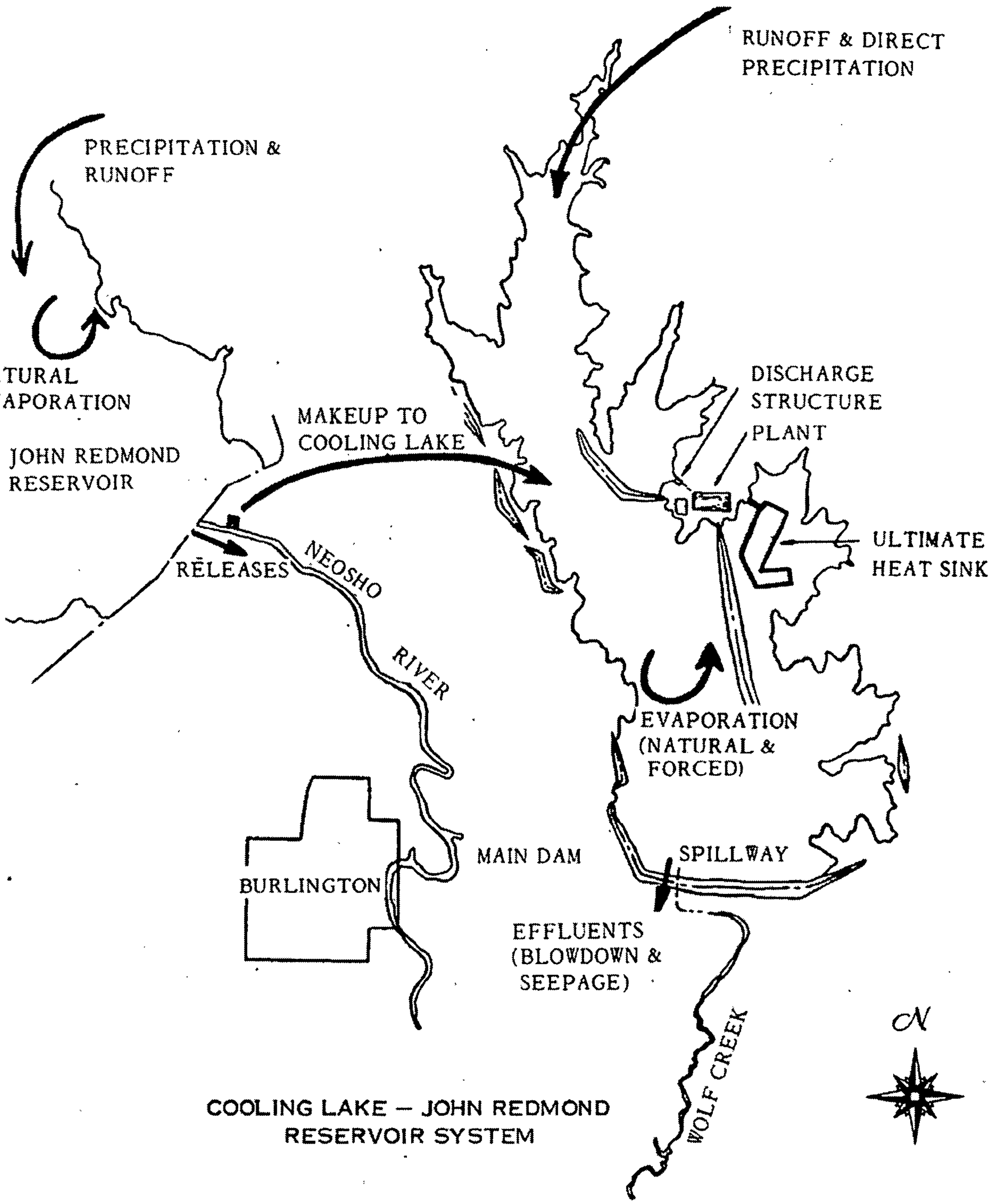
Division of Environment

Donald R. Carlson

Donald R. Carlson
Sanitary Engineer
Water Pollution Control

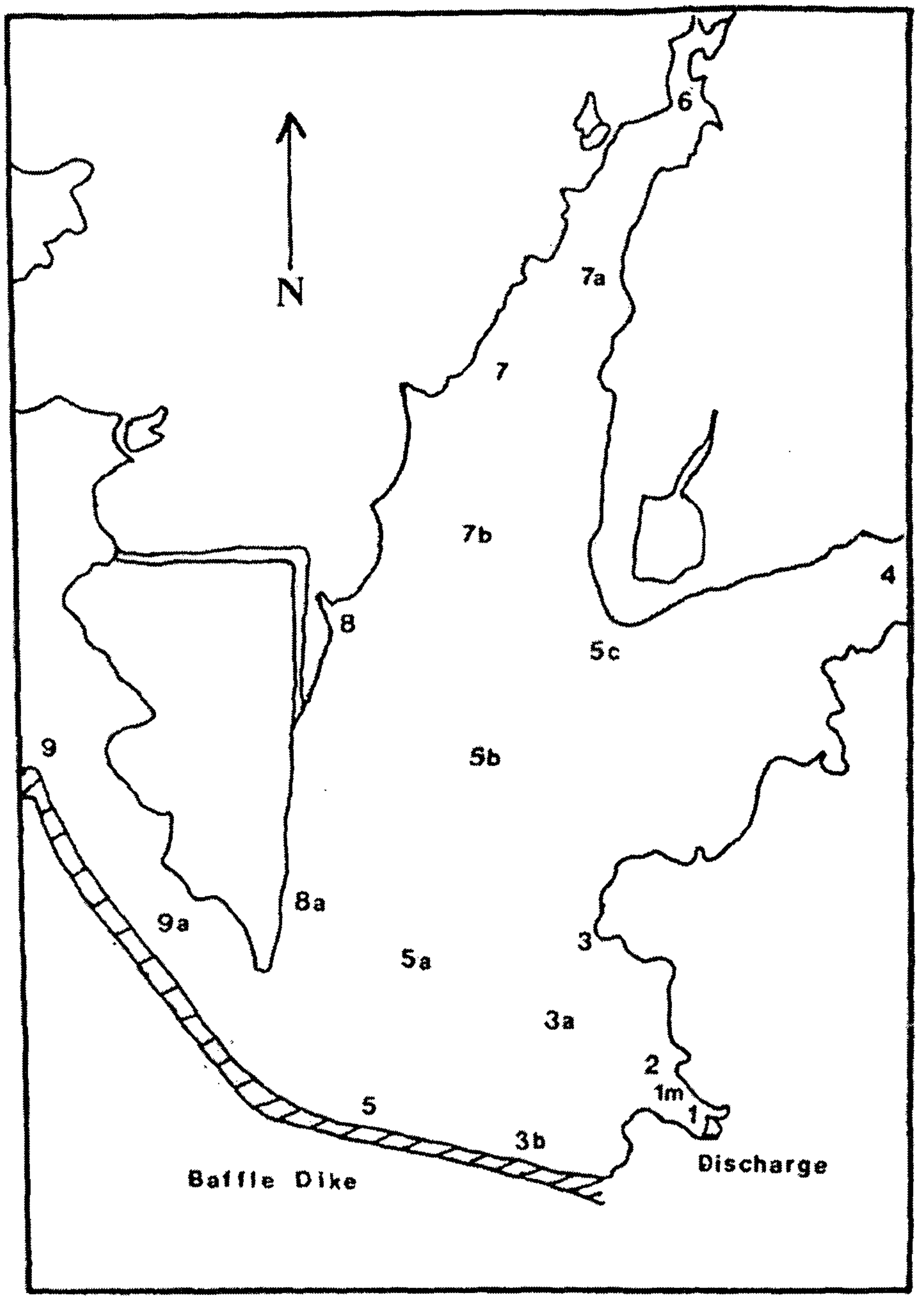
DRC:jac

Figure 1



COOLING LAKE — JOHN REDMOND
RESERVOIR SYSTEM

Figure 2. Discharge Cove



Corrections to Wolf Creek Nuclear Operating Corporation's application for renewal of the operating license for Wolf Creek Generating Station

2.3.2 Engineered Safety Features

This section of the application addresses scoping and screening results for the following systems:

- Nuclear sampling system
- Containment spray system
- Containment integrated leak rate test system
- Decontamination system
- Liquid Radwaste system
- Reactor makeup water system
- Containment purge HVAC system
- Breathing air system
- Hydrogen control system
- High pressure coolant injection system
- Residual heat removal system

2.3.2.1 Nuclear Sampling System

System Description

The purpose of the nuclear sampling system is to obtain and analyze samples from various systems and locations in the nuclear steam supply system (NSSS) for radiological monitoring and control of chemistry parameters. The system consists of piping, tubing, valves, coolers and analysis equipment necessary to collect and analyze process stream samples. Sample station rooms are located in the auxiliary building, radwaste building and turbine building to service NSSS, radwaste and secondary sample points respectively.

System Function

The nuclear sampling system provides automatic isolation functions for the system containment penetrations. Portions of the nuclear sampling system are within the scope of license renewal based on the criteria of 10 CFR 54.4(a)(1). Portions of the system tubing to start and align the NCP EDG, the unavailability of RWST, CST, and steam generator level instrumentation, and the high stress factor that would be present in the SBO scenario.

The total CDF frequency of SBO sequences SBOS02 through SBOS32 is 1.61E-05. Multiplying this total by the SAMA failure probability of 1.0E-01 results in a frequency of 1.61E-06, which represents a reduction of 1.45E-05 (1.61E-05 – 1.61E-06 = 1.45E-05).

For the Level 2 model, the proposed SAMA will provide negligible or no risk reduction to the ISLOCA and SGTR release categories. Therefore, the release category frequencies for these contributors are assumed to remain unchanged. The ECF and CIF release category frequencies are determined based on the remaining CDF cutsets and Level 2 containment safeguards systems failures (containment coolers, containment sprays, containment isolation). Since the proposed NCP/DG change will provide negligible additional benefit for the containment safeguards systems, an upper bound estimate of the impact of this SAMA on the ECF and CIF frequencies may be obtained by reducing their baseline frequencies by the percentage reduction realized for CDF. The LCF and NCF release category frequencies are estimated using the conditional probabilities determined in the IPE, as described in Section F.2.8.

The cost of implementation for providing a dedicated diesel generator (DG) for the advanced boiling water reactor (ABWR) Feedwater or Condensate pumps was estimated to be $1.2 million in 1994 (GE 1994). The capacity of the generator required for the ABWR application likely exceeds that required for the WCGS NCP, which is only about 500kW. As a result, the ABWR cost has been reduced by 33 percent and not inflated to 2006 dollars to estimate a cost of implementation for this SAMA ($800,000).

Results

Implementation of this SAMA yields a reduction in the CDF, Dose-risk, and Offsite Economic cost-risk. The results are summarized in the following table.