DUANE ARNOLD ENERGY CENTER

CEDAR RIVER OPERATIONAL ECOLOGICAL STUDY

ANNUAL REPORT

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INTRODUCTION

This report presents the results of the physical, chemical and biological studies of the Cedar River in the vicinity of the Duane Arnold Energy Center during the second year of station operation. The Duane Arnold Energy Center Operational Study of the Cedar River was implemented in mid-January, 1974.

Prior to plant start-up, extensive pre-operational data have been collected since April 1971. These pre-operational studies provided "base-line" data which have made it possible to assess the effects of station operation on the limnology and water quality of the Cedar River.

SITE DESCRIPTION

The Duane Arnold Energy Center, a nuclear fueled electrical generating plant, operated by the Iowa Electric Light & Power Company is located on the west side of the Cedar River, about 2½ miles north-northeast of Palo, Iowa in Linn County. The plant employs a boiling water nuclear power reactor producing about 550 MWe of power at full capacity. Waste heat rejected from the turbine cycle to the condenser circulating water is removed by two closed loop induced draft cooling towers, which require a maximum of 11,000 gpm (about 24.5 cfs) from the Cedar River. A maximum of 7,000 gpm (about 15.5 cfs) will be lost through evaporation, while 4,000 gpm (about 9 cfs) will be returned to the river as blowdown water from the cool side of the cooling towers.

OBJECTIVES

Studies to determine the baseline physical, chemical and biological characteristics of the Cedar River near the Duane Arnold Energy Center prior to plant start-up were instituted in April of 1971. These pre-operational studies are described in earlier reports.[1,2,3] Data from these studies served as a basis for the development of the operational study.

The operational studies were designed to identify and evaluate any significant effects of chemical or thermal discharges from the generating station into the Cedar River as well as the magnitude of impingement on intake screens or entrainment in the condenser make-up water and were first implemented in January 1974.[4]

The specific objectives of the operational study are threefold:

1. To continue routine water quality determinations in the Cedar River in order to identify any conditions which could result in environmental or water quality problems.

2. To conduct physical, chemical and biological studies in and adjacent to the discharge canal and to compare the results with similar studies above the intake. This will make it possible to determine any water quality changes occurring as the result of chemical additions or condenser passage and to identify any impact of the plant effluent on aquatic communities adjacent to the discharge.
3. To identify and quantify organisms impinged on the intake screens and entrained in the intake water in order to estimate the magnitude and effects of impingement and condenser passage on the ecology of the Cedar River.

STUDY PLAN

During the operational phase of the study sampling sites have been established in the discharge canal and at four locations in the Cedar River (Figure 1): (1) upstream of the plant at the Lewis Access Bridge (Station 1); (2) directly above the plant intake (Station 2); (3) at a point approximately 140 feet below the plant discharge (Station 3); and (4) adjacent to Comp Farm about ½ mile below the plant (Station 4). Samples were also taken from the discharge canal (Station 5).

Samples for general chemical, bacterial and plankton anaysis were taken twice per month while complete chemical analysis and benthic studies were conducted during the spring, summer and fall quarters.

The following specific studies were conducted:

I. <u>General Water Quality Analysis</u>

A. Frequency: Twice per month

B. Location: At all five sites

C. Parameters measured:

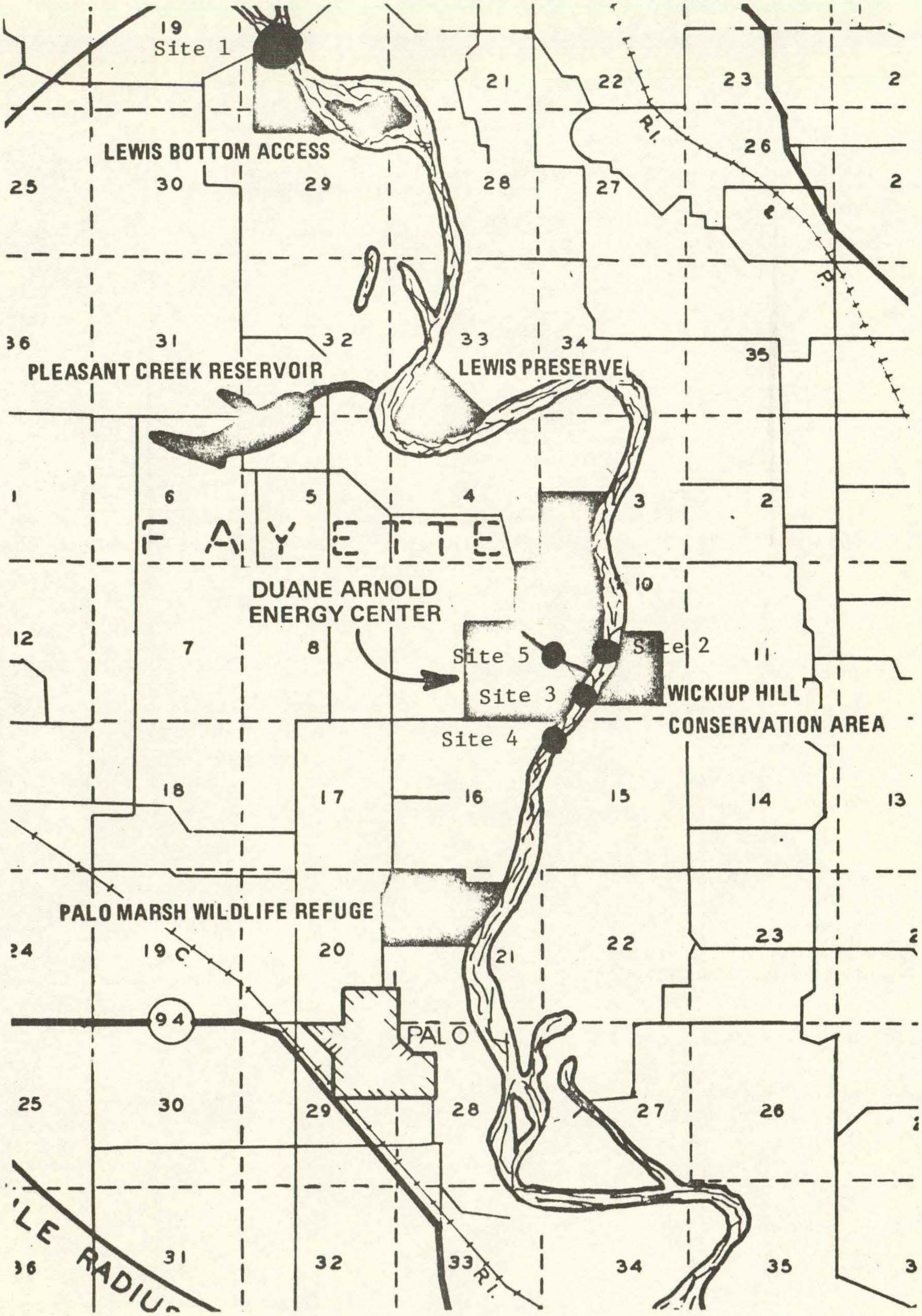

Figure 1. Location of Operational Sampling Sites

1. Temperature
2. Turbidity
3. Color
4. Solids series
5. Dissolved oxygen
6. Carbon Dioxide
7. Alkalinity
8. pH
9. Hardness series
10. Phosphate series
11. Ammonia
12. Nitrate
13. Iron
14. Lignins and Tannins
15. Chemical oxygen Demand
16. Biochemical oxygen Demand
17. Taste and odor

II. Complete Water Quality Analysis

A. Frequency: Three times per year

B. Location: At all five locations

C. Parameters measured: All general water quality parameters plus:

1. Copper
2. Zinc
3. Mercury
4. Lead
5. Chromium (Cr^{+6})
6. Manganese
7. Chloride
8. Sulfate
9. Nitrite
10. Pesticides in fish from two sites above and below the plant

In addition, dissolved oxygen, pH and alkalinity were determined at each site every four hours over a 24 hour period.

III. Plankton Studies

A. Frequency: Twice per month

B. Location: At all five locations

C. Analyses made: Number and kinds (to genus whenever possible) of organisms present.

IV. Bacteriological Studies

A. Frequency: Twice per month. Additional determinations of fecal coliforms were conducted on samples from the effluent from the station's wastewater treatment plant.

B. Location: At all five locations

C. Analyses Made:

1. Total plate count (37°C)

2. Total coliform (MF)

3. Fecal coliform (MF)

4. Fecal streptococci (MF)

V. Benthic (bottom organisms) Studies

A. Frequency: Three times per year

B. Location: At four sites (Station 5 in discharge canal omitted)

C. Analysis: Kinds (to genus whenever possible) and numbers of organisms present.

Periphyton studies were conducted during the summer and fall but were not conducted during the spring quarter due to the extremely high river stage present.

METHODS

Analysis for alkalinity, pH, dissolved oxygen and temperature were performed in the field at the time of sampling. Other analyses were performed in the laboratory. All laboratory work was performed in the water laboratory of the Energy Engineering Division located in the University Water Treatment Plant. Most of the chemical tests were made in accordance with EPA or Standard Methods[5,6] with a few minor variations that involved the use of reagents prepared by the Hach Chemical Company. Pesticide anaysis utilized methods described in the Pesticide Analytical Manual.[7] Bacterial counts were made by use of the Millipore Filter Procedure. Plankton counts were made on centrifuged samples by use of the Whipple micrometer disc and the Sedgwick-Rafter slide. Bacterial and plankton procedures are described in Standard Methods. A sample of uncentrifuged water was also examined from each site in order to include those blue-green algae that are lighter than water and are eliminated by the centrifuging process.

OBSERVATIONS

Physical Conditions

Hydrology (Table 1)

Flow in the Cedar River during the period January 1975-July 1975, with the exception of the month of February, was above normal. From August through November flows were below normal while December discharge was slightly above the 1941-70 median. Mean monthly discharges at the Cedar Rapids gauging station ranged from 62% of the 1941-70 monthly median flow in October to 228% of the monthly median in April and were classified as excessive (greater than 75% quartile) from April through June. Maximum flows occurred during April when the mean monthly discharge exceeded 10,750 cfs. A maximum estimated spring flow of 32,200 cfs occurred on March 24. A low flow of 398 cfs occurred on December 19 as a result of upstream construction activities. River flows of less than 1,000 cfs occurred at intervals from September through December. Hydrological data are summarized in Table 1.

Temperature (Tables 2-3)

River water temperatures during the period ranged from 0.0^{o}C (32.0^{o}F) to 27.2^{o}C (81.0^{o}F). Maximum temperatures were observed at all stations on June 30. The highest discharge canal (Station 5) temperature observed during the period was 28.2^{o}C (82.4^{o}F), recorded on July 28. A maximum ΔT value (Station 2 vs Station 5) of 18.5^{o}C (33.3^{o}F) was observed on December 1. A maximum ΔT value between upstream and downstream temperatures (Station 2 vs Station 3) of 8.9^{o}C (16^{o}F) was measured on December 15. However, temperature elevation at the Comp Farm station (Station 2 vs Station 4) at this time was only 1.0^{o}C (1.8^{o}F). In general, however, natural variations in river temperatures appeared to overshadow any effects of station discharge. The station was not operational on February 10 and as a result the differentials frequently observed between the upstream and downstream river temperatures during the winter months were not observed at that time. Temperature differentials between upstream and downstream river locations and between the upstream river station and the discharge canal are summarized in Table 2. Temperature data for all sampling locations are given in Table 3.

Turbidity (Table 4)

Maximum turbidity values of 550 J.T.U. were observed in mid-June. High values also occurred in late March and early April. Turbidity values were generally low during the winter months. Minimum turbidity values of from 4-5 J.T.U. were observed in February.

Color (Table 5)

Color values were relatively high ranging from 10-70 standard units. Maximum values occurred during periods of runoff in late March. Low values occurred in the winter.

Solids (Tables 6-14)

Solids determinations included total, total volatile, total fixed, total dissolved, total suspended, suspended fixed, suspended volatile, dissolved fixed and dissolved volatile solids.

In river samples total solids values ranged from 286 to 1,546 mg/l with the highest values generally occurring in mid-June and directly below the discharge canal (Station 3) on November 17. Total volatile solids values ranged from 70 to 270 mg/l with highest values usually occurring in early May. Total fixed solids values ranged from 182 to 1,020 mg/l, with high values occurring in June and low values in late March. Total dissolved solids values ranged from 167 to 1,134 mg/l. High values occurred in mid-June and below the discharge on November 17 while low values occurred in March. Total suspended solids values ranged from 10 to 930 mg/l. Highest suspended solids values were observed during June; the lowest concentrations occurred in the winter. Solids values in the discharge canal were consistently higher than in river samples. A maximum total solids concentration of 2,850 mg/l was observed in the discharge canal on February 25. Levels in excess of 2,000 mg/l also occurred in November and December.

Chemical Conditions

Dissolved Oxygen (Table 15)

Dissolved oxygen concentrations in the river ranged from 4.5 to 15.3 mg/l during the period. Lowest concentrations were observed in August following the death and subsequent decay of a large plankton bloom. Highest dissolved oxygen concentrations occurred in October accompanying large algal populations. No fish kills or other water quality problems associated with low dissolved oxygen concentrations were observed at any of the sampling stations during the course of the study. Dissolved oxygen concentrations in the discharge canal (Station 5) were generally slightly lower than those observed in the river.

Carbon Dioxide (Table 16)

Free carbon dioxide in concentrations ranging from 5.3 to 8.8 mg/l was present in all river samples taken from January through early May. Concentrations declined during May accompanying increased algal populations and carbon dioxide was present only intermittently for the remainder of the year. Carbon dioxide concentrations were frequently higher in the discharge canal than in the river during the July to December period.

Alkalinity, pH, Hardness (Tables 17-21)

These interrelated factors were influenced by both climatic and biological conditions. In general, highest hardness and total alkalinity values in the river occurred during the winter while low values occurred in late March and early fall. Phenolphthalein alkalinity was present in most river samples from July through December. Maximum phenolphthalein alkalinity values of 26 mg/l occurred in the river in September during a period when large algal populations were present.

pH values ranged from 7.6 in March to 9.4 in November. High pH values accompanied large algal blooms.

In general, hardness values were higher and total alkalinity values lower in the discharge canal in the river.

Phosphates (Tables 22 & 23)

Total phosphate concentrations in river samples ranged from 0.10 to 4.20 mg/l with highest values occurring in January and early February. Lowest values occurred in late October and early November. Orthophosphate concentrations in river samples ranged from <0.03 to 1.60 mg/l. Minimum values occurred in September, probably as a result of uptake by algae.

Phosphate values in the discharge canal were frequently higher than in the river.

Ammonia and Nitrate Nitrogen (Tables 24 & 25)

Ammonia nitrogen concentrations in the river ranged from trace amounts to 1.24 mg/l. Highest values occurred during high river flows in March while low values apparently resulted from uptake of ammonia by algae in September and October. Nitrate nitrogen concentrations were high at all stations from January through mid-July, ranging from 0.04 mg/l in late March to 12.2 mg/l on July 14. Low river flows during the period August-November contributed to reduced nitrate concentrations. Nitrate concentrations were frequently higher in the discharge canal than in river samples. A maximum nitrate nitrogen concentration of 10.0 mg/l was observed in the discharge canal on March 10.

Iron (Table 26)

Iron concentrations in the river ranged from 0.02 to 0.94 mg/l. Highest concentrations occurred during high water periods in April and May. Low levels occurred in the fall and winter months. A maximum iron concentration of 2.90 mg/l was observed in the discharge canal on February 25.

Lignins and Tannins (Table 27)

These substances are derived primarily from decaying plant material and varied from trace amounts to 1.70 mg/l in river samples. Low values were observed during periods of low river flow in January and during subsiding river flow in May. Highest concentrations occurred during periods of runoff in January and March. Lignin and tannin concentrations in excess of 2.6 mg/l were occasionally observed in the discharge canal but no consistent pattern of high levels was apparent.

Chemical Oxygen Demand (Table 28)

Chemical oxygen demand (COD) values in the river ranged from 4 to 104 mg/l. Minimum values occurred during low flow periods in February and following extended runoff in June. Maximum values followed a period of rainfall in late March and early April. High values also accompanied large algal populations in September and November.

Biochemical Oxygen Demand (Table 29)

Five-day biochemical oxygen demand (BOD_5) values in the river ranged from 0.9 to 18.6 mg/l. Minimum BOD values occurred in early February and December. Maximum values accompanied algal blooms in October. BOD values in the discharge canal were similar to those observed in the river.

Threshold Odor Number (Table 30)

Threshold odor values ranged from 5.6 to 24. Highest values occurred during spring runoff in late March. Large algal populations in the fall had little influence on odor values. Slightly higher odor values were occasionally noted in the discharge canal.

Biological Conditions

Total Bacteria (Tables 31 & 32)

Total bacterial populations in the river exhibited wide temporal and spatial fluctuations during the period ranging from 10,000 to 43,000,000 organisms/100 ml when grown at 37^{o}C and from <10,000 to 1,200,000 at 20^{o}C. Maximum populations frequently occurred at the beginning of periods of increased runoff. Total bacterial populations in the discharge canal were frequently much larger than river populations and, on occasion, contributed to high levels at the downstream DAEC site (Station 3). High bacterial levels in the canal may have resulted from the sloughing off of bacterial slime growths on the cooling towers.

Total Coliform Bacteria (Table 33)

The number of total coliform bacteria present in the river samples ranged from <100 to 23,000 organisms/100 ml. Highest counts occurred in mid-June. Minimum values occurred during late October. Total coliform values in the discharge canal were occasionally higher than at river locations.

Fecal Coliform Bacteria (Table 34)

Fecal coliform populations were considerably lower than total coliform populations, but were sufficiently high to indicate substantial additions of human or animal wastes into the river. Fecal coliform populations in the river ranged from <10 to 8,700 organisms/100 ml. High counts frequently occurred at the beginning of periods of runoff or rainfall while low numbers of organisms were usually observed in February and during low runoff periods in September and October. Fecal coliform concentrations in the discharge canal were occasionally higher than in river samples. A maximum population of 32,500 organisms/100 ml was observed on November 4.

Fecal Streptococcus Bacteria (Table 35)

Fecal streptococci populations ranged from <10 to 7,900 organisms/100 ml. Large numbers were observed during mid-January and during periods of runoff in March and June. Lowest counts occurred during periods of low flow or declining runoff in February, September and October.

Plankton (Table 36)

Total plankton populations exhibited fluctuations similar to those observed during the previous year. Largest river plankton populations were present during September and October when total counts were frequently in excess of 100,000 organisms/ml. Maximum counts of ca. 170,000 organisms/ml occurred in early October and high levels persisted through November. Smallest populations were present from January through March. The diatoms, chiefly *Cyclotella* and *Nitzschia*, and unidentified flagellates continued to be the dominant organisms observed during the period. A wide variety of green algae and blue-green algae, chiefly *Oscillatoria* were common from July through September. Operation of the discharge canal appeared to have little effect on downstream plankton populations.

QUARTERLY STUDIES

In addition to twice monthly studies, extensive studies of the limnology and water quality were conducted during the spring (May 5 - June 6), summer (July 22-28) and fall (October 20-28) periods. These studies included additional chemical determinations, diurnal chemical analysis, benthic studies, fisheries studies and fish pesticide residue determinations.

Spring Studies

Additional Chemical Determinations

Samples for nitrite, sulfate, chloride and heavy metal analysis were collected at all sampling stations on May 6. With the exception of chlorides, which exhibited a good deal of variation between locations, there was little variation between the stations. Concentrations of all of the above parameters were within the expected ranges. Nitrite concentrations did not exceed 0.01 mg/l, indicating little evidence of recent sewage pollutions. Heavy metal concentrations were usually low, ranging from 2.2 μg/ml for mercury to 0.05 mg/l for manganese. Mercury and copper concentrations were slightly higher and zinc concentrations lower than those observed during the comparable period in 1974. The results of chemical determinations are given in Table 37.

Diurnal Variations

Diurnal studies of dissolved oxygen, carbon dioxide, alkalinity, pH and water temperatures were conducted on May 5 and 6 and are summarized in Table 38. Oxygen concentrations ranged from 7.4 to 9.1 mg/l with the highest values occurring in the late afternoon. Maximum diurnal variation in dissolved oxygen was 1.5 mg/l at Station 4 (Comp Farm). Diurnal variations in dissolved oxygen concentrations in the canal did not exceed 0.5 mg/l.

Bottom Fauna

Bottom samples were taken from channel edge areas at all four river locations on June 6 by means of a Ponar dredge. All samples were composed primarily of shifting sand. Samples were returned to the laboratory and sieved through a #30 mesh soil sieve.

No organisms were present in the eight samples collected. It appeared that high river flows and shifting bottom conditions present during the spring had greatly reduced benthic populations in the area.

Fishery Studies

Fisheries studies were conducted by the Iowa State Conservation Commission in cooperation with personnel from the University of Iowa Department of Environmental Engineering during the period June 5 and 6. Fish were collected upstream and downstream of the plant by means of 22" diameter, 3/4" mesh hoop nets baited with cheese. Electroshocking was carried out at both upstream and downstream locations.

Carpsuckers, carp and channel catfish were the only forms commonly collected. Carpsucker and carp were most commonly collected by shocking at the upstream site while channel catfish were most abundant in the downstream net collections. The results of fisheries studies are summarized in Table 39.

Fish Pesticide Residues

Pesticide residues found in specimens of carpsucker, carp, large-mouth buffalo and northern redhorse collected June 5 and 6 are summarized in Table 40. Breakdown products of DDT were found in highest concentrations. Aldrin, dieldrin, heptachlor, lindane and β-BHC were also found. Concentrations were similar to those observed during the previous spring study and no significant differences in pesticide levels were observed between fish taken upstream and downstream of the station.

Summer Studies

Additional Chemical Determinations

Samples for the summer quarterly chemical analysis were collected at all stations on July 28. Chloride and sulfate concentrations exhibited significant variations between stations. These concentrations were higher in the discharge canal (Station 5) and immediately below the plant (Station 3) than at the other stations due likely to evaporation and subsequent re-concentration in the cooling towers. All other parameters exhibited little variation between stations. Concentrations of all the parameters were within the expected ranges. Nitrite concentrations were slightly higher than during the spring studies but never exceeded 0.02 mg/l. Chloride values ranged from 17.5 mg/l at Station 4 to 50.5 mg/l at the discharge canal (Station 5). Sulfates also varied widely ranging from 46.0 mg/l at Lewis Access (Station 1) to 660.0 mg/l in the discharge canal. Heavy metals concentrations were generally low. Copper and manganese levels were greater and mercury concentrations lower than in samples taken during the spring studies. Heavy metal concentrations ranged from less than 0.01 μg/l for mercury to 0.21 mg/l for manganese. Manganese, lead and mercury concentrations were slightly lower and copper higher than those observed during a comparable period in 1974. The results of chemical determinations are given in Table 37.

Diurnal Variations

Diurnal variations in dissolved oxygen, carbon dioxide, alkalinity, pH and water temperatures were determined on July 28-29 are are summarized in Table 38.

Dissolved oxygen values exhibited considerable fluctuation during the day, ranging from 6.3 to 14.4 mg/l. As might be expected, lowest dissolved oxygen values occurred shortly after sunrise, while maximum values occurred in late afternoon. There appeared to be greater diurnal variation at the upstream stations. A maximum dissolved oxygen diurnal variation of 7.4 mg/l occurred at the Lewis Access station (Station 1) while a diurnal variation of 5.0 mg/l occurred at Comp Farm (Station 4). These data indicate relatively high photosynthetic activity. Dissolved oxygen values in the discharge canal exhibited far less variation ranging from 6.3 to 8.5 mg/l. The canal was empty during various times throughout the study. The pH values ranged from 7.8 to 9.0 and little variation occurred within stations.

Bottom Fauna

Samples were taken on August 1, 1975 at all four sites. Samples were taken with a Ponar dredge at the channel edge on the station side of the river, returned to the laboratory and sieved through a #30 mesh soil sieve.

Benthic organisms were scarce in all samples. Samples from stations 1 and 2 contained the chironomidae Chironomous (1) Polypedilum (5), and Procladius (4) on a fine sand bottom type. Station 3 consisted of both fine sand and mud. The chironomidae Chironomous (4), Polypedilum (6), and Procladius (5) were observed at Station 3. In addition, the tubificidae Limnodrilus hoffmeisteri (8) and L. maumeesusis (6) were also identified at this station. The coarse sand found at Station 4 did not support any benthic organisms.

Periphyton Studies

Artificial glass substrates were placed above and below the plant (Stations 2 and 3 respectively) on June 19 to determine the size and composition of periphyton populations in the area. The substrates were removed July 3 and analyzed for species composition and biomass. Results of the periphyton studies are found in Table 41.

Little variation in either species composition or biomass existed between the upstream and downstream stations. Although periphyton diversity is not great in this area as compared to other Iowa rivers, there is no evidence that operation of the plant affects periphytic communities at the downstream sampling locations.

Fishery Studies

Fisheries studies were conducted by the Iowa Conservation Commission and University of Iowa personnel during the period July 22-24. Samples were taken at locations above and below the station by means of cheese baited hoop nets and seining. Electroshocking was not carried out due to mechanical problems with the generator. The results are summarized in Table 39.

Channel catfish continued to be the dominant fish collected with the largest numbers being collected in hoop net sets at the downstream location. Carpsuckers were also relatively common in seine collections at the upstream site. Carp, which are usually common in the area, were not collected during the July study. Seine hauls yielded large numbers of bigmouth shiners, both upstream and downstream.

Black crappie and northern pike were the only game fish collected. These forms were present in very small numbers in the seine hauls and nets.

Fish Pesticide Residues

Pesticide residues found in specimens of channel catfish, carpsucker and northern pike are summarized in Table 40. Dieldrin and breakdown products of DDT were found in the greatest quantities in all three species. Heptachlor epoxide and heptachlor were also observed in the fish. Concentrations of pesticide residues were higher this year than during the spring quarter of 1974. Dieldrin and breakdown products of DDT were significantly higher in the catfish and carpsucker collected from below the plant than in those collected above. Heptachlor epoxide was also found in higher concentrations in channel catfish from below the plant but carpsucker below the plant contained no heptachlor epoxide. Carpsucker taken upstream of the plant, however, did contain heptachlor epoxide residues. Wide variations in pesticide concentrations are frequently observed and these results do not indicate an adverse effect of station operation on pesticide concentrations in fish since these organisms are highly motile and can easily move up or down stream from the site.

Fall Studies

Additional Chemical Determinations

Fall quarterly chemical analyses were conducted on samples from all stations on October 20. The results of these analyses are given in Table 37. Nitrite concentrations at all stations were higher than during the previous 1975 quarterly studies and also during a comparable period during the 1974 study period. Chloride values in the river were also slightly higher than during the July studies. Heavy metals concentrations ranged from <0.01 mg/l for lead at all stations and zinc at Lewis Access (Station 1) to 0.36 mg/l of manganese in the discharge canal. Metals concentrations tended to exhibit little variation between stations. Mercury values were not computed during this period due to contamination of the samples prior to analysis.

Diurnal Variations

Diurnal variations in dissolved oxygen, carbon dioxide, alkalinity, pH and temperature were determined on October 20-21 and are summarized in Table 38. Dissolved oxygen concentrations varied from 6.3 to 16.3 mg/l, with the highest values occurring in the late evening. Lowest dissolved oxygen values (6.3-7.8 mg/l) were observed in the discharge canal where the highest temperatures were also recorded. Dissolved oxygen values were also low at Station 3 immediately downstream from the plant. Diurnal variation in dissolved oxygen at Stations 1, 2 and 4 was 5.5 mg/l, 4.9 mg/l and 7.5 mg/l respectively. Diurnal variation at Station 3 was only 2.0 mg/l.

the pH values observed during this 24 hour period ranged from 8.1 to 9.0 in the river stations and from 6.2 to 8.1 in the discharge canal. Carbon dioxide was observed in the river only immediately downstream from the plant during early morning hours on October 21.

Bottom Fauna

Bottom samples were taken at all four river locations on September 28 by means of a Ponar dredge from channel edge areas on the station side of the river. All samples were composed primarily of shifting sand. Samples were returned to the laboratory and sieved through a #30 mesh soil sieve.

A few chironomidae larvae were present in samples from Stations 1, 3 and 4. These included the genera Chironomous (9), Pentaneura (5) and Polypedilum (5). The tubificidae Limnodrilus hoffmeisteri(19) and L. cervix (14) were identified in Stations 3 and 4. The presence of these tubificids was probably due to the nature of the bottom type at these stations (a mixture of sand and silt). No biota was present in samples from Station 2. This absence of organisms was not unusual due to the coarse sand bottom present at this site.

Periphyton Studies

Fall periphyton studies were conducted from October 27 through December 1 when artifical glass substrates were placed above and below the plant site (Stations 2 and 3 respectively). Species composition and biomass determinations are found in Table 41.

Results indicate slight variations in species composition with greater diversity occurring upstream of the plant. Biomass values, however, were similar at both stations. Species composition during the fall study was different from that observed during the summer study due to seasonal variations in periphyton communities. Biomass was significantly lower during the fall study, probably as a result of lower water temperatures and the partial scouring of the substrates by floating ice.

Fishery Studies

Fishery studies were conducted by the Iowa Conservation Commission on October 28. Samples were taken above and below the site by electo-shocking. Nets were not used due to low river levels. The results of the sampling are summarized in Table 39.

Carp, carpsucker, channel catfish and northern redhorse were the only fish collected during this period. Carp and carpsucker were the dominant fish taken, although numbers were not as high as during previous studies in 1974. No shiners were collected during the study since seining was not conducted.

Evidence of attraction of fish to the heated waters of the discharge plume was observed during the October 28 study. A congregation of carp, and a few channel catfish were observed at the outlet structure. No dead fish or evidence of abnormal behavior were observed in the area of the discharge plume.

Fish Pesticide Residues

Pesticide residues were determined in carp, carpsucker and redhorse taken during the October study. The breakdown products of DDT and aldrin were the only pesticide residues observed in these fish. Carp exhibited the highest pesticide residue concentrations.

ADDITIONAL STUDIES

Impingement Studies

A review of the Duane Arnold Energy Center trash basket record during the period of operation January-December 1975 indicates that fish impingement is not a significant problem at the Station. Daily trash basket counts conducted by DAEC personnel indicated that a total of 71 fish were impinged and collected in the trash basket during the January-November period. Four 24-hour trash basket counts were conducted by University of Iowa personnel during the period. Winter impingement studies were conducted on February 10, at which time two channel catfish, 5.0 and 5.5 centimeters in length and one small largemouth bass 6.5 centimeters in length were removed from the basket. The second 24-hour trash basket count was conducted on April 7. A total of six fish were taken at this time; one channel catfish ca. 7 centimeters in length and 5 unidentified forms less than 5 centimeters in length. On June 30 the third study was conducted. No fish were impinged at that time. The fourth trash basket study was conducted on November 25. The results of this study are summarized in Table 42.

Fish Basket Studies

Studies to determine the effects of blowdown discharge from the DAEC on native fish were conducted during the period July 24-25, 1975. Channel catfish were collected from the Coralville Reservoir by the Iowa Conservation Commission and placed in live boxes in the Cedar River and the discharge canal at the DAEC site. Ten fish were placed in each of three live boxes located (1) in the Cedar River about 100 feet upstream of the intake structure (2) in the discharge canal at a point ca. 100 feet upstream of the walkway across the canal and (3) near the bank of the Cedar River ca. 100 feet below the discharge canal, well within the mixing zone for the effluent from the station.

The boxes were left in place for a period of 48 hours. During this period the boxes were periodically checked to determine fish condition and water temperature. Chlorine residuals were also determined during the period of condenser chlorination.

The fish were placed in the canal and river at 0900 hours on July 24 and showed no abnormal behavior during the first five hours. During this period chlorination of the condensers resulted in a maximum total residual chlorine concentration of <0.05 mg/l at both the discharge canal box and at the downstream river box at 1430 hours.

The first evidence of deteriorated fish condition was observed in the discharge canal box at 1400 hours when fish activity decreased markedly. The first dead fish was observed in the discharge canal and at the upstream box at 2100 hours on July 25 at which time three of 10 were dead in the upstream box and one of 10 was dead in the discharge canal. A summary of fish mortality is given below:

	Mortality		
Time Elapsed	Upstream	Downstream	Canal
0	0	0	0
0	0	0	0
12	0	0	0
18	0	0	0
24	0	0	0
30	0	0	0
36	30%	0	10%
40	40%	0	40%
44	90%	50%	40%
48	90%	80%	60%

Fish mortality was approximately equal in the upstream and downstream boxes, although no mortality was observed in the latter for 44 hours. Fish mortality in the discharge canal box was significantly less than at the other two boxes.

Water temperatures determined during the study ranged from 23.0°C (57.6°F) to 27.2°C (81.0°F). Maximum ΔT values between upstream river and canal temperatures was 2.7°C (4.9°F). Dissolved oxygen values ranged from 14.3 to 6.6 mg/1 and no significant differences were observed between canal and river samples.

The approximate equal mortality rate at the upstream and downstream stations after 48 hours indicates that factors unrelated to plant operation were the actual cause of death. One such factor could be the increased stress resulting from the pectoral spine catching and breaking off in the live box mesh holding the catfish in captivity. The stress of captivity alone could be a significant factor in the mortality rates.

Thermal Plume Mapping

Thermal plume studies were conducted on the Cedar River below the discharge canal at the Duane Arnold Energy Center on October 16. River discharge was approximately 800 cfs. At the time of the study station ouput was ca. 80 % of capacity. Water temperatures in the canal were 20.5^{o}C (68.9^{o}F) at the beginning of the study and 20.8^{o}C (69.4^{o}F) at the conclusion. Ambient (upstream) river temperature was 13.5^{o}C (56.3^{o}F). Temperatures were determined with a Model T-4 Marine Hydrographic Thermometer, manufactured by Hydrolab Corporation of Austin, Texas, at the surface and at a 2 foot depth. No water deeper than 4 feet was found in the plume area.

In general, the plume from the station was relatively homogeneous in temperature from the surface to the bottom and tended to hug the bank of the river. The maximum extent of the 5^{o}F excess isotherm was ca. 250 feet downstream and ca. 50 feet offshore.

The 1^{o}F excess isotherm extended ca. 500 feet downstream and 60 feet offshore. The estimated area of the river subjected to a ΔT of 5^{o}F or greater was ca. 0.14 acres. Less than 0.35 acres of the river was subjected to a ΔT of 1^{o}F or more.

Entrainment Studies

Three entrainment studies were conducted at the Duane Arnold Energy Center during the 1975 study period to obtain estimates of the volume and composition of plankton and larval fish entrained in the closed cycle cooling system.

On June 19 ten liters of water were collected just in front of the intake structure and zooplankton was concentrated by means of a plankton net. Zooplankton and larval fish sampling was also attempted by positioning a plankton net in front of the intake screens. Because of the current patterns in this area the plankton net collections were not successful. A sample of unconcentrated water was also collected at this time and phytoplankton determinations were made from this sample. Velocity of the water at the traveling screens was less than 0.5 fps. River flow at this time was 10,860 cfs and high turbidities in the river made accurate enumeration difficult. The results of entrainment studies are summarized in Table 43. The majority of the organisms collected were diatoms and flagellates with some blue-green algae. Crustaceans, rotifers and larval fish were not observed in any of the samples.

The second entrainment study was conducted on July 19. The plankton net was positioned in front of the intake structure for 5 minutes. Intake velocity was 0.21 fps during the study. A total volume of 623 liters were filtered through the net. No larval fish were collected and few zooplankton were observed in the sample. The results are summarized in Table 43.

On November 25 the plankton net was placed in front of the intake structure for 3 minutes for determination of the fall entrainment. Velocity was calculated as 0.24 fps at the intake structure and a total of 427 liters were filtered through the net. No larval fish were collected and few zooplankton were found in the sample. The results are summarized in Table 43.

DISCUSSION AND CONCLUSIONS

Results of the second year operational survey (January-December) 1975) are consistent with the earlier pre-operational and operational studies. As in previous years the major factor affecting the water quality of the Cedar River in the vicinity of the station was runoff from agricultural land. Turbidity, color, solids, phosphate, ammonia, nitrate, lignins and tannins, COD threshold odor and bacterial values frequently increased during high flow periods while minimum values usually occurred during low flow periods in the fall or winter. Differences in water quality between the 1974 and 1975 operational studies could also be attributed to hydrological differences between the two years. During the period August-December 1975, flow in the Cedar River was lower than during the comparable period in 1974. As might be expected several water quality parameters related directly to runoff, notably total solids, phosphate, nitrate and iron were also lower during the August-December 1975 period.

The effects of station operation on the water quality of the river were confined to a small area directly below the discharge canal. Because of evaporation from the cooling towers and the resulting concentrations of many parameters studied were frequently higher in the discharge canal and at river Station 3 (DAEC downstream), 140 feet downstream from the discharge canal than at upstream locations. However, concentrations of all parameters in samples from Station 4 (Comp Farm) about ½ mile below the station were generally similar to levels observed at the upstream sites. Statistical analysis of water quality data was carried out to determine if significant differences existed between the four river sampling stations. Parameters compared statistically are listed in Table 44 along with the observed range and mean for each variable.

A one-way analysis of variance with the student-Newman Keuls multiple comparison test as well as linear combination of averages of sites 1 and 2 (upstream) against averages of sites 3 and 4 (downstream) were employed to test for differences ($P \leq 0.05$) in the concentrations of those parameters listed in Table 44. Table 45 summarizes the results of these tests. As can be seen, only site 3 (DAEC downstream) exhibited significantly altered water quality, with sites 1, 2 and 4 being indistinguishable. Since site 3 was located directly in the discharge plume prior to mixing with the river it is nto unexpected to note altered water quality at this location. Blowdown discharge had become mixed with the river at Station 4 (Comp Farm) and the water quality had returned to the level observed in the river upstream of the Duane Arnold Energy Center.

Agricultural land runoff and the morphometry of the Cedar River appeared to be the major factors influencing the nature of the benthic (bottom fauna) community in the vicinity of the station. Limited numbers of chironomid (midge) arvae and tubificid worms were the only benthic organisms collected during the 1975 studies. This is not surprising considering the nature of the benthic habitat in the study area. The heavy sediment loads carried by the river and the lack of quiet backwater or rocky bottom areas have resulted in a benthic habitat characterized by limited diversity and consisting primarily of shifting sand and silt substrates. In previous studies samples taken from the few rocky areas in the vicinity of the station have contained a greater diversity or organisms including caddisfly larvae and mayfly nymphs, organisms generally indicative of fair to good water quality. None of the studies to date have indicated that the operation of the Duane Arnold Energy Center has affected the size or composition of the benthic community in the vicinity of the station.

During the 1975 period the composition of the fishery appeared to be similar to that observed in earlier operational and pre-operational surveys. Catch per unit of effort was somewhat lower than during the previous operational survey but no significant differences in the composition of the fishery between upstream and downstream sampling locations were observed. Carp and carpsucker were taken in greater abundance at the upstream stations during June while channel catfish were more abundant in the downstream locations in July. Carp, carpsucker and channel catfish were the dominant forms collected. Shiners were common in sein collections in July. As in previous years, other game fish were uncommon in the collections. The only evident effect of station operation on the fishery of the river was the attraction of some fish, primarily carp, to the warmer waters at the mouth of the discharge canal during the fall of 1975. The design of the discharge structure is such, however, that fish are unable to swim into the discharge canal where they would be most subject to thermal shock. No signs of thermal shock or other evidence of damage to the fishery as a result of the chemical or physical characteristics of the blowdown discharge were observed in the vicinity of the canal during the period. The results of the July live box studies also indicate that the impact of the blowdown discharge on the fishery of the river is minimal.

The results of the impingement and entrainment studies conducted during 1975 are comparable to the 1974 studies and indicate the the intake of make up water has little effect upon the limnology or the fishery of the river. The low intake velocity, small volume of water used and the design of the intake structure contributed to a minimal rate of impingement during the period.

Entrainment of planktonic organisms by the station is a minimal problem, due largely to the small volume of water entrained in relation to river flow. In addition, the majority of the fish species found in the Cedar River do not have a pelagic larval stage. Thus the number of immature fish available for entrainment is insignificant when compared to the total number of young produced.

Table 1

SUMMARY OF HYDROLOGICAL CONDITIONS
CEDAR RIVER AT CEDAR RAPIDS*

Date 1975	Mean Monthly Discharge (cfs)	Percent of 1941-1970 Median Discharge
January	1,622	179
February	1,228	75
March	8,516	140
April	10,775	228
May	8,861	188
June	8,658	209
July	3,952	132
August	1,254	72
September	1,251	73
October	818	67
November	1,105	78
December	1,490	141

*Data obtained from U. S. Geological Survey records.

Table 2

SUMMARY OF WATER TEMPERATURE DIFFERENTIALS
AND STATION OPERATIONAL DATA DURING
PERIODS OF CEDAR RIVER SAMPLING
1975

Date	ΔT (°C) U/S River (Sta.2) vs Disch. Canal (Sta.5)	ΔT (°C) U/S River (Sta.2) vs D/S River (Sta.3)	Station Output % of full power
Jan. 13	17.0	5.6	60
Jan. 27	----	---	65
Feb. 10	----	-0.2	0
Feb. 25	10.6	1.3	80
Mar. 10	18.4	0.9	87
Mar. 24	6.7	0	57
Apr. 7	9.4	0.7	92
Apr. 25	1.3	0	0
May 6	3.4	0.5	0
May 19	6.0	0.8	50
June 2	3.1	0.5	50
June 16	-1.1	-0.1	0
June 30	-2.9	0.5	0
July 14	-4.1	0	0
July 28	1.3	0.1	76
Aug. 11	---	-0.2	62
Aug. 25	-0.1	-0.6	64
Sep. 8	1.8	1.1	62
Sep. 22	7.4	3.8	79
Oct. 6	7.3	4.9	80
Oct. 20	9.3	4.5	80
Nov. 4	4.5	2.9	4
Nov. 17	12.8	6.8	80
Dec. 1	18.5	0.2	82
Dec. 15	16.1	8.9	22

TEMPERATURE
°C

Table 3

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	0	0	5.6	0.2	17.0
27	0	0	---	---	----
Feb. 10	0	0.2	0	0.2	----
25	0.5	0.2	1.5	0.8	10.8
Mar. 10	0.3	0.2	1.1	1.4	18.6
24	2.2	1.6	1.6	1.8	8.3
Apr. 7	5.2	5.1	5.8	5.0	14.5
25	12.4	12.0	12.0	11.9	13.3
May 6	16.0	15.5	16.0	15.8	18.9
19	21.0	21.1	21.9	20.7	27.0
June 2	18.1	18.2	18.7	18.0	21.3
16	18.0	17.9	17.8	18.0	16.8
30	27.4	27.2	27.7	27.2	24.3
July 14	21.1	21.2	21.2	20.4	17.1
28	26.2	26.9	27.0	26.2	28.2
Aug. 11	24.8	24.8	24.6	24.6	----
25	25.9	25.6	25.0	25.0	25.5
Sep. 8	21.6	21.9	23.0	20.9	23.7
22	14.6	15.0	18.8	14.8	22.4
Oct. 6	15.8	16.5	21.4	16.5	23.8
20	10.0	10.9	15.4	10.7	20.2
Nov. 4	15.2	15.4	18.3	16.8	19.9
17	9.4	11.0	17.8	9.6	23.8
Dec. 1	0	0	0.2	0.1	18.5
15	1.0	1.4	10.3	2.4	17.1

TURBIDITY
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Table 4

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	14	9	8	19	10
27	13	9	17	*420	13
Feb. 10	4	5	5	5	--
25	11	15	11	12	*270
Mar. 10	4	4	5	4	14
24	*260	*235	*210	*230	*165
Apr. 7	*260	*270	*270	*250	*210
25	31	30	31	28	26
May 6	39	41	40	40	35
19	24	28	19	25	29
June 2	29	29	25	31	46
16	*550	*500	*480	*480	*410
30	15	15	18	35	18
July 14	20	21	20	20	16
28	--	--	--	--	--
Aug. 11	7	10	8	11	--
25	5	6	10	5	23
Sep. 8	14	14	32	14	46
22	16	20	20	17	22
Oct. 6	14	18	20	16	23
20	15	25	24	14	30
Nov. 4	15	20	26	9	33
17	11	14	42	18	40
Dec. 1	22	17	34	13	84
15	8	8	20	8	21

*Read on Jackson apparatus

COLOR

Table 5

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	20	25	20	30	20
27	10	15	15	20	15
Feb. 10	10	10	10	10	--
25	10	10	15	10	15
Mar. 10	10	10	15	15	15
25	70	70	70	70	70
Apr. 7	40	40	50	40	40
25	20	15	15	15	10
May 6	20	20	20	20	20
19	15	15	15	15	15
June 2	20	20	20	20	45
16	40	40	40	40	70
30	20	15	15	15	20
Luly 14	20	20	20	20	15
28	30	30	30	40	50
Aug. 11	20	20	20	20	--
25	20	20	20	20	40
Sep. 8	15	15	20	20	30
22	50	50	50	50	50
Oct. 6	40	30	30	30	40
20	50	40	30	30	40
Nov. 4	30	30	30	40	40
17	20	20	40	20	60
Dec. 1	10	10	10	10	40
15	10	10	10	10	10

TOTAL SOLIDS
mg/1

Table 6

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	320	355	434	428	584
27	410	390	430	950	860
Feb. 10	430	420	420	410	---
25	398	392	392	---	2,854
Mar. 10	366	378	374	442	822
25	330	286	310	320	358
Apr. 7	590	575	600	560	822
25	430	420	430	360	420
May 6	540	550	530	600	480
19	500	530	520	540	610
June 2	440	430	410	440	990
16	1,240	1,140	1,170	1,140	800
30	540	580	520	540	450
July 14	480	510	470	510	430
28	340	340	880	370	1,350
Aug. 11	360	370	320	330	-----
25	344	412	534	344	1,202
Sep. 8	298	306	772	306	1,280
22	328	336	574	358	726
Oct. 6	298	308	624	328	788
20	308	304	520	328	726
Nov. 4	384	404	864	340	1,178
17	372	364	1,548	400	2,022
Dec. 1	408	394	654	370	2,080
15	388	382	470	382	520

TOTAL VOLATILE SOLIDS
mg/l

Table 7

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	106	137	146	150	140
27	90	120	100	160	670
Feb. 10	140	130	130	100	---
25	142	150	148	---	---
Mar. 10	70	118	106	106	166
24	89	94	102	100	82
Apr. 7	128	116	156	106	204
25	150	130	130	150	130
May 6	170	180	270	270	150
19	210	230	180	240	140
June 2	110	110	110	120	190
16	220	220	230	160	160
30	130	120	120	120	90
July 14	140	130	120	160	120
28	100	120	220	120	350
Aug. 11	90	90	70	60	---
25	140	84	112	144	204
Sep. 8	136	106	244	110	236
22	88	104	152	106	166
Oct. 6	98	106	152	114	166
20	110	96	148	100	190
Nov. 4	110	128	220	130	264
17	118	88	414	138	500
Dec. 1	80	84	128	84	362
15	86	78	108	82	126

TOTAL FIXED SOLIDS
mg/1

Table 8

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	214	218	288	278	444
27	320	270	330	790	190
Feb. 10	290	290	290	310	---
25	256	242	244	---	---
Mar. 10	296	260	268	336	656
24	241	182	208	220	276
Apr. 7	462	459	444	454	618
25	280	290	300	210	290
May 6	370	370	260	330	330
19	290	300	340	300	470
June 2	330	320	300	320	800
16	1,020	920	940	980	640
30	410	460	400	420	360
July 14	340	380	350	350	310
28	240	220	660	250	1,000
Aug. 11	270	280	250	270	-----
25	204	328	422	200	998
Sep. 8	162	200	478	196	1,044
22	240	232	422	252	560
Oct. 6	200	202	472	214	522
20	198	208	372	228	536
Nov. 4	274	276	644	210	914
17	254	276	1,134	262	1,522
Dec. 1	328	310	526	286	1,718
15	302	304	362	300	394

TOTAL DISSOLVED SOLIDS
mg/1

Table 9

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	304	337	418	328	570
27	370	370	410	200	830
Feb. 10	420	400	400	400	---
25	375	372	376	---	---
Mar. 10	360	360	347	357	751
24	175	200	175	167	265
Apr. 7	310	288	308	288	642
25	335	330	340	275	380
May 6	400	420	400	470	400
19	325	310	320	310	410
June 2	360	330	340	340	930
16	310	320	350	450	290
30	440	440	420	460	380
July 14	410	440	400	440	380
28	280	260	720	310	1,270
Aug. 11	270	260	260	240	-----
25	308	294	340	300	944
Sep. 8	224	242	570	222	876
22	274	282	520	313	667
Oct. 6	230	230	539	262	701
20	264	260	456	298	670
Nov. 4	319	326	782	321	1,098
17	330	318	1,423	376	1,916
Dec. 1	357	358	491	356	1,696
15	369	364	426	372	455

TOTAL SUSPENDED SOLIDS
mg/l

Table 10

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	16	18	16	100	14
27	40	20	20	750	30
Feb. 10	10	20	20	10	--
25	23	20	16	--	2,575
Mar. 10	6	18	27	85	71
24	155	86	135	53	93
Apr. 7	280	287	292	272	180
25	95	90	90	85	60
May 6	140	130	130	130	80
19	175	220	200	230	200
June 2	80	100	70	100	60
16	930	820	820	690	510
30	100	140	100	80	70
July 14	70	70	70	70	50
28	60	80	160	60	80
Aug. 11	90	110	60	90	---
25	36	118	194	44	258
Sep. 8	74	64	152	84	404
22	54	54	54	45	59
Oct. 6	68	78	85	66	87
20	44	44	64	30	56
Nov. 4	65	78	82	19	80
17	42	46	125	24	106
Dec. 1	51	36	163	14	384
15	19	18	44	10	65

SUSPENDED FIXED SOLIDS
mg/l

Table 11

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	13	14	14	90	10
27	30	15	15	710	25
Feb. 10	5	15	15	5	--
25	5	4	3	--	--
Mar. 10	5	17	25	78	77
24	128	66	105	123	66
Apr. 7	236	245	244	228	156
25	75	75	75	70	50
May 6	115	105	105	105	60
19	135	180	170	190	160
June 2	60	80	60	80	50
16	810	690	700	610	450
30	80	120	80	70	60
July 14	50	50	50	50	40
28	40	50	120	40	50
Aug. 11	50	70	20	50	--
25	32	100	180	34	228
Sep. 8	52	50	124	64	374
22	41	42	38	32	39
Oct. 6	41	50	53	39	56
20	30	28	40	16	31
Nov. 4	52	59	59	10	57
17	26	28	80	10	74
Dec. 1	44	31	150	12	346
15	14	13	42	8	58

SUSPENDED VOLATILE SOLIDS
mg/l

Table 12

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	3	4	2	10	4
27	10	<5	<5	40	5
Feb. 10	<5	<5	<5	<5	-
25	17	16	13	--	-
Mar. 10	1	1	2	7	4
24	27	20	30	30	27
Apr. 7	44	42	48	44	24
25	20	15	15	15	10
May 6	25	25	25	25	20
19	40	40	30	40	40
June 2	20	20	10	20	10
16	120	130	120	80	60
30	20	20	20	10	10
July 14	20	20	20	20	10
28	20	30	40	20	30
Aug. 11	40	40	40	40	--
25	4	18	14	10	30
Sep. 8	22	14	28	20	30
22	13	12	16	13	20
Oct. 6	27	28	32	27	31
20	14	16	24	14	25
Nov. 4	13	19	23	9	23
17	16	18	45	14	32
Dec. 1	7	5	13	2	38
15	5	5	2	2	7

DISSOLVED FIXED SOLIDS
mg/1

Table 13

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	201	204	274	188	434
27	290	255	315	80	165
Feb. 10	285	275	275	305	---
25	255	238	241	---	---
Mar. 10	291	243	243	258	579
24	113	116	103	97	210
Apr. 7	226	214	200	226	462
25	205	215	225	140	260
May 6	255	265	155	225	270
19	155	120	170	110	310
June 2	270	240	240	240	750
16	210	230	240	370	190
30	330	340	320	350	300
July 14	290	330	300	300	270
28	200	170	540	210	950
Aug. 11	220	210	230	220	---
25	172	228	242	166	770
Sep. 8	110	150	334	132	670
22	199	190	384	220	521
Oct. 6	159	152	419	175	566
20	168	180	332	212	505
Nov. 4	222	217	585	200	857
17	228	248	1,054	252	1,448
Dec. 1	284	279	376	274	1,372
15	288	291	320	292	336

DISSOLVED VOLATILE SOLIDS
mg/l

Table 14

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	103	133	144	140	136
27	80	115	95	120	665
Feb. 10	>135	>125	>125	>95	---
25	125	134	135	--	---
Mar. 10	69	117	104	99	164
24	62	74	72	70	55
Apr. 7	84	74	108	62	180
25	103	115	115	135	120
May 6	145	155	245	245	130
19	170	190	150	200	100
June 2	90	90	100	100	180
16	100	90	110	80	100
30	110	100	100	110	80
July 14	120	110	100	140	110
28	80	90	180	100	320
Aug. 11	50	50	30	20	---
25	136	66	98	134	174
Sep. 8	114	92	216	90	206
22	75	92	136	93	146
Oct. 6	71	78	120	87	135
20	96	80	124	86	165
Nov. 4	97	109	197	121	241
17	112	70	369	124	468
Dec. 1	73	79	115	82	324
15	81	73	106	80	119

DISSOLVED OXYGEN
mg/1

Table 15

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	11.0	11.3	10.3	10.5	9.2
27	10.5	10.1	10.6	9.4	8.6
Feb. 10	11.6	11.5	11.7	12.2	---
25	10.6	11.0	10.9	11.5	6.0
Mar. 10	11.7	11.5	11.3	8.0	12.0
24	9.6	9.0	7.6	9.3	8.7
Apr. 7	10.1	10.6	10.5	10.4	8.9
25	9.4	9.3	9.6	9.4	10.6
May 6	8.9	8.2	7.9	7.6	8.7
19	8.1	8.5	8.3	8.2	7.3
June 2	8.4	8.3	8.5	8.6	8.7
16	7.1	7.2	7.3	6.6	8.6
30	6.0	6.9	6.9	6.7	8.4
July 14	8.8	8.8	9.5	8.5	9.6
28	8.8	9.3	8.4	10.1	8.1
Aug. 11	9.3	8.9	9.4	7.7	---
25	4.5	4.6	4.9	4.5	6.2
Sep. 8	11.5	11.5	9.5	11.1	7.0
22	13.9	13.8	10.5	12.2	8.3
Oct. 6	15.3	13.2	8.2	15.6	6.8
21	12.0	11.3	9.4	12.9	7.8
Nov. 4	15.2	14.2	9.7	15.7	7.8
17	10.7	10.7	8.6	10.4	6.2
Dec. 1	12.3	11.9	11.0	11.8	5.0
15	11.2	8.5	9.6	10.8	7.6

CARBON DIOXIDE
(as $CaCO_3$) - mg/l

Table 16

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	5.3	5.3	5.3	5.3	5.3
27	8.8	8.8	8.8	7.0	7.0
Feb. 10	8.8	7.0	8.8	7.0	---
25	8.8	8.8	8.8	8.8	8.8
Mar. 10	7.0	8.8	8.8	8.8	0
24	8.8	8.8	7.0	7.0	7.0
Apr. 7	7.0	7.0	7.0	7.0	7.0
25	8.8	8.8	8.8	8.8	0
May 6	7.0	7.0	5.3	5.3	8.8
19	0	0	0	0	0
June 2	0	0	0	0	3.5
16	3.5	0	0	0	0
30	0	0	0	0	0
July 14	0	0	0	0	0
28	0	0	0	0	18.0
Aug. 11	0	0	0	0	---
25	5.3	3.5	3.5	3.5	5.3
Sep. 8	0	0	0	0	0
22	0	0	0	0	0
Oct. 6	0	0	0	0	3.5
20	0	0	0	0	3.5
Nov. 4	0	0	0	0	3.5
17	0	0	0	0	0
Dec. 1	0	0	0	0	5.3
15	0	0	0	0	0

TOTAL ALKALINITY
(as $CaCO_3$) - mg/l

Table 17

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	208	208	186	200	140
27	222	224	206	236	124
Feb. 10	244	242	248	240	---
25	222	216	216	216	196
Mar. 10	220	214	226	212	140
24	82	80	80	82	74
Apr. 7	164	168	168	166	148
25	180	178	180	182	208
May 6	196	190	180	184	204
19	206	208	200	200	100
June 2	184	194	184	188	44
16	176	186	180	180	202
30	216	210	212	202	222
July 14	226	214	226	226	234
28	212	212	204	216	176
Aug. 11	126	126	124	126	---
25	160	162	162	154	48
Sep. 8	116	114	84	112	70
22	156	158	110	150	76
Oct. 6	130	130	94	120	76
20	136	148	104	148	60
Nov. 4	182	172	102	162	50
17	200	210	280	200	162
Dec. 1	226	196	188	198	44
15	222	212	240	224	272

PHENOLPTHALEIN ALKALINITY
(as $CaCO_3$) - mg/l

Table 18

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	0	0	0	0	0
27	0	0	0	0	0
Feb. 10	0	0	0	0	-
25	0	0	0	0	0
Mar. 10	0	0	0	0	14
24	0	0	0	0	0
Apr. 7	0	0	0	0	0
25	0	0	0	0	14
May 6	0	0	0	0	0
19	10	14	12	12	8
June 2	4	4	6	6	0
16	0	-	-	-	-
30	6	6	8	6	12
July 14	20	16	16	20	14
28	22	20	8	14	0
Aug. 11	8	6	6	4	-
25	0	0	0	0	0
Sep. 8	24	26	10	22	4
22	16	18	8	16	4
Oct. 6	18	20	8	20	0
20	18	20	8	20	0
Nov. 4	24	24	8	24	0
17	10	8	8	8	10
Dec. 1	6	6	6	6	0
15	8	10	16	10	18

pH

Table 19

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	8.2	8.2	8.2	8.2	8.2
27	7.9	8.0	7.6	8.0	8.0
Feb. 10	8.0	8.1	8.1	8.1	---
25	8.2	8.2	8.2	8.2	8.2
Mar. 10	8.3	8.3	8.2	8.3	8.9
24	7.7	7.6	7.7	7.7	7.9
Apr. 7	8.1	8.1	8.1	8.1	8.1
25	8.1	8.1	8.1	8.1	8.6
May 6	8.0	8.0	7.9	8.0	8.0
19	8.3	8.4	8.4	8.4	8.3
June 2	8.3	8.3	8.3	8.3	7.5
16	8.2	8.4	8.3	8.4	8.6
30	8.5	8.5	8.5	8.5	8.8
July 14	8.9	8.9	8.9	8.9	8.8
28	8.8	8.6	8.5	8.8	7.8
Aug. 11	8.6	8.6	8.6	8.5	---
25	7.8	7.9	7.9	7.9	7.7
Sep. 8	9.6	9.5	8.9	9.5	8.3
22	9.0	9.1	8.9	9.0	8.6
Oct. 6	9.1	9.3	8.7	9.3	8.0
20	8.7	8.8	8.4	8.9	8.1
Nov. 4	9.3	9.3	8.6	9.4	8.1
17	8.5	8.4	8.4	8.4	8.4
Dec. 1	8.4	8.4	8.4	8.4	8.1
15	8.5	8.5	8.7	8.4	8.8

TOTAL HARDNESS
(as $CaCO_3$) - mg/1

Table 20

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	364	320	324	320	404
27	292	280	328	384	504
Feb. 10	376	324	296	304	---
25	308	260	276	276	296
Mar. 10	316	284	276	276	500
24	180	184	144	164	196
Apr. 7	184	228	216	216	420
25	268	248	268	264	296
May 6	264	268	264	284	272
19	272	284	296	300	416
June 2	268	272	264	276	404
16	288	308	264	296	272
30	280	276	276	280	272
July 14	292	264	256	276	276
28	240	228	468	228	692
Aug. 11	160	180	168	176	---
25	212	212	236	236	476
Sep. 8	160	140	296	144	408
22	188	224	388	220	396
Oct. 6	160	180	340	188	432
20	196	180	288	212	380
Nov. 4	196	220	440	208	464
17	260	272	892	264	1,720
Dec. 1	260	268	312	292	1,080
15	284	264	240	280	228

CALCIUM HARDNESS
(as $CaCO_3$) - mg/l

Table 21

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	248	268	272	236	308
27	200	200	224	204	360
Feb. 10	252	208	244	236	---
25	200	204	192	196	276
Mar. 10	204	184	188	200	352
24	80	88	116	100	176
Apr. 7	148	144	152	144	312
25	196	200	192	196	200
May 6	184	204	196	200	180
19	244	252	224	216	308
June 2	188	180	184	180	368
16	272	180	198	264	196
30	196	204	200	196	180
July 14	192	204	180	200	192
28	160	152	292	144	464
Aug. 11	88	84	80	84	---
25	120	124	148	116	360
Sep. 8	76	60	188	68	304
22	140	164	216	160	292
Oct. 6	88	97	208	84	280
20	100	96	160	132	212
Nov. 4	124	136	296	124	400
17	160	172	612	200	920
Dec. 1	180	172	208	172	708
15	200	232	204	208	200

TOTAL PHOSPHATE
mg/1

Table 22

Date 1975	Station1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	4.20	2.70	3.40	4.10	4.50
27	3.60	3.50	3.80	3.20	5.90
Feb. 10	4.00	3.90	3.40	3.60	----
25	2.40	1.50	1.50	1.35	1.65
Mar. 10	1.50	1.50	1.50	2.16	2.49
24	0.96	0.99	0.90	0.90	0.90
Apr. 7	0.88	0.90	0.84	0.93	1.23
25	0.84	1.03	0.78	0.78	0.72
May 6	0.65	0.67	0.60	0.63	0.71
19	0.45	0.49	0.51	0.52	0.49
June 2	0.45	0.40	0.42	0.38	0.58
16	0.30	0.50	0.53	0.42	0.42
30	0.59	0.69	0.56	0.65	0.58
July 14	0.54	0.48	0.48	0.51	0.45
28	0.52	0.51	0.72	0.35	0.79
Aug. 11	1.13	1.04	0.95	0.99	----
25	0.84	1.02	1.15	0.71	1.57
Sep. 8	0.80	0.61	1.31	0.52	1.90
22	0.52	0.52	0.55	0.55	1.07
Oct. 6	0.49	0.64	0.86	0.27	1.59
20	0.10	0.23	0.44	0.23	0.51
Nov. 4	0.22	0.23	0.44	0.13	0.55
17	0.25	0.26	0.60	0.27	0.83
Dec. 1	0.34	0.34	0.40	0.29	1.16
15	0.33	0.58	0.33	0.35	0.39

ORTHOPHOSPHATE
mg/l

Table 23

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	1.40	1.00	1.20	1.30	1.30
27	1.50	1.20	1.30	1.00	1.60
Feb. 10	1.60	1.38	1.55	1.52	----
25	0.93	0.95	1.05	1.15	1.30
Mar. 10	1.15	1.15	1.20	1.40	1.50
24	0.65	0.67	0.65	0.79	0.61
Apr. 7	0.75	0.75	0.75	0.69	1.05
25	0.55	0.58	0.55	0.50	0.48
May 6	0.63	0.63	0.45	0.58	0.69
19	0.44	0.48	0.44	0.40	0.53
June 2	0.40	0.35	0.45	0.36	0.55
16	0.34	0.55	0.55	0.45	0.48
30	0.41	0.48	0.47	0.40	0.42
July 14	0.36	0.36	0.36	0.52	0.39
28	0.07	0.06	0.16	0.04	0.27
Aug. 11	0.11	0.14	0.08	0.11	----
25	0.46	0.46	0.50	0.43	0.91
Sep. 8	<0.03	<0.03	<0.03	<0.03	<0.03
22	0.03	<0.03	0.03	0.03	0.09
Oct. 6	0.12	0.28	0.40	0.15	0.34
20	0.03	0.05	0.11	0.03	0.20
Nov. 4	0.08	0.09	0.25	0.04	0.40
17	0.20	0.21	0.50	0.21	0.71
Dec. 1	0.26	0.24	0.34	0.23	0.74
15	0.15	0.16	0.15	0.14	0.22

AMMONIA
(as N) - mg/1

Table 24

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	0.63	0.55	0.33	0.52	0.28
27	0.58	0.58	0.52	0.60	0.19
Feb. 10	0.75	0.85	0.79	0.75	----
25	0.60	0.40	0.50	0.50	0.20
Mar. 10	0.70	0.55	0.55	1.00	0.72
24	1.24	1.20	1.12	1.20	0.72
Apr. 7	0.72	0.96	0.80	0.80	0.20
25	0.16	0.16	0.32	0.12	T
May 6	0.24	0.08	0.12	0.20	0.12
19	0.17	0.11	0.07	0.11	0.09
June 2	0.70	0.67	0.10	0.30	0.16
16	0.04	0.08	0.12	0.08	0.24
30	0.20	0.28	T	0.12	0.08
July 14	0.18	0.02	0.14	0.06	0.02
28	0.10	0.06	0.08	0.06	0.08
Aug. 11	0.18	0.15	0.10	0.20	----
25	0.05	0.11	0.10	0.18	0.11
Sep. 8	0.12	0.09	0.08	0.09	0.08
22	T	T	T	T	T
Oct. 6	0.24	0.04	0.08	0.16	0.08
20	0.04	0.02	0.04	0.06	0.08
Nov. 4	0.02	0.02	0.14	0.01	0.10
17	0.01	0.01	0.04	0.02	0.90
Dec. 1	0.26	0.28	0.26	0.20	0.48
15	0.34	0.28	0.28	0.42	0.26

NITRATE
(as N) - mg/l

Table 25

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	1.10	0.90	1.10	1.20	1.30
27	1.75	1.20	0.95	1.25	2.15
Feb. 10	3.00	2.80	2.80	0.70	----
25	4.40	4.00	3.70	4.20	6.00
Mar. 10	4.90	5.10	5.00	5.80	10.00
24	0.80	1.80	0.40	1.25	0.60
Apr. 7	5.50	5.00	5.50	5.50	8.00
25	8.00	7.60	8.00	7.60	3.80
May 6	7.20	7.20	5.70	8.00	3.80
19	4.80	5.00	4.50	3.80	7.30
June 2	5.80	4.50	4.80	4.50	9.20
16	----	----	----	----	----
30	1.80	6.40	2.60	5.00	5.80
July 14	7.00	12.00	12.20	9.80	8.00
28	0.41	0.33	0.63	0.36	0.82
Aug. 11	0.06	0.06	0.05	0.05	----
25	0.24	0.42	0.36	0.36	2.10
Sep. 8	0.06	0.06	0.12	0.08	0.82
22	0.18	0.25	0.40	0.28	0.62
Oct. 6	0.16	0.18	0.68	0.24	1.92
20	0.04	0.06	0.08	1.84	0.50
Nov. 4	0.26	0.26	2.18	0.80	4.40
17	1.20	1.10	5.10	1.40	9.20
Dec. 1	4.05	4.60	4.85	3.65	9.70
15	4.52	4.97	5.18	4.76	5.79

IRON
mg/1

Table 26

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	0.40	0.40	0.38	0.77	0.45
27	0.30	0.22	0.41	----	0.68
Feb. 10	0.06	0.06	0.10	0.10	----
25	0.09	0.25	0.10	0.20	2.90
Mar. 10	0.11	0.21	0.19	0.40	0.14
24	0.62	0.32	0.30	0.48	0.24
Apr. 7	0.50	0.30	0.30	0.30	0.30
25	0.77	0.61	0.91	0.54	0.73
May 6	0.87	0.89	0.89	0.94	0.83
19	0.53	0.35	0.46	0.46	0.53
June 2	0.06	0.04	0.02	0.03	0.04
16	0.48	0.19	0.32	0.48	0.75
30	0.11	0.14	0.15	0.11	0.24
July 14	0.22	0.32	0.29	0.30	0.22
28	0.24	0.24	0.50	0.27	0.52
Aug. 11	0.51	0.27	0.27	0.51	----
25	0.16	0.13	0.42	0.11	0.38
Sep. 8	0.10	0.02	0.27	0.10	0.48
22	0.02	0.02	0.09	0.02	0.13
Oct. 6	0.02	0.02	0.12	0.06	0.32
20	0.12	0.08	0.12	0.08	0.20
Nov. 4	0.14	0.09	0.13	0.10	0.21
17	0.02	0.02	0.08	0.02	0.10
Dec. 1	0.10	0.05	0.11	0.04	0.36
15	0.04	0.04	0.12	0.02	0.14

LIGNINS & TANNINS
mg/1

Table 27

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	1.20	1.10	1.30	1.60	1.30
27	0.05	T	0.55	0.10	2.65
Feb. 10	0.60	0.75	0.90	0.75	----
25	0.70	0.70	0.70	0.70	0.70
Mar. 10	0.55	0.55	0.50	1.10	1.00
24	1.15	1.13	1.15	1.70	0.78
Apr. 7	0.10	0.10	0.10	0.10	0.10
25	0.40	0.33	0.40	0.47	0.70
May 6	0.05	0.05	0.05	0.06	0.01
19	0.40	0.10	0.15	0.10	0.50
June 2	1.03	0.88	0.45	0.70	2.62
16	0.30	0.25	0.14	0.35	0.05
30	0.55	0.47	0.35	0.45	0.47
July 14	0.75	0.78	0.78	0.70	0.50
28	0.07	0.09	1.00	0.07	1.60
Aug. 11	0.25	0.30	0.32	0.25	----
25	0.72	0.90	0.91	0.80	0.77
Sep. 8	0.08	0.12	0.28	0	0.32
22	0.42	0.42	0.42	0.50	0.50
Oct. 6	0.50	0.58	0.58	0.58	0.66
20	0.58	0.58	0.58	0.67	0.67
Nov. 4	0.58	0.50	0.58	0.50	0.58
17	0.50	0.25	0.66	0.42	0.90
Dec. 1	0.42	0.25	0.34	0.25	1.07
15	0.12	0.11	0.10	0.12	0.12

CHEMICAL OXYGEN DEMAND
mg/l

Table 28

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	24	--	32	48	----
27	15	40	25	55	14.0
Feb. 10	18	15	10	20	----
25	9	7	9	14	44
Mar. 10	14	14	36	14	54
24	97	40	15	32	58
Apr. 7	56	88	104	80	48
25	16	40	48	32	12
May 6	44	60	84	52	40
19	56	56	60	64	68
June 2	8.7	13.1	4.4	43.6	48
16	53	39	39	53	15
30	12	8	12	4	16
July 14	8	20	16	24	12
28	8	8	36	36	56
Aug. 11	48	40	40	52	--
25	32	36	44	52	76
Sep. 8	68	52	84	60	132
22	40	16	4	12	16
Oct. 6	40.4	40.4	40.8	40.4	88
20	40	32	48	20	48
Nov. 4	97	96	96	60	116
17	36	40	48	44	40
Dec. 1	20	12	28	20	88
15	40	28	20	8	24

BIOCHEMICAL OXYGEN DEMAND
(5 Day) - mg/l

Table 29

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	5.0	3.5	3.9	4.2	3.2
27	---	---	---	---	---
Feb. 10	1.9	1.8	2.2	1.3	---
25	1.5	1.4	1.7	2.7	1.8
Mar. 10	3.0	2.0	3.0	3.0	3.0
24	5.9	4.3	4.2	4.5	4.5
Apr. 7	3.8	4.0	3.6	4.0	5.0
25	3.0	3.0	3.2	2.8	3.2
May 6	4.8	5.0	5.2	4.8	4.6
19	5.0	4.4	4.3	4.4	4.5
June 2	2.3	2.7	2.8	3.0	3.2
16	2.7	3.4	3.3	4.0	2.9
30	3.2	3.2	3.1	3.0	2.0
July 14	7.3	6.3	6.5	6.1	3.9
28	7.2	7.3	7.3	7.9	7.5
Aug. 11	10.2	9.8	9.4	10.0	---
25	5.6	5.1	6.2	5.7	9.2
Sep. 8	15.2	14.8	14.2	14.4	13.2
22	11.0	10.2	11.2	9.2	11.8
Oct. 6	16.0	18.0	17.0	14.0	17.0
20	18.0	13.8	18.6	13.2	16.5
Nov. 4	14.2	14.8	14.6	9.4	14.0
17	5.8	6.0	8.8	6.6	9.4
Dec. 1	3.2	3.0	4.4	2.2	8.2
15	0.9	0.9	3.6	3.0	3.6

THRESHOLD ODOR NUMBER

Table 30

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	7.5	18	10	18	24
27	7.5	10	10	--	13
Feb. 10	10	13	13	10	--
25	13	10	13	7.5	13
Mar. 10	10	10	13	13	13
24	24	18	24	18	24
Apr. 7	7.5	18	18	18	13
25	10	10	7.5	5.6	10
May 6	5.6	7.5	7.5	10	10
19	10	7.5	13	10	13
June 2	10	10	13	13	18
16	13	10	10	10	13
30	13	7.5	13	13	18
July 14	13	13	13	18	10
28	13	13	13	7.5	13
Aug. 11	7.5	10	10	10	--
25	13	18	18	18	18
Sep. 8	7.5	13	10	7.5	10
22	13	7.5	10	10	18
Oct. 6	7.5	10	13	7.5	18
20	5.6	13	13	10	18
Nov. 4	7.5	7.5	18	10	18
17	10	10	18	10	24
Dec. 1	7.5	10	18	18	18
15	13	13	13	13	18

TOTAL BACTERIA 37°
organisms/100 ml

Table 31

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	>10,000,000	300,000	>10,000,000	1,500,000	>10,000,000
27	290,000	200,000	520,000	---------	1,030,000
Feb. 10	100,000	110,000	210,000	30,000	---------
25	30,000	170,000	100,000	170,000	2,900,000
Mar. 10	210,000	320,000	260,000	280,000	400,000
24	800,000	1,400,000	600,000	700,000	3,300,000
Apr. 7	140,000	6,000,000	15,000,000	220,000	300,000
25	80,000	100,000	110,000	150,000	140,000
May 6	150,000	110,000	100,000	230,000	120,000
19	80,000	50,000	50,000	100,000	420,000
June 2	120,000	320,000	180,000	330,000	340,000
16	2,200,000	2,600,000	1,100,000	1,000,000	1,700,000
30	140,000	110,000	150,000	280,000	130,000
July 14	290,000	1,530,000	290,000	150,000	780,000
28	470,000	740,000	7,700,000	950,000	560,000
Aug. 11	1,420,000	250,000	150,000	30,000	-------
25	1,800,000	2,200,000	3,400,000	800,000	13,000,000
Sep. 8	200,000	210,000	670,000	1,500,000	29,300,000
22	150,000	1,300,000	1,300,000	300,000	2,400,000
Oct. 6	10,000	30,000	1,280,000	150,000	2,500,000
20	110,000	40,000	900,000	80,000	1,500,000
Nov. 4	40,000	930,000	5,100,000	270,000	16,200,000
17	300,000	1,100,000	43,000,000	190,000	67,200,000
Dec. 1	270,000	240,000	480,000	760,000	92,000,000
15	170,000	150,000	480,000	450,000	1,240,000

TOTAL BACTERIA 20°
organisms/100 ml

Table 32

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Mar. 24	700,000	500,000	200,000	200,000	-------
Apr. 7	50,000	<10,000	20,000	80,000	100,000
25	90,000	80,000	130,000	40,000	150,000
May 6	300,000	210,000	360,000	200,000	150,000
19	10,000	10,000	30,000	10,000	50,000
June 2	60,000	60,000	70,000	210,000	220,000
16	1,000,000	1,200,000	1,100,000	100,000	1,000,000
30	<10,000	<10,000	---------	<10,000	10,000
July 14	<10,000	<10,000	<10,000	<10,000	<10,000
28	<10,000	<10,000	<10,000	<10,000	<10,000
Aug. 11	30,000	10,000	20,000	10,000	------
25	810,000	720,000	270,000	190,000	1,900,000
Sep. 8	<10,000	10,000	30,000	<10,000	30,000
22	60,000	<10,000	60,000	30,000	360,000
Oct. 6	20,000	40,000	50,000	20,000	120,000
20	<10,000	<10,000	<10,000	<10,000	<10,000
Nov. 4	30,000	90,000	280,000	50,000	150,000
17	120,000	160,000	250,000	90,000	300,000
Dec. 1	30,000	40,000	110,000	170,000	260,000
15	80,000	120,000	130,000	80,000	90,000

TOTAL COLIFORM
organisms/100 ml

Table 33

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	10,000	2,000	9,000	1,700	1,900
27	9,600	4,400	3,700	-----	600
Feb. 10	2,500	1,800	2,300	2,100	---
25	6,200	1,000	4,700	2,000	10,000
Mar. 10	2,800	3,000	3,400	2,700	3,100
24	2,400	2,300	2,500	3,000	3,200
Apr. 7	3,200	3,400	2,800	4,500	1,200
25	1,300	2,300	2,700	2,200	3,200
May 6	3,200	2,700	2,600	1,600	2,700
19	1,500	400	1,000	800	400
June 2	2,000	2,600	2,100	2,600	3,600
16	15,000	23,000	12,000	23,000	13,000
30	3,200	1,800	2,000	1,900	1,500
July 14	1,000	1,800	1,300	1,400	1,400
28	200	300	500	100	500
Aug. 11	1,900	900	1,400	1,000	---
25	800	500	700	500	300
Sep. 8	1,500	500	2,600	100	2,600
22	600	200	100	200	700
Oct. 6	200	300	3,200	1,000	4,500
20	300	<100	400	<100	1,900
Nov. 4	2,300	1,800	20,000	<100	35,000
17	2,400	2,100	18,000	2,500	28,000
Dec. 1	12,000	9,000	16,000	6,000	40,000
15	400	500	600	700	400

FECAL COLIFORM
organisms/100 ml

Table 34

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge	Sewage Effluent
Jan. 13	1,000	600	500	600	600	7,000
27	390	90	140	---	30	180,000
Feb. 10	320	10	80	10	--	-------
25	1,100	<10	350	40	200	<1,000
Mar. 10	190	120	420	170	360	8,000
24	1,180	1,000	990	750	1,000	26,000
Apr. 7	360	460	300	610	180	6,000
25	860	670	840	620	450	1,000
May 6	110	200	170	160	260	1,000
19	110	140	80	80	160	2,000
June 2	710	960	910	850	1,220	<1,000
16	8,700	5,200	8,300	8,300	800	2,000
30	260	100	300	410	310	4,000
July 14	170	180	120	160	100	8,000
28	30	30	30	10	60	12,000
Aug. 11	50	50	50	60	--	4,000
25	200	200	--	300	<10	20,000
Sep. 8	210	30	10	30	700	12,000
22	520	<10	10	10	<10	7,000
Oct. 6	150	160	500	40	1,500	3,000
20	100	<10	<10	<10	50	3,000
Nov. 4	800	800	4,700	30	32,500	3,000
17	180	290	<10	140	<10	5,000
Dec. 1	3,400	2,800	4,800	4,300	15,200	4,000
15	380	360	430	560	330	5,000

FECAL STREPTOCOCCUS
organisms/100 ml

Table 35

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	7,000	5,400	5,800	6,600	4,100
27	200	160	120	-----	80
Feb. 10	160	100	40	10	--
25	230	130	210	80	100
Mar. 10	190	110	180	180	60
24	2,100	3,000	2,600	2,500	300
Apr. 7	60	60	40	40	10
25	210	100	100	240	50
May 6	60	100	50	90	100
19	50	50	30	30	60
June 2	200	240	270	240	210
16	4,400	6,300	4,800	6,800	4,900
30	320	360	310	350	190
July 14	70	100	20	60	80
28	200	210	270	210	260
Aug. 11	2,500	1,250	970	1,210	---
25	60	170	120	190	530
Sep. 8	<10	20	180	40	140
22	10	<10	30	10	30
Oct. 6	20	<10	40	30	90
20	<10	10	60	10	190
Nov. 4	20	70	120	40	520
17	90	50	340	60	850
Dec. 1	8,700	9,100	8,400	5,300	8,400
15	230	240	350	330	410

TOTAL PLANKTON
organisms/ml

Table 36

Date 1975	Station 1 Lewis Access	Station 2 DAEC Upstream	Station 3 DAEC Downstream	Station 4 Comp Farm	Station 5 Discharge
Jan. 13	800	1,120	1,310	930	1,020
27	1,700	1,520	1,790	---	2,180
Feb. 10	600	820	620	620	-----
25	1,020	980	800	1,070	24,320
Mar. 10	800	780	730	1,020	3,500
24	5,120	3,680	4,160	4,960	2,430
Apr. 7	2,080	3,520	3,200	3,360	4,640
25	4,220	3,460	2,940	3,330	3,460
May 6	15,810	16,480	19,400	15,490	12,800
19	26,410	27,720	22,630	22,450	29,060
June 2	8,870	9,660	10,830	7,950	15,550
16	-----	-----	------	-----	------
30	8,300	10,200	10,570	7,350	6,590
July 14	41,480	31,320	35,810	31,030	25,480
28	24,610	34,380	41,830	32,760	45,400
Aug. 11	61,270	44,030	47,050	56,480	------
25	15,520	17,770	17,750	7,790	34,180
Sep. 8	100,020	86,640	108,463	104,370	135,470
22	101,850	91,490	105,080	84,170	113,790
Oct. 6	109,410	122,860	169,420	150,720	173,180
20	83,650	85,600	106,690	107,610	119,740
Nov. 4	82,190	83,320	121,360	65,300	160,320
17	37,320	39,880	94,270	39,880	159,360
Dec. 1	13,130	15,650	11,370	12,510	68,960
15	6,340	5,600	9,540	5,070	11,460

Table 37
QUARTERLY CHEMICAL ANALYSES

Station	Nitrogen as NO_2 mg/l	Cl^- mg/l	$SO_4^=$ mg/l	Mn mg/l	Zn mg/l	Cu mg/l	Cr^{+6} mg/l	Pb mg/l	Hg µg/l
May 6, 1975									
1. Lewis Access	<0.001	19.0	33.0	<0.05	<0.01	0.02	<0.01	<0.01	2.0
2. Upstream	<0.001	22.5	32.0	<0.05	<0.01	0.03	<0.01	<0.01	2.0
3. Downstream	<0.001	46.0	28.0	<0.05	<0.01	0.02	<0.01	<0.01	2.2
4. Comp Farm	<0.001	44.0	24.5	<0.05	<0.01	<0.01	<0.01	<0.01	1.1
5. Discharge	0.005	65.5	23.0	<0.05	<0.01	<0.01	<0.01	<0.01	1.1
July 28, 1975									
1. Lewis Access	0.02	18.5	46.0	0.20	0.015	0.085	<0.01	0.019	0.2
2. Upstream	0.02	18.0	49.0	0.15	0.015	0.080	<0.01	0.017	0.1
3. Downstream	0.02	31.5	425.0	0.21	0.015	0.060	<0.01	0.019	<0.1
4. Comp Farm	0.02	17.5	58.0	0.16	0.012	0.075	<0.01	0.015	<0.1
5. Discharge	0.02	50.5	660.0	0.15	0.015	0.085	<0.01	0.021	<0.1
October 20, 1975									
1. Lewis Access	0.04	30.0	66.7	0.25	<0.010	0.124	0.055	<0.01	---
2. Upstream	0.06	31.1	75.5	0.27	0.014	0.110	0.023	<0.01	---
3. Downstream	0.08	37.0	55.0	0.27	0.013	0.084	0.025	<0.01	---
4. Comp Farm	1.84	17.8	43.3	0.31	0.012	0.082	0.014	<0.01	---
5. Discharge	0.50	52.2	167.0	0.36	0.012	0.089	0.014	<0.01	---

Table 38
TWENTY-FOUR HOUR CHEMICAL ANALYSIS
May 5-6, 1975

Station	Time	D.O. mg/l	CO_2 mg/l	Alkalinity as $CaCO_3$ Phth.	Alkalinity as $CaCO_3$ Total	pH	Water Temp.°C	Air Temp.°C
1. Lewis Access	1800	9.1	7.0	0	---	---	17.4	28
	2115	8.8	7.0	0	192	---	16.2	17
	0100	8.8	10.6	0	186	---	15.2	14
	0345	8.8	10.6	0	176	---	15.0	11
	0735	9.0	5.3	0	180	8.0	14.9	12
	1045	8.9	7.0	0	196	8.0	16.0	18
	1400	9.0	7.0	0	184	7.9	16.1	20
	1715	7.9	5.3	0	192	8.0	16.4	18
2. DAEC Upstream	1840	9.0	7.0	0	---	---	16.8	28
	2140	8.8	8.8	0	162	---	16.2	17
	0130	8.6	10.6	0	174	---	14.6	14
	0415	8.5	10.6	0	184	---	14.0	11
	0800	8.9	5.3	0	180	8.0	15.0	12
	1115	8.2	7.0	0	190	8.0	15.5	18
	1420	8.0	7.0	0	184	8.0	16.1	20
	1735	8.9	5.3	0	182	8.0	16.2	18
3. DAEC Downstream	1850	9.0	7.0	0	---	---	17.2	28
	2145	8.8	8.8	0	180	---	16.4	17
	0135	8.8	10.6	0	174	---	14.8	14
	0420	8.7	10.6	0	186	---	14.4	11
	0805	8.5	5.3	0	182	8.0	14.9	12
	1125	7.9	5.3	0	180	7.9	16.0	18
	1430	8.0	7.0	0	186	8.0	16.0	20
	1740	8.6	5.3	0	178	8.2	16.8	18

Table 38 (con't)
TWENTY-FOUR HOUR CHEMICAL ANALYSIS
May 5-6, 1975

Station	Time	D.O. mg/l	CO_2 mg/l	Alkalinity as $CaCO_3$ Phth.	Alkalinity as $CaCO_3$ Total	pH	Water Temp. °C	Air Temp. °C
4. John Comp Farm	1920	8.9	7.0	0	---	---	16.8	28
	2215	8.8	8.8	0	172	---	16.4	17
	0200	8.7	10.6	0	166	---	15.2	14
	0450	8.4	10.6	0	194	---	15.0	11
	0820	8.7	7.2	0	176	7.8	14.9	12
	1150	7.6	5.3	0	184	8.0	15.8	18
	1450	7.8	7.0	0	184	8.0	16.3	20
	1800	7.4	5.3	0	186	8.2	16.4	18
5. Discharge Canal	1855	8.7	7.0	0	---	---	20.4	28
	2140	8.3	8.8	0	184	---	19.0	17
	0130	8.3	10.6	0	200	---	16.4	14
	0415	8.3	12.3	0	172	---	16.2	11
	0805	8.8	5.3	0	204	8.0	17.2	12
	1130	8.7	8.8	0	204	8.0	18.9	18
	1430	8.7	5.3	0	208	8.0	18.0	20
	1740	8.6	7.0	0	200	8.2	18.1	18

Table 38 (con't)
TWENTY-FOUR HOUR CHEMICAL ANALYSIS
July 28-29, 1976

Station	Time	D.O. mg/l	CO_2 mg/l	Alkalinity as $CaCO_3$ Phth.	Alkalinity as $CaCO_3$ Total	pH	Water Temp. °C	Air Temp. °C
1. Lewis Access	0600	7.0	0	14	212	8.7	25.6	18.0
	0915	8.8	0	22	212	8.8	26.2	24.4
	1230	11.6	0	22	212	8.9	27.7	35.0
	1545	14.4	0	26	196	9.0	29.2	----
	1945	13.2	0	18	172	8.8	28.6	26.0
	2300	10.3	0	16	170	8.8	27.2	22.5
	0215	8.7	0	10	164	8.6	26.2	18.0
	0515	7.0	0	12	164	8.8	25.3	16.0
2. DAEC Upstream	0624	7.2	0	14	196	8.3	25.4	18.0
	0927	9.3	0	20	212	8.6	26.9	24.4
	1242	11.7	0	24	212	8.9	27.7	35.0
	1555	12.9	0	26	196	8.9	29.0	----
	2010	12.0	0	16	156	8.8	28.2	26.0
	2330	10.3	0	10	164	8.7	27.8	22.5
	0240	8.3	0	10	172	8.6	26.6	18.0
	0540	7.1	0	10	164	8.8	25.6	16.0
3. DAEC Downstream	0630	7.5	0	18	208	8.6	25.5	18.0
	0935	8.4	0	8	204	8.5	27.0	24.4
	1301	10.9	0	14	166	8.7	27.5	35.0
	1610	10.6	0	24	164	8.8	29.4	----
	2020	8.8	0	8	110	8.5	29.1	26.0
	2340	9.0	0	8	120	8.5	27.4	22.5
	0250	8.5	0	10	166	8.6	26.1	18.0
	0550	7.0	0	8	164	8.7	25.0	16.0

Table 38 (con't)
TWENTY-FOUR HOUR CHEMICAL ANALYSIS
July 28-29, 1975

Station	Time	D.O. mg/l	CO_2 mg/l	Alkalinity as $CaCO_3$ Phth.	Alkalinity as $CaCO_3$ Total	pH	Water Temp. °C	Air Temp. °C
4. John Comp Farm	0641	8.2	0	18	210	8.3	25.6	18.0
	0955	10.1	0	14	216	8.8	26.2	24.4
	1330	12.1	0	20	202	8.9	28.0	35.0
	1627	12.2	0	26	192	8.9	28.4	----
	2030	12.0	0	14	150	8.7	28.5	26.0
	2400	9.6	0	10	152	8.6	27.4	22.5
	0310	8.5	0	10	162	8.6	26.0	18.0
	0605	7.2	0	10	164	8.8	25.6	16.0
5. Discharge Canal	0635	---	-	--	---	---	----	18.0
	0940	8.1	18	0	176	7.8	28.2	24.4
	1300	8.1	12	0	34	7.8	28.8	35.0
	1605	8.5	0	14	144	8.8	29.6	----
	2017	6.3	7.0	0	58	8.1	28.6	26.0
	2335	7.5	3.5	0	70	8.1	27.4	22.5
	0255	---	--	-	--	---	----	18.0
	0555	---	--	-	--	---	----	16.0

Table 38 (con't)
TWENTY-FOUR HOUR CHEMICAL ANALYSIS
October 20-21, 1975

Station	Time	D.O. mg/1	CO_2 mg/1	Alkalinity as $CaCO_3$ Phth.	Total	pH	Water Temp. °C	Air Temp. °C
1. Lewis Access	0600	10.4	0	10	138	8.5	9.8	8.0
	0915	12.0	0	18	136	8.7	10.0	13.4
	1230	14.5	0	20	148	8.8	12.9	20.0
	1545	15.9	0	26	134	9.0	13.4	21.8
	2050	15.5	0	22	138	8.8	12.5	13.5
	2235	13.6	0	22	128	8.9	12.2	8.5
	0205	11.9	0	14	132	8.7	11.6	6.0
	0500	11.0	0	12	132	8.6	11.0	7.0
2. DAEC Upstream	0630	10.7	0	12	146	8.6	10.0	8.0
	0950	11.3	0	20	148	8.8	10.9	13.4
	1250	13.7	0	24	148	8.9	12.8	20.0
	1605	14.5	0	24	148	9.0	14.0	21.8
	2005	15.0	0	22	136	9.0	12.5	13.5
	2300	12.5	0	20	130	8.9	12.1	8.5
	0230	11.3	0	16	128	8.8	11.6	6.0
	0530	10.1	0	12	120	8.6	11.2	7.0
3. DAEC Downstream	0640	9.1	0	2	102	8.3	13.2	8.0
	1000	9.4	0	8	104	8.4	15.4	13.4
	1300	9.8	0	8	100	8.5	17.8	20.0
	1610	8.4	0	10	90	8.7	18.5	21.8
	2015	10.4	0	10	98	8.4	16.4	13.5
	2315	9.8	0	8	94	8.5	15.7	8.5
	0235	9.0	1.8	0	94	8.2	15.1	6.0
	0535	9.4	1.8	0	92	8.1	14.2	7.0

Table 38 (con't)
TWENTY-FOUR HOUR CHEMICAL ANALYSIS
October 20-21, 1975

Station	Time	D.O. mg/l	CO_2 mg/l	Alkalinity as $CaCO_3$ Phth.	Alkalinity as $CaCO_3$ Total	pH	Water Temp. °C	Air Temp. °C
4. John Comp Farm	0710	9.8	0	12	146	8.7	8.8	8.0
	1030	12.9	0	20	148	8.9	10.7	13.4
	1320	13.8	0	24	156	9.0	13.7	20.0
	1635	10.7	0	28	134	9.1	14.4	21.8
	1935	16.3	0	26	134	9.0	12.8	13.5
	2335	12.7	0	10	134	8.7	11.8	8.5
	0305	8.8	0	10	126	8.5	11.2	6.0
	0600	9.6	0	8	122	8.4	11.0	7.0
5. Discharge Canal	0645	7.2	3.5	0	66	8.1	17.0	8.0
	1010	7.8	3.5	0	60	8.1	20.2	13.4
	1300	6.7	5.3	0	56	8.0	23.0	20.0
	1610	6.3	3.2	0	56	8.1	23.5	21.8
	2015	6.4	3.5	0	62	6.4	20.6	13.5
	2315	7.0	3.5	0	62	6.2	19.6	8.5
	0235	7.0	3.5	0	58	6.3	19.0	6.0
	0535	6.5	3.5	0	62	6.2	18.6	7.0

Table 39
Fishery Survey - Species Composition
June 5-6, 1975

Species	ABOVE DAEC				BELOW DAEC			
	NETS (3 Net Days)		SHOCKING (45 minutes)		NETS (4 Net Days)		SHOCKING (50 minutes)	
	Number	Weight (lbs)	Number	Weight (lbs)	Number	Weight (lbs)	Number	Weight (lbs)
Buffalo	-	-	2	4.25	-	-	1	1.75
Carp	1	1.75	24	44.75	1	1.25	12	18.0
Carpsucker	-	-	62	29.50	2	1.50	12	7.0
Channel Catfish	8	1.13	-	-	24	4.25	1	0.75
Flathead Catfish	1	1.25	-	-	-	-	-	-
Northern Redhorse	-	-	3	4.00	1	1.75	1	1.75

Table 39 (con't)
Fishery Survey - Species Composition
July 22-24, 1975

Species	ABOVE DAEC			BELOW DAEC		
	NETS (6 Net Days)		SEINES (3 Hauls)	NETS (8 Net Days)		SEINES (3 Hauls)
	Number	Weight (lbs)	Number	Number	Weight (lbs)	Number
Carpsucker	3	2.31	120	1	0.31	14
Channel Catfish	5	0.56	-	154	28.25	--
Flathead Catfish	-	-	-	1	0.75	--
Black Crappie	1	0.25	-	3	0.50	--
Northern Redhorse	1	1.13	9	3	3.75	1
Bigmouth Shiner	-	-	53	-	-	91
Bluntnose Minnow	-	-	23	-	-	--
Gizzard Shad	-	-	7	-	-	--
Spotfin Shiner	-	-	3	-	-	--
Northern Pike	-	-	-	-	-	1

Table 39 (con't)
Fishery Survey - Species Composition
October 28, 1975

Species	ABOVE DAEC SHOCKING (25 minutes)		BELOW DAEC SHOCKING (25 minutes)	
	Number	Weight (lbs)	Number	Weight (lbs)
Carp	10	22.0	13	24.31
Carpsucker	12	9.25	11	9.31
Channel Catfish	5	9.38	4	4.56
Northern Redhorse	-	-	2	3.25

Table 40
Fish Pesticide Analysis
Spring-June 1975

Species	Location (Above/Below Site	Length (in)	Weight (grams)	PESTICIDE RESIDUES IN PARTS PER BILLION						
				pp'DDD	pp'DDE	Aldrin	Dieldrin	Heptachlor	Lindane	B-BHC
Carpsucker	Above	12.0	411.2	82.2	64.2	19.2	---	3.3	---	----
Carpsucker	Above	10.5	251.0	9.7	12.1	1.9	---	1.0	---	----
Largemouth Buffalo	Above	14.5	714.5	33.5	29.0	7.5	2.5	1.6	2.1	----
Largemouth Buffalo	Above	15.0	723.4	15.1	32.5	1.8	---	1.3	1.9	24.0
Carp	Below	12.0	472.0	----	----	0.2	2.0	0.4	0.2	----
Northern Redhorse	Below	11.5	272.2	13.9	33.3	2.5	---	4.0	---	----
Largemouth Buffalo	Below	15.5	965.2	77.2	56.1	---	---	3.6	---	----
Largemouth Buffalo	Below	17.0	1357.6	42.9	29.4	6.4	---	4.2	---	----

Table 40 (con't)
Fish Pesticides Analysis
Summer-July 1975

Species	Location (Above/Below Site	Length (in)	Weight (grams)	PESTICIDE RESIDUES IN PART PER BILLION						
				pp'DDT	pp'DDD	pp'DDE	Aldrin	Dieldrin	Heptachlor	Heptachlor Epoxide
Channel Catfish	Above	8.5	67.8	4.8	---	8.8	---	2.4	---	2.7
Channel Catfish	Above	9.5	86.1	13.0	9.0	11.6	2.0	14.4	1.0	10.0
Carpsucker	Above	10.5	330.0	10.7	---	9.3	---	11.1	Trace	5.5
Carpsucker	Above	11.0	368.1	48.0	---	34.0	6.8	26.0	2.0	19.2
Northern Pike	Above	27.0	1460.0	36.0	96.0	65.6	---	53.2	---	14.9
Channel Catfish	Below	19.0	1408.0	50.3	50.3	57.0	14.7	147.4	6.7	53.6
Channel Catfish	Below	9.5	124.0	13.3	---	11.1	2.0	-	1.8	16.1
Carpsucker	Below	10.0	213.0	73.7	---	33.2	2.6	-	4.0	--
Carpsucker	Below	10.0	203.3	24.7	6.7	33.3	---	44.0	5.3	--

Table 40 (con't)
Fish Pesticide Analysis
Fall-October 1975

Species	Location (Above/Below Site	Length (in)	Weight (grams)	PESTICIDE RESIDUES IN PARTS PER BILLION		
				pp'DDD	pp'DDE	Aldrin
Carp	Above	15.0	794.3	----	102.0	---
Carpsucker	Above	12.0	418.1	----	25.3	0.8
Carp	Below	13.5	536.8	---	77.9	0.6
Carpsucker	Below	12.0	415.6	---	4.8	0.6
Northern Redhorse	Below	13.0	443.5	39.5	14.7	0.6

Table 41
Summer Periphyton Study
June 19-July 3, 1975

Upstream DAEC Species	Downstream DAEC Species
Anacystis	Anacystis
Cyclotella	Cyclotella
Gyrosigma	Gomphonema
Melosira	Gyrosigma
Navicula	Melosira
Nitzschia	Navicula
Oocystis	Nitzschia
Scenedesmus	Oocystis
Scenedesmus	Scenedesmus
Biomass	**Biomass**
Ash-free weight	Ash-free weight
0.0091 gms/area slide	0.0092 gms/area slide

Fall Periphyton Studies
October 27-December 1, 1975

Upstream DAEC Species	Downstream DAEC Species
Ankistrodesmus	Melosira
Cosmarium	Microcystis
Cymbella	Navicula
Melosira	Nitzschia
Microcystis	Protozoa (ciliate unidentified)
Navicula	Tabellaria
Nitzschia	Unidentified filamentous, green, probably Batrachospermum (in reproductive state)
Phormidium	
Protozoa (ciliate, unidentified)	
Vorticella	
Biomass	**Biomass**
Ash-free weight	Ash-free weight
0.004 gms/area slide	0.004 gms/area slide

Table 42
Impingement Study
November 1975

Species	Length (mm)	Weight (gms)
Channel Catfish	120	14
" "	110	10
" "	115	11
" "	85	5
" "	80	4
" "	70	4
" "	75	4
" "	70	4
" "	80	5
" "	80	5
" "	70	4
" "	60	3
" "	60	3
" "	60	3
" "	70	4
" "	60	2.5
" "	60	2.5
" "	60	2.5
" "	65	3
" "	65	3
" "	65	2.5
" "	60	2
" "	60	2
" "	60	2
" "	75	4
" "	65	3
" "	50	2
White Crappie	90	10
White Sucker	100	10
Dace	35	1
Notropis (Topminnow)	65	3
Notropis	40	1
Notropis	40	1

Table 43
Entrainment Studies
Duane Arnold Energy Center

June 19, 1975

River Discharge - 10,860 cfs *% of river flow entering plant - 0.22

Plankton at Intake	Units/100 ml
Blue-green algae	
Oscillatoria	31,100 (trichomes)
Diatoms	
Cyclotella	144,000 (organisms)
Melosira	16,000 (filaments)
Nitzschia	160,000 (organisms)
Navicula	16,000 (organisms)
Stephanodiscus	16,000 (organisms)
Unidentified	32,000 (organisms)
Flagellates	
Unidentified	288,000 (organisms)
Other	
Ciliates	32,000 (organisms)
**Crustaceans	None
**Rotifera	None
**Larval fish	None

*Assuming intake volume of 24.5 cfs.
**None collected by plankton net in the raw unconcentrated sample.

Table 43 (con't)
Entrainment Studies
Duane Arnold Energy Center

July 10, 1975

River Discharge - 4,850 cfs *% of river flow entering plant - 0.5

Plankton at Intake	Organisms/10 liters
Crustaceans	
Copepods	3
Cladocerans	5
Rotifera	2
Larval fish	None

*Assuming intake volume of 24.5 cfs.

Table 43 (con't)
Entrainment Studies
Duane Arnold Energy Center

November 25, 1975

River Discharge - 1,200 cfs *% of river flow entering plant - 2.0

Plankton at Intake	Organisms/10 liters
Crustaceans	
Copepods	2
Cladocerans	2
Rotifera	1
Larval fish	None

*Assuming intake volume of 24.5 cfs.

Table 44

Mean and Range Values of Water Quality Parameters Determined for Each of the Five Sampling Sites in the Cedar River Above and Below DAEC for All Data Collected From January 1975 to December 1975.

Parameter		Sta. 1	Sta. 2	Sta. 3	Sta. 4	Discharge Canal
Temperature	Mean	12.3	12.4	14.7	12.9	19.6
(°C)	Range	0.0-27.4	0.0-27.2	0.0-27.7	0.1-27.2	8.3-28.2
Turbidity	Mean	58.4	56.8	58.1	71.8	72.0
(JTU)	Range	4-550	4-500	5-480	4-480	10-410
Color (C-P Color	Mean	24.8	24.0	25.2	25.2	33.5
Units)	Range	10-70	10-70	10-70	10-70	10-70
Total Solids	Mean	433.7	435.0	590.8	462.3	971.8
(mg/l)	Range	298-1240	286-1140	310-1170	306-1140	358-2854
Tot. Volatile	Mean	122.0	122.8	160.6	130.4	218.5
Solids (mg/l)	Range	70-220	78-220	70-270	60-270	82-670
Tot. Fixed	Mean	311.6	428.0	428.2	331.9	663.3
Solids (mg/l)	Range	162-1020	182-920	208-1134	196-980	190-1718
Total Dis.	Mean	324.8	324.4	461.2	327.3	751.0
Solids (mg/l)	Range	175-440	200-440	175-1423	167-470	265-1916
Total Sus.	Mean	108.9	110.6	127.6	130.9	242.3
Solids (mg/l)	Range	6-930	18-820	16-820	10-750	14-2575
Susp. Fixed	Mean	86.8	87.9	102.7	113.5	114.4
Solids (mg/l)	Range	5-810	4-690	3-700	5-710	10-450
Susp. Vol.	Mean	22.0	22.4	24.6	21.2	22.3
Solids (mg/l)	Range	1-120	1-130	2-120	2-80	4-60
Dis. Fixed	Mean	225.0	224.0	324.7	218.3	554.3
Solids (mg/l)	Range	110-330	116-340	103-1054	80-370	165-1448
Dis. Vol.	Mean	98.6	136.2	136.2	109.5	196.3
Solids (mg/l)	Range	50-170	50-190	30-369	20-245	55-665
Dissolved	Mean	10.3	10.0	9.2	10.0	8.1
Oxygen (mg/l)	Range	4.5-15.3	4.6-14.2	4.9-11.7	4.5-12.2	5.0-12.0
Carbon Diox. (mg/l as	Mean	3.2	3.0	2.9	2.7	3.8
$CaCO_3$)	Range	0.0-8.8	0.0-8.8	0.0-8.8	0.0-8.8	0.0-18.0

Table 44 (continued)

Parameter		Sta. 1	Sta. 2	Sta. 3	Sta. 4	Discharge Canal
Total Alk.	Mean	184.5	182.9	175.4	181.0	133.5
(mg/l as $CaCO_3$)	Range	82-244	80-242	80-248	82-240	44-272
Phenolphthalein (mg/l as	Mean	7.8	7.9	5.1	7.5	4.5
$CaCO_3$)	Range	0-24	0-26	0-16	0-24	0-18
pH	Mean	8.4	8.5	8.3	8.5	8.3
	Range	7.7-9.6	7.6-9.5	7.6-8.9	7.7-9.5	7.5-8.9
Tot. Hardness	Mean	250.7	246.7	312.6	254.6	469.7
(mg/l as $CaCO_3$)	Range	160-376	140-324	144-892	144-384	196-1720
Calcium Hard. (mg/l as	Mean	169.6	168.4	215.0	170.4	328.2
$CaCO_3$)	Range	76-272	60-268	80-296	68-264	176-920
Tot.Phosph.	Mean	1.08	1.01	1.08	1.00	1.35
(mg/l)	Range	.10-4.2	.23-3.9	.33-3.8	.13-4.1	.39-5.9
Orthophosph.	Mean	.51	.49	.54	.50	.67
(mg/l)	Range	T-1.6	T-1.4	T-1.6	T-1.5	T-1.6
Ammonia	Mean	.33	.30	.27	.31	.25
(mg/l N)	Range	T-1.24	T-1.20	T-1.12	T-1.20	T-.90
Nitrate	Mean	2.80	3.16	3.20	3.02	4.63
(mg/l N)	Range	.04-8.0	.06-12.0	.05-12.2	.05-9.8	.5-10.0
Iron	Mean	.25	.21	.28	.27	.47
(mg/l)	Range	.02-.87	.02-.89	.02-.91	.02-.94	.04-2.90
Lignins & Tannins	Mean	.48	.45	.53	.52	.81
(mg/l)	Range	.05-1.2	T-1.1	.05-1.2	0.0-1.7	.05-2.65
Chemical Oxygen Demand	Mean	36.0	35.0	39.3	37.6	50.6
(mg/l)	Range	8.0-97	7.0-96	4.0-104	4.0-80	12.0-132
Biochemical Oxygen De-	Mean	6.5	6.2	6.8	6.0	6.9
mand (mg/l)	Range	.9-18.0	.9-18.0	2.2-18.6	1.3-14.4	1.8-17.0
Threshold	Mean	10.4	11.5	13.3	11.4	15.9
Odor	Range	5.6-24	7.5-18	7.5-24	5.6-18	10-24

Table 44 (continued)

Parameter		Sta. 1	Sta. 2	Sta. 3	Sta. 4	Discharge Canal
Tot. Bacteria						
37°C Nat. Log	Mean	12.13	12.74	13.28	12.45	14.35
(org/100 ml)	Range	9.21-14.6	10.31-15.61	10.82-17.58	10.31-14.22	11.70-18.34
Total Bacteria						
20°C Nat. Log	Mean	11.46	11.53	11.83	11.14	11.94
(org/100 ml)	Range	9.21-13.82	9.21-13.49	9.90-12.79	9.21-12.25	9.21-14.46
Tot. Coliforms						
Nat. Log	Mean	7.55	7.24	7.73	7.23	7.83
(org/100 ml)	Range	5.30-9.62	5.30-10.04	4.61-9.80	4.61-10.04	5.70-10.60
Fecal Coliforms						
Nat. Log	Mean	5.88	5.52	5.82	5.33	5.35
(org/100 ml)	Range	3.40-9.07	2.30-8.56	2.30-9.02	2.30-9.02	<2.3-10.39
Fecal Strepto-coccus Nat.						
Log (org/100	Mean	5.63	5.65	5.60	5.48	5.37
ml)	Range	3.00-9.07	3.91-9.12	3.00-9.04	2.30-8.82	2.30-9.04
Tot. Plankton						
Nat. Log	Mean	9.42	9.46	9.56	9.40	9.93
(org/100 ml)	Range	6.40-11.53	6.66-11.72	6.43-11.71	6.43-11.92	6.93-12.06

Table 45

Summary of One-Way ANOVA, Linear Contrast and Student-Newman-Keuls Multiple Comparisons On Water Quality Parameters at the Four Sampling Sites in the Cedar River Above (Stations 1 and 2) and Below (Stations 3 and 4) DAEC For Data Collected From January 1975 to December 1975.

Parameter	One-Way ANOVA F Among Locations	One-Way ANOVA P (Significant at $P \leq 0.05$)	Linear Contrast: Average of Sta. 1 & 2 against average of St. 3 & 4 F	Linear Contrast P (significant at $P \leq 0.05$)	Student-Newman Keuls Multiple Comparison (Only those comparisons of $P \leq 0.05$)
Temperature	10.72	<.01	11.17	<.01	Sta. 1,2, 4 <Sta. 3
Tot. Solids	6.22	<.01	9.13	<.01	Sta. 1,2, 4 <Sta. 3
Tot. Vol. Sol.	5.57	<.01	9.30	<.01	Sta. 1,2, 4 <Sta. 3
Tot. Fixed Sol.	5.52	<.01	7.82	<.01	Sta. 1,2, 4 <Sta. 3
Tot. Dis. Sol.	7.32	<.01	8.00	<.01	Sta. 1,2, 4 <Sta. 3
Dis. Fixed Sol.	6.75	<.01	5.87	.05	Sta. 1,2, 4 <Sta. 3
Dis. Vol. Sol.	6.34	<.01	12.38	<.01	Sta. 1,2, 4 <Sta. 3
Dis. Oxygen	4.30	.01	5.92	.05	Sta. 3 <Sta. 1,2, 4
Carbon Dioxide	N.S.		4.63	.05	N.S.
P-Alkalinity	4.65	<.01	6.19	.01	Sta. 3 <Sta. 1,2, 4
pH	5.41	<.01	N.S.		Sta. 3 <Sta. 1,2, 4
Tot. Hardness	4.42	.01	5.54	.05	Sta. 1,2, 4 <Sta. 3
Calcium Hard.	5.16	<.01	5.59	.05	Sta. 1,2, 4 <Sta. 3
Iron	N.S.		4.11	.05	Sta. 1,2, 4 <Sta. 3
Biochem Oxygen Demand	2.90	.05	N.S.		Sta. 4 Sta.<1,2, 3; Sta. 1,2, 4 <Sta. 3

Table 45 (continued)

Parameter	One-Way ANOVA F Among Locations	 P (Significant at $P \leq 0.05$)	Linear Contrast Average of Sta. 1 & 2 against average of Sta. 3 & 4 F	 P (significant at $P \leq 0.05$)	Student-Newman Keuls Multiple Comparison (Only those comparisons of $P \leq 0.05$)
Threshold Odor No.	4.04	.01	5.57	.05	Sta. 1 <Sta. 2,3, 4; Sta. 1,2, 4 <Sta. 3
Nat. Log (A) (Tot. Bacteria)	4.87	<.01	N.S.		Sta. 1,2, 4 <Sta. 3; Sta. 1,4 <Sta. 2,3
Nat. Log (B) (Tot. Bacteria)	N.S.		N.S.		Sta. 4 <Sta. 1,2, 3; Sta. 1,2, 4 <Sta. 3
Nat. Log (Tot. Coliforms)	3.83	.05	N.S.		Sta. 1,2, 4 <Sta. 3; Sta. 2,4 <Sta. 1,3
Nat. Log (Tot. Plankton)	3.01	.05	N.S.		Sta. 4 <Sta. 1,2, 3; Sta. 1,2, 4 <Sta. 3

REFERENCES CITED

1. McDonald, D. B., "Cedar River Bseline Ecological Study Annual Report April 1971-April 1972. Duane Arnold Energy Center." Report prepared for Iowa Electric Light & Power Company by the University of Iowa, 1972.

2. McDonald, D. B., "Cedar River Baseline Ecological Study Annual Report April 1972-April 1973. Duane Arnold Energy Center." Report prepared for Iowa Electric Light & Power Company by the University of Iowa, 1974.

3. McDonald, D. B., "Cedar River Baseline Ecological Study, Final Pre-operational Report, May 1973-January 1974." Report prepared for Iowa Electric Light & Power Company by the University of Iowa, 1974.

4. McDonald, D. B., "Cedar River Baseline Ecological Study Annual Operational Report January 1974-January 1975. Duane Arnold Energy Center." Report prepared for Iowa Electric Light & Power Company by the University of Iowa, 1975.

5. Environmental Protection Agency, Methods for Chemical Analysis of Water and Wastes, Cincinnati, Ohio, 1971.

6. APHA, AWWA, WPCF, Standard Methods for the Examination of Water and Wastewater, 13th Ed., 1971.

7. U. S. Department of Health, Education and Welfare, Food and Drug Administration, Pesticide Analytical Manual, Vol. 1, 1968.