United States
Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Total Maximum Daily Load (TMDL)
For
Fecal Coliform
In Jewel Lake
Anchorage, Alaska

In compliance with the provisions of the Clean Water Act, 33 U.S.C. § 1251 et seq., as amended by the Water Quality Act of 1987,P.L. 100-4, the Environmental Protection Agency is establishing a Total Maximum Daily Load (TMDL) that would reduce the presence of fecal coliform in Jewel Lake to comply with the beneficial use of this water body.

This TMDL shall become effective immediately. Subsequent actions must be consistent with this TMDL.

Signed this 30th day of Sep, 1997.

Philip G. Millam for
Director,
Office of Water

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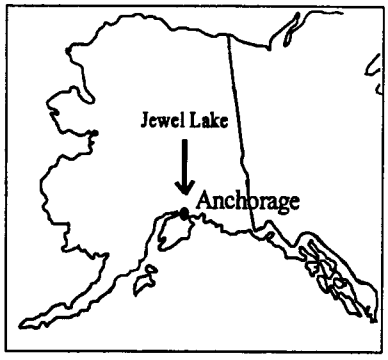
Jewel Lake

TMDL AT A GLANCE:

Water Quality Limited:	Yes
Segment Identifier:	20409-402
Parameter of Concern:	Fecal Coliform
Uses Affected:	Water Supply
Source:	Non-Point Runoff
Loading Capacity:	4.4×10^8 FCU/day
Load Allocation:	4.0×10^8 FCU/day
Margin of Safety:	4.0×10^7 FCU/day



Overview:

This Total Maximum Daily Load (TMDL), developed under section 303(d) of the Federal Clean Water Act (CWA), addresses the nonpoint source loading of fecal coliform bacteria during the summer into Jewel Lake. Jewel Lake is one in a series of lakes scattered throughout the Anchorage bowl that exceeds water quality standards for fecal coliform bacteria. Designated beneficial uses for Jewel Lake include: 1) water supply, 2) water recreation, and 3) growth and propagation of fish, shellfish, and other aquatic life. The affected designated use is water supply. Existing data shows that the water supply standard for fecal coliform is exceeded from June through September.

The primary source of fecal coliform to Jewel Lake, based on the available data, is runoff from the public beach on the northeast side of the lake where Canada geese congregate during June and July. Analysis performed as part of this TMDL shows that the observed number of Canada geese in that area are the likely source contributing the measured levels of fecal coliform.

The loading capacity, based on Alaska's water quality standards, is 4.4×10^8 FCU/day or 20 FC/100mL. The load allocation is 4.0×10^8 FCU/day or 18 FC/100mL, which requires a reduction in fecal coliform counts of 81 percent from the estimated 1997 fecal coliform counts. The margin of safety is ten percent of the loading capacity, 4.0×10^7 FCU/day or 2 FC/100mL. Future actions for Jewel Lake should be aimed at preventing runoff containing fecal coliform from entering Jewel Lake during the summer.

Part 1: Background Information

1.a General Water Body and Watershed Description

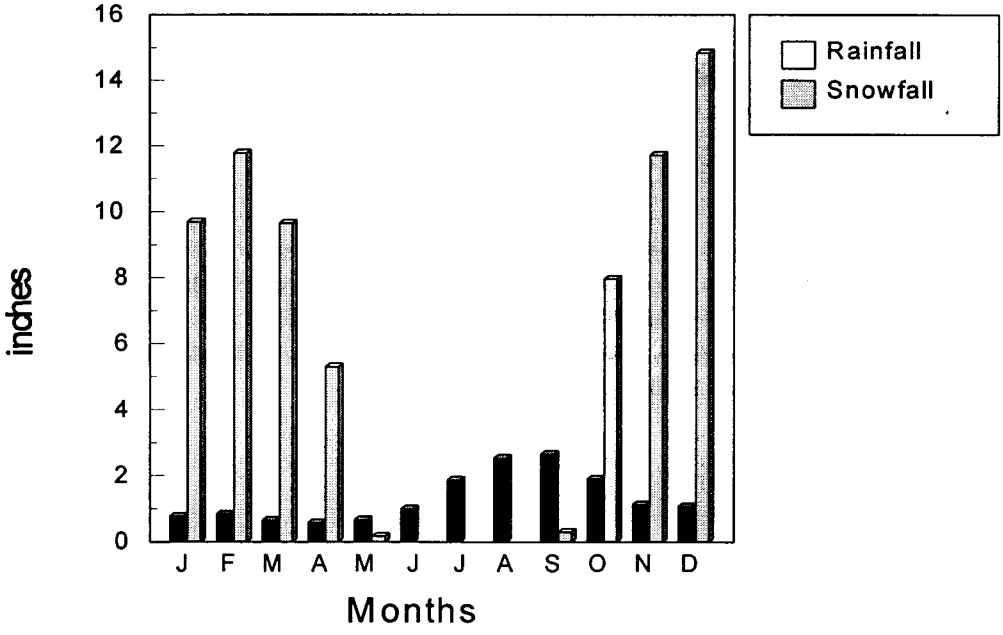
Jewel Lake, located in south central Alaska, lies within the Municipality of Anchorage, the urban center for the Anchorage Bowl. The population of Anchorage Borough based on the 1990 Census, is 226,338 (133.32 persons per square mile). The Anchorage bowl comprises a broad triangular plain bordered by the Chugach Mountains on the east and the waters of Turnagain Arm and Knik Arm to the southwest and northwest respectively. Underlying rock formations beneath the Anchorage bowl consist of quaternary and tertiary volcanic rocks and glacial moraines.

1.b Climate

The Anchorage area is generally free from permafrost in the lowlands. In the higher elevations, isolated masses of permafrost exist. Land surrounding Jewel Lake is free from permafrost. Ice covers Jewel Lake from mid-November through early April. Weather data from Anchorage International Airport was used in characterizing seasonal variation in temperature and precipitation for Jewel Lake. Forty-four years of climatological data exist for the Anchorage International Airport.

From October through Mid-April, average daily maximum mean temperatures range from 21.6°F to 40.6°F. Average daily minimum mean temperatures during this same period range from 8.2 °F to 28.5°F. The Anchorage bowl, which is dominated by snow in the winter and rain in the summer, receives an average yearly precipitation of 88.13 inches. Of that precipitation, 15.69 inches falls as rain (with rainfall lowest in spring and increasing as the summer progresses), while the remaining 72.44 inches falls as snow (Figure 1). Surface wind in this zone are generally light. (NCDC Data Base, 1995)

Figure 1: Anchorage Precipitation



1.c Study Area

Jewel Lake, which is located in the Campbell Creek watershed, lies to the south of both Sand Lake and Sundi Lake (Figure 2), and lies to the north of Campbell Lake. Physical characteristics of Jewel Lake are summarized in Table 1. Natural vegetation surrounding Jewel Lake consists of wetland marshes that extend northward one mile to Sand Lake. Residential housing surrounds both the eastern and western shores of Jewel Lake. In addition, Jewel Lake Park, located on the northeast side of the lake, includes a public beach and swimming area. A parking area at the southern end of Jewel Lake provides access for fishing. During the summer, Jewel Lake is stocked with rainbow trout and landlocked king salmon. One storm water outfall drains to Jewel Lake.

Table 1 - Characteristics of Jewel Lake

Physical Characteristics of Jewel Lake	
Mean Depth	6.5 ft
Maximum Depth	14.5 ft
Surface Area	26.16 Ac
Volume	170.24 Ac-ft
Lake Width	800-100 ft
Lake Length	1500-2000 ft

Part 2: Applicable Water Quality Standards

2.a Designated Uses

Fresh water designated uses are established by regulation and are found in the State of Alaska Water Quality Standards [18 AAC 70 Alaska Water Quality Standard]. For surface waters of the state, these designated uses included: 1) water supply, 2) water recreation, and 3) growth and propagation of fish, shellfish and other aquatic life. The Alaska Department of Environmental Conservation (ADEC) established freshwater designated uses found at 18 AAC 70.020(a)(1). Jewel Lake exceeds the water supply criterion during the summer months.

2.b Parameter of Concern

The Alaska 1996 Section 303(d) list identified Jewel Lake as water quality limited due to exceedences of fecal coliform.

Figure 2: Map of Jewel Lake

2.c Applicable Water Quality Criteria

Within the State of Alaska, water quality standards are published pursuant to Title 46 of the Alaska Statutes (AS). Regulations dealing with water quality (46.03.020 & 46.03.080), are found in Title 18, Chapter 70 of the Alaska Administrative Code (AAC). Through the adoption of water quality standards, Alaska has defined the beneficial uses to be protected in each of its drainage basins and the criteria necessary to protect these uses. (See Table 2)

In Alaska, all waters are protected for all uses, existing and designated, and if a waterbody is protected for more than one use class, the most stringent criterion applies (18 AAC 70.030(1)). Fecal coliform criteria have been established for the protection of human health in terms of drinking water supply and contact recreation. The water supply use designation sets a fecal coliform criterion of 20 FC/100 mL. The fecal coliform criterion for water contact recreation is 100 FC/100 mL.

Table 2 - Alaska Water Quality Standards for Fecal Coliform

Fecal Coliform Bacteria	
(A) Water Supply (I) drinking, culinary and food processing	Based on a minimum of 5 samples taken in a 30-day period the mean may not exceed 20 FC /100 ml, and not more than 10% of the samples may exceed 40 FC/100 ml. For groundwater, the FC concentration must be less than 1 FC/100 ml, using the fecal coliform Membrane Filter Technique, or less than 3 FC/100 ml using the fecal coliform most probable number (MPN) technique.
(A) Water Supply (ii) agriculture, including irrigation and stock watering	For products normally cooked and for dairy sanitation of pasteurized products, the mean, based on a minimum of 5 samples taken in a 30 day period, may not exceed 200 FC/100 ml, and not more than 10% of the sample may exceed 400 FC/100 ml. For products not normally cooked and for dairy sanitation of unpasteurized products, the criteria for drinking water (1)(A)(I) apply.
(A) Water Supply (iii) aquaculture	For products normally cooked the mean, based on a minimum of 5 samples taken in a 30 day period, may not exceed 200 FC/100 ml, and not more than 10% of the sample may exceed 400 FC/100 ml. For products not normally cooked, the criteria for drinking water (1)(A)(I) apply.
(A) Water Supply (iv) Industrial	Where worker contact is present, the mean, based upon a minimum of 5 samples taken in a 30 day period, may not exceed 200 FC/100 ml, and not more than 10% of the samples may exceed 400 FC/100 ml.
(B)Water Recreation (I) contact recreation	Based on a minimum of 5 samples taken in a 30 day period, the mean may not exceed 100 FC/100 ml, and not more than one sample or more than 10% of the sample if there are more than 10 samples, may exceed 200 FC/100 ml.
(B) Water Recreation (ii) secondary recreation	Based on a minimum of 5 samples taken in a 30 day period, the mean not exceed 200 FC/100 ml, and not more 10% of the total samples may exceed 400 FC/100 ml.
(C) Growth and Propagation of Fish, Shellfish, other Aquatic Life, and Wildlife	Not applicable for freshwater.

Part 3: Pollutant Sources

3.a Non-Point Source

The primary nonpoint source of fecal coliform to Jewel Lake is runoff from the public park and beach that are host to large numbers of waterfowl in June and July. In addition, two potential non-point sources were considered: the three residences not connected to the city sewer system and runoff from the other residential areas surrounding Jewel Lake.

Three homes on the western side of Jewel Lake are on individual septic systems. The houses are located on a bench approximately 40 feet above the lake, and their septic systems are located more than 100 feet from the lake on a slope that drains away from the lake. (Memo from T. Rumfelt, ADEC, 3/96.) Because of these circumstances, EPA believes these three homes are not a source of fecal coliform. Additionally, fecal coliform from failing septic systems tend to be associated with fecal coliform counts significantly higher than those observed at Jewel Lake. All of the other homes surrounding Jewel Lake are connected to the city sewer system.

Runoff from other residential areas fronting the lake were considered as potential nonpoint sources for fecal contamination, as dogs, cats, moose, and other animals may contribute to fecal coliform via runoff, particularly during spring melt when many months accumulation of fecal matter could be transported to the lake. If these residential areas were a significant source, they would provide noticable loads in April and May, when most of the spring melt occurs. While no data is available for April, the fecal coliform levels during May are low, well below the water supply criterion. This indicates that runoff from the residential area along the lake probably is not a significant source of fecal coliform.

Since the late 1980's and early 1990's, the number of Canada geese in Cook Inlet have been on the rise. Cook Inlet surveys have shown that the population index had increased from about 1,500 Canada geese in the early 1980's to 5,000 Canada geese in 1993. Anchorage counts of breeding geese increased from a few hundred in 1974 to more than 2,600 in 1996 (Anchorage Waterfowl Working Group (AWWG), White Paper, January 1997). Surveys at Jewel Lake in early July show counts of 64 birds in 1993, 58 in 1996, and 90 in 1997 (Personal communication from USFWS, 8/_/97). See Table 3.

Two factors apparently have led to the creation of favorable habitat for Canada geese in Anchorage. Natural forested and bog habitats have been converted to abundant natural and created lakes and ponds. Also, the tall grass surrounding these areas have been converted to lawns, and many nearby areas, such as airports, parks, golf courses, and ball fields, contain lawns that provide an attractive food source for geese (Anchorage Goose Management Plan, January 1997). Grassy areas adjacent to lakes that provide landing and takeoff sites, drinking water, and little harrassment from dogs and humans, attract nesting geese. Wide, open grassy areas, as are typical of airports, parks, golf courses, and ball fields, also attract hungry geese whether or not water is present.

Table 3: Waterfowl Counts at Jewel Lake

DATE		COUNT
1993	April 12	0
	April 19	0
	July 5	64
	July 13	41
	July 22	46
	August 11	1
	August 24	0
1996	April 19	0
	July 9	58
	August 21	0
1997	April 29	3
	July 7	90

Migratory geese typically arrive in the Anchorage bowl in late May/early June. The goslings usually hatch between the months of June and July. During the molting and brooding-rearing period in July, Canada geese shed their wing and tail feathers and are incapable of flight. Individual breeding pairs (geese usually mate for life) often use the same nesting and brood-rearing areas each year. Shortly after hatching, adults lead goslings to the nearest lake or wetlands, usually within a few city blocks. Geese are relatively stationary during the molt, but move daily from roosting and loafing areas to forage on lawns. Most migratory geese leave by early or mid-August. (AWWG, White Paper, January 1997). It is during the molting and brooding-rearing period when fecal coliform counts are highest.

At Jewel Lake, the geese congregate in the grassy area of the park, and that is where most of the goose fecal matter is located. The gravel beach also contains noticeable quantities of fecal matter. Few geese are observed in the residential areas fronting the lake (personal communication, ADEC, 8/19/97). Rain events may transport the fecal coliform from the beach into the lake, and during summer storms, runoff from the grassy area may transport fecal coliform to the lake. Geese may also contribute fecal coliform directly by defacating into the lake.

3.b Point Source

A small storm water outfall drains road runoff from a short section of a road (Diamond Boulevard) along the south side of Jewel Lake, emptying into the southern end of Jewel Lake. There is no sampling data for the storm drain discharge. EPA and ADEC personnel conducted a site visit of Jewel Lake to evaluate the potential fecal coliform contributions from the outfall. EPA and ADEC staff believe that runoff entering the drain is unlikely to contain significant fecal coliform loadings because the runoff drains a short section of paved road. Further, the drain

discharges only episodically into the lake, and the discharge location is located approximately 1,500 feet form the sampling location (at the park beach) where exceedances have been measured. Because there is no indication that this discharge causes or contributes to the fecal coliform exceedances measured in Jewel Lake, the outfall is not considered to be a significant source.

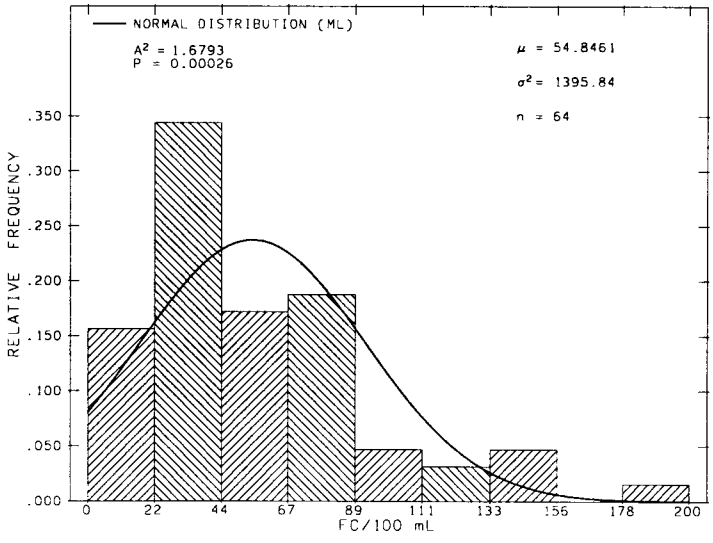
Part 4: Water Quality Analysis

4.a Water Quality Data

In December 1987, the Municipality of Anchorage contracted with James M. Montgomery, Consulting Engineers, Inc. in association with HDR/Ott Engineering, Inc., to develop and implement an area wide water quality monitoring program with a focus on swimming beaches. The Municipality of Anchorage Department of Health and Human Services implemented this program and monitored Jewel Lake during the summer months from 1992 - 1994. The samples were taken in the vicinity of the park beach.

Fecal coliform data for Jewel Lake show exceedences of the water supply criterion during the months of June through September. Using available water quality data, EPA developed a profile describing fecal coliform counts. A frequency distribution plot (Figure 3) of fecal coliform counts indicates that most of the data lie between the water supply criterion of 20 FC/100 mL and the primary contact recreation criterion of 100 FC/100 mL.

Figure 3 - Distribution of Fecal Coliform in Jewel Lake



This analysis used a rolling geometric mean with a 30-day averaging period to evaluate whether Alaska water quality standards were exceeded. Table 4 below indicates that the rolling geometric mean fecal coliform counts in Jewel Lake increase from May and June to a level that

frequently exceeds the State of Alaska drinking water supply criterion of 20 FC/100 mL. These exceedances persist throughout the month of July, gradually decreasing in August, then increasing again in September. Based on existing water quality data, July and September are the months with the highest coliform counts. Neither the monitoring reports nor other information indicate whether and how many migratory geese were present, nor the weather conditions, on the days when samples were taken.

Based on data presented in Figure 3, the mean fecal coliform value (Table 4) for the months sampled exceeded the water supply criterion, although it met the contact and secondary recreation criteria. July and September were the months when the highest loading of fecal coliform occurred. July's counts correspond to the goose population and August and September counts correspond to the the period of greatest rainfall.

Table 4: Mean Fecal Coliform Counts

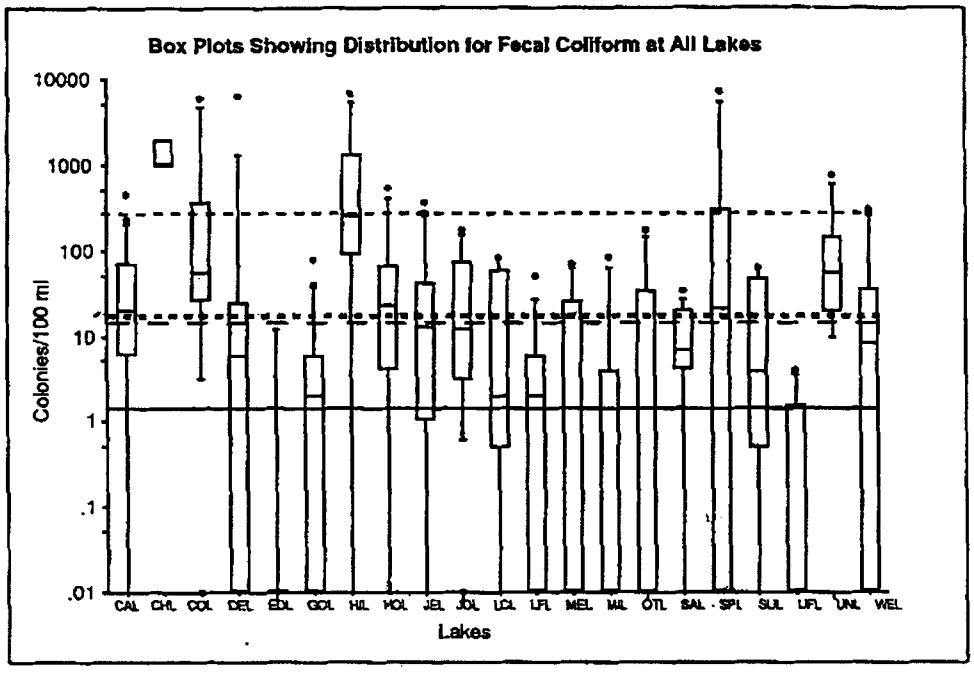
Month	Mean Values
May	12
June	48
July	66
August	48
September	65

Within the Anchorage bowl, Jewel Lake is one of six lakes with mean fecal coliform counts above 20 FC/100 mL (Figure 4).

4.b Non-Point Source Loading Analysis

EPA conducted a loading analysis to determine whether runoff containing fecal coliform from Canada geese at Jewel Lake Park accounts for the fecal coliform in Jewel Lake. This analysis was based on two previous studies conducted by B.A. Manny, W.C Johnson, R.G. Wetzel (1994), and Christine B. Reichgott, G. Chris Holdren, Michael R. Martin, and Marlene R. Miller (1990). The analysis uses information about the loading rate for Canada geese, residence time of geese on the beach and park area, runoff rates, and the volume of water in the area adjacent to the beach to develop potential fecal coliform counts. Table 5 displays results from this analysis. Detailed discussion of this analysis is attached in the Technical Appendix.

Figure 4: Fecal Coliform Counts in Anchorage Lakes



LEGEND

Water Quality Standards

Drinking Water Standard (18AAC 70) = 20 FC/100ml

Primary Contact Standard (18AAC 70) = 20 FC/100ml

Secondary Contact Standard = 200 FC/100 ml

Detection Limit

CAL = CAMPBELL LAKE
CHL = CHENEY LAKE
COL = CONNORS LAKE
DEL = DELONG LAKE
EDL = EDMONDS LAKE
GOL = GOOSE LAKE
HIL = HIDEAWAY LAKE
HOL = HOOD LAKE
JEL = JEWEL LAKE
JOL = JONES LAKE
LCL = LITTLE CAMPBELL LAKE
LFL = LOWER FIRE LAKE
MEL = MEADOW LAKE
MIL = MIRROR LAKE
OTL = OTIS LAKE
SAL = SAND LAKE
SPL = SPENARD LAKE
SUL = SUNDI LAKE
UFL = UPPER FIRE LAKE
UNL = UNIVERSITY LAKE
WEL = WESTCHESTER LAGOON

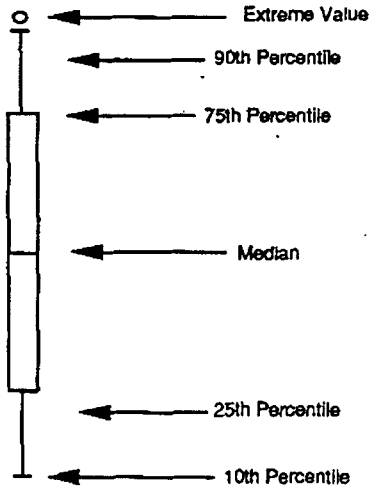


Table 5: Potential Fecal Coliform Counts

Number of Geese	Potential Fecal Coliform Counts (# FC/100 mL)
20	50
30	75
40	100
50	125
60	150
70	200
80	225
90	250

Based on the potential fecal coliform counts presented in Table 5, fecal coliform counts attributable to the goose population appear to account for the fecal coliform levels measured in Jewel Lake. The model predicts higher fecal coliform counts than observed (comparing Tables 4 and 5), which demonstrates the model's conservative assumptions. Several factors, such as rainfall during the summer months, the number of geese on shore versus the number of geese on the lake, and the sampling location(s) may influence the mean fecal coliform counts and potential values. See the Technical Appendix for further discussion. As a result of these factors and other assumptions, the number of geese associated with the potential fecal coliform counts should be considered a rough estimate.

As Table 3 shows, the waterfowl population at Jewel Lake increased almost 41 percent between 1996 and 1997. Extrapolating the same increase from Table 4's mean fecal coliform counts as the increase in waterfowl counts yields a 1997 estimated fecal coliform level of 93 FC/100mL. This level approaches but does not exceed the primary contact recreation criterion.

4.c Conclusions

Based on data presented in Section 4.a, mean fecal coliform values exceed the water supply criterion during the summer and threatens to exceed the primary contact recreation criterion. July and September were the months when the heaviest fecal coliform counts occured in Jewel Lake. The primary source of fecal coliform loading to Jewel Lake is runoff from Jewel Lake Park, which probably includes feces of both Canada geese and, to a much lesser degree, dogs and other animals. Because the population of Canada geese has increased since 1994 when Jewel Lake's water quality was last monitored, fecal coliform at Jewel Lake may be significantly higher than measured in 1993 and 1994, perhaps close to the primary contact recreation criterion.

Part 5: TMDL Evaluation

5.a General Approach

A total maximum daily load or TMDL is a planning and management tool to restore and protect water quality. The TMDL document presents an analysis of the relationship between pollution sources and water quality conditions. It identifies the loading capacity and associated wasteload allocation(s) from point sources, load allocation(s) from non-point sources or background, and a margin of safety to compensate for uncertainty. As new information becomes available in the future, the TMDL may be refined.

5.b Loading Capacity

This TMDL sets a loading capacity for Jewel Lake that is protective of human health and meets the State of Alaska water quality standards. Loading capacity may be expressed in a variety of ways. In terms of the State of Alaska's water supply criterion, the loading capacity is 20 FC/ 100 mL, which represents a 78 percent reduction from the estimated 1997 level.

Alternately, the loading capacity may be restated to reflect the amount of load a particular waterbody can receive of a particular pollutant without violating water quality standards. For the purposes of this TMDL, EPA estimated the area of greatest impact from the park runoff's loadings to calculate the loading capacity. Use of this smaller volume rather than the lake's entire volume is necessary because of the limited mixing in the lake. Use of the smaller volume to calculate loading capacity provides greater assurance that water quality standards will be met. The loading capacity is calculated as the water quality criterion (20 FC/100 mL) times the volume of the estimated impact area (2.32×10^9 mL), as explained in the Technical Appendix. See Table 6.

This calculation assumes the following:

- the runoff of fecal matter from the beach is an episodic load, with bacteria introduced within the first hours of a daily storm event;
- the runoff completely mixes within the estimated impact area;
- there is no build-up of bacteria over time due to a combination of dilution with surrounding lake water, during and between storm events, and bacterial die-off.

5.c Load Allocation

The load allocation is the portion of the loading capacity associated with non-point sources and background. Because in this TMDL the point source does not contribute significantly, if at all, the non-point source load allocation is equal to the loading capacity minus a set-aside for a margin of safety. This yields a load allocation of 4×10^8 FCU/day or 18 FC/100mL. See Table 6.

In order to reduce fecal coliform counts from the mean in Table 4 (based on available data) to the load allocation, a 72% reduction from the 1994 maximum level would be necessary. However, since the number of waterfowl observed at Jewel Lake has increased significantly

since the fecal coliform data was collected in 1993-1994, fecal coliform counts at Jewel Lake may have increased significantly. Consequently, a larger reduction may be needed to comply with the water supply criterion. Extrapolating from the mean fecal coliform counts (66 FC/100mL) and waterfowl counts as discussed in the non-point source loading analysis above, a fecal coliform reduction of 81 percent from the 1997 estimated level would reasonably assure compliance with the water quality criterion.

5.d Wasteload Allocation

As discussed above, the point source is not a significant source. Consequently, it has no wasteload allocation.

5.d Margin of Safety

For Jewel Lake, ten percent of the loading capacity (4.0×10^7 FCU/day or 2 FC/100mL) is established as the margin of safety. This margin accounts for uncertainties in the data and the lack of data. This margin of safety is reasonable because 1) the load allocation is based on conservative assumptions, 2)there are no aquatic life impacts, and 3) the human health impacts are temporary and easily avoidable.

The discussion of loading capacity, load and wasteload allocation, and margin of safety are summarized in Table 6 below.

Table 6: Alternate Expressions of the Jewel Lake TMDL

	"Loading" in FC/day	Concentration in #/100 ml	% Reduction in fecal coliform from estimated 1997 levels
Loading Capacity	4.4×10^8 FCU/day	20 FC/100 ml	78
Load Allocation	4.0×10^8 FCU/day	18 FC/100 ml	81
Wasteload Allocation	none	none	none
Margin of Safety	4.0×10^7 FCU/day	2 FC/100 ml	NA

Part 6: Possible Future Actions

Anchorage Waterfowl Work Group

Potential future actions to reduce fecal coliform in Jewel Lake are the subject of the Anchorage Waterfowl Workgroup. In early 1996, the Anchorage Waterfowl Working Group (AWWG) was formed to devise solutions to deal with increased migratory bird population in the Anchorage bowl. The AWWG is composed of representatives of the Alaska Department of Fish and Game (ADF&G), U.S. Fish and Wildlife Service (USFWS), Municipality of Anchorage Department of Health and Human Services (DHHS), Cultural and Recreational Services, Merrill Field, and Loussac Library; U.S Department of Agricultural - Animal Control Division (ADC); Federal Aviation Administration (FAA); Elmendorf Air Force Base (EAFB); Fort Richardson

Army Post; Alaska Department of Transportation and Public Facilities-Anchorage International Airport (AIA); Anchorage Audubon Society; and the National Wildlife Federation.

The AWWG is moving forward to complete the following: 1) to inform Anchorage citizens, agencies and businesses of the problems and benefits associated with urban Canada geese; 2) to provide a forum for exchange of ideas and information between the community and responsible government agencies; 3) to educate the Anchorage community on health and safety problems, both to people and waterfowl, that result from feeding waterfowl in Anchorage; and 4) develop a responsible, practical and effective plan for cooperative management of waterfowl and their habitat in Anchorage.

While Jewel Lake is not the primary focus of the AWWG, their educational and management activities will be relevant to Jewel Lake. These measures will reduce the number of geese attracted to Jewel Lake, thereby reducing fecal coliform levels in the lake.

Some specific measures the AWWG could consider are prohibiting the feeding of waterfowl, replacing short grass on the beaches with tall grass, and adding landscape features to minimize or delay runoff from entering Jewel Lake.

Monitoring

Future monitoring of Jewel Lake would help to measure the reduction of fecal coliform in response to implemented control actions, reduce the uncertainty in this TMDL, and allow the Municipality to notify the public if or when Jewel Lake exceeds the standard for primary contact recreation. EPA recognizes that Jewel Lake is not a high priority for monitoring presently.

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Technical Appendix

Loading Analysis for Fecal Coliform from Jewel Lake Park

To estimate the potential contribution of fecal coliform bacteria into Jewel Lake from Jewel Lake Park, a loading analysis was conducted. Methodology and assumptions used in this analysis was based two previous studies conducted by B.A. Manny, W.C Johnson, R.G. Wetzel, 1994 and Christine B. Reichgott, G. Chris Holdren, Michael R. Martin, and Marlene R. Miller, 1990. This loading analysis relies on available data, previous studies of other sites, knowledge of the area, and assumptions.

Concept

The general concept for th is loading analysis is that once fecal matter is deposited on the grass and/or gravel in Jewel Lake park, rainfall will wash much of the bacteria into Jewel Lake.

Assumptions

- Canada geese remain on the grassy area in a park for an average of six hours a day during the molting and brooding season (Reichgott et al., 1990).
- Fecal matter from geese builds up in a grassy area of the park. Droppings are approximately 1/4 inch in diameter and 1 inch long, droppings occur approximately 1 dropping every sq.ft.. (Personal communication, Patrick-Riley, ADEC, 8/19/97)
- Ten percent of the deposited fecal matter is washed into a section of the lake adjacent to the park beach (the estimated impact area). (Reichgott et al., 1990)
- The estimated impact area is approximately 311.6 ft. long (the length of the beach),100 ft. wide (assumed impact distance offshore), and 2.5 ft deep (the mean depth of this area) (Personal communication, Patrick-Riley, ADEC, 8/19/97).
- The area affected is 77900 ft^3, with a volume of 2.206×10^9 mL.
- The runoff of fecal matter from the beach is an episodic load, with bacteria introduced within the first hours of a daily storm event.
- Runoff completely mixes within the estimated impact area.
- Bacteria does not build up over time due to a combination of dilution with surrounding lake water, during and between storm events, and bacterial die-off.

Limitations

This loading analysis acknowledges the several limitations:

- Available water quality data did not specify:
  1) The number of geese present during the time of sampling (on shore and on the lake),
  2) The climatic conditions at time of sampling,
  3) Sampling locations near the beach (i.e approximate distance offshore where samples were taken and depth of sample).
- The number of fecal coliform sampes taken during the summer months was less than the State of Alaska water quality criteria of 5 samples in a 30-day period.
- Data is not available to determine a site specific die-off rate for bacteria suspended in Jewel Lake.

- Direct defection from Canada geese into Jewel Lake was not factored into the analysis, because the average on-lake time for Canada geese is unknown.
- Nutrient content in Jewel Lake is unknown.
- Fecal coliform inputs from dogs or other animals is not factored into in the analysis, due to the lack of data.

In computing possible fecal coliform counts, the equation below was used. This equation factors in loading rate from geese, time geese spend at the park, and percent that runs off the park and beach, average weight of geese droppings, and the defecation rate and divides these factors by percentage of the lake volume. The final product results in a loading coefficient ($L_{(Coefficient)}$).

Loading Coefficient Equation

$$L_{(Coefficient)} = LR*T*PR/\ V(fraction)$$

LR Loading rate for Canada geese = loading rate of geese x average weight of geese dropping x defecation rate = 11.06 X 10^7 fc/g x .714 g x 28 per/ days) (Where fc= fecal coliform colonies and g= gram (Ray B. Owen.Jr; Manny et al., 1994)

T Number of hours on beach = 6 hours = .25 per/day (Reichgott et al., 1990)

PR Percent Runoff = 0.10 (Reichgott et al., 1990)

V Volume of water in area = 2.206 X 10^9 mL

The $L_{(Coefficient)}$ is multiplied by the number of geese present to derive a possible bacterial concentration in Jewel Lake due to geese. The result is expressed in FC/100 mL and is presented in the Table below.

Potential Fecal Coliform Counts

Number of Geese	$L_{(Coefficient)}$	Potential Fecal Coliform Counts # FC/100 mL
20	2.51	50.2
30	2.51	75.3
40	2.51	100
50	2.51	126
60	2.51	151
70	2.51	176
80	2.51	201
90	2.51	226

Response: The White Paper cited in the TMDL was developed by a group of people representing a spectrum of perspectives and included members who are knowledgeable about waterfowl populations and the problems they may present. While there is always room for debate in scientific issues, including the historic populations of waterfowl in Anchorage, EPA believes the White Paper presents credible conclusions.

Because the water quality in Jewel Lake is impaired, the Clean Water Act requires preparation of a TMDL. While the various anthropogenic causes of this impairment cannot all be addressed in this TMDL, it identifies specific, local actions that could be taken to reduce the pollution. EPA pointed out that it is runoff from Jewel Lake Park that is the pollution, not the geese. The suggested steps focused on delaying and preventing the runoff from reaching the lake and making the park a less desirable goose destination.

EPA does not support filling in wetlands to eliminate goose habitat.

Editorial Comments

Comment: ADEC provided several editorial and technical comments.

Response: EPA appreciates the opportunity to correct and clarify statements and calculations in the TMDL.

Outreach to Potential Commenters

Comment: ADEC requests that EPA develop a strategy for providing draft TMDLs to local citizen groups in a timely fashion. Two groups potentially interested in this TMDL did not receive it in sufficient time to review and comment.

Response: EPA would be happy to work with ADEC to develop local mailing lists for citizen groups and others interested in future TMDLs.