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GLEN CANYON NATIONAL RECREATION AREA

**WATER QUALITY ON THE COLORADO RIVER
GLEN CANYON DAM TO LEE'S FERRY
1994 FECAL COLIFORM MONITORING**

NOVEMBER, 1994

(Revised May 1995)

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I. Introduction

Monitoring of water quality to determine the presence of fecal coliform bacteria on the Colorado River corridor between Glen Canyon Dam and Lees Ferry within Glen Canyon National Recreation Area was continued in 1994. This monitoring was initiated in 1992 as part of a series of "Interim Flow Monitoring" studies funded cooperatively by the National Park Service and the Bureau of Reclamation's Glen Canyon Environmental Studies (GCES). Water quality on the 15 mile reach of the Colorado River below the dam to Lees Ferry is controlled and influenced by several factors including the quality of water released from the dam, erosion and runoff from beach and margin deposits, recreational use impacts, cattle and wildlife impacts, and contaminants entering from side drainages or accidents at upstream facilities. The monitoring objective was to determine the presence or absence of fecal coliform and, if present, the amount. Samples were collected three times on one day during June, July, August and September at six locations. Collection times coincided with "interim flow" water release patterns.

The original proposal called for four collections to be made at 0600, 1000, 1400, and 1800 at six sites along the corridor between Glen Canyon Dam and Lees Ferry. Each site was to be sampled once a month from April through September. Two modifications were made to this proposal. Only three collections were made each sampling day due to the logistics of collecting and holding time requirements for processing of water samples, and sampling began in June rather than April due to hiring and training seasonal employees.

Fecal coliform are a type of bacteria found in the intestinal tracts of warm blooded animals. Coliform bacteria are generally not considered health hazards in themselves, but serve as an indicator for the presence of fecal contamination in water. Coliforms are almost always present in water containing enteric pathogenic bacteria and viruses, although pathogenic organisms can also be present in waters with low coliform bacteria counts.

II. Site Description

The six monitoring sites chosen were out of the current in relatively calm waters where bacteria could flourish if present and are areas of concentrated human use (five sites) or accessible by livestock. The distribution of sites in the 15 mile river reach extended from river mile -14.75 to mile -2.5.

The first site, at river mile -14.75, is located approximately 500 yards downstream from the dam on the right bank of the river. It is a calm eddy pool off a sandy beach. An exposed gravel bar is located immediately upstream, which deflects the current forming the eddy. Anglers frequently park boats on the lee side of the gravel bar, out of the current while they fish. This site is the final large beach area reached when traveling upstream towards the dam. This location is also the only water sampling point to be located upstream from the Page Water Treatment Plant, a series of sewage ponds situated some 300 yards from the eastern edge of the canyon rim. Day use only is allowed at this site.

River mile -13, river left, is the second sample site. It is located on the inside of a 90 degree turn of the river and is therefore very calm. Again, use by anglers is high due to an upstream gravel bar and gently sloping beach. Beavers (Castor canadensis), which are also carriers of coliform bacteria, have been spotted along this stretch of river. This is a day use site only.

Site three is located offshore of the Ferry Swale camps, mile -11, river left. This established overnight campsite has a self-contained toilet. The campsite is on the inside turn of a meander of the river and is relatively calm water with gently sloping beach.

Site four is at the boat landing area for the Petroglyph Panel at river left, mile -10. This fourth site experiences heavy, short duration use by Wilderness River Adventures (WRA) river float trips. The beach serves as a staging area for hikes to the panel and is equipped with two self-contained toilets. An eddy current causes river water to move upstream while near the shallow gently sloping beach. This is a day use only site.

The fifth site, a beach near Finger Rock, serves as the picnic lunch area for the WRA tours (37,114 passengers in 1994). It is located at mile -7.5, river left. A local rainfall runoff event caused erosion in a side drainage which affected the site, and mid-summer the lunch beach site had to be moved about 100 yards downstream. Generally 50 to 200 people visit this site daily through the commercial trips available. This site is a designated overnight campsite area.

The sixth site at river left, mile -2.5 lies in deep, calm water off a large beach of sand dunes. Eddies and upstream flows are caused by a submerged point which originates downriver and extends parallel to the beach for some distance upstream. Livestock from the Navajo Reservation can access this beach. During this monitoring period a dead cow decayed near the water's edge. This site is a day use site only.

III. Methods and Procedures

Samples were collected three times on June 24, July 11, and August 8 and twice on September 12. Water samples were collected from a boat near shore where the water was 2-4 feet deep. Two 100 ml samples were collected at each collection time at a depth of 4 inches below the surface of the water at each site using a Van Dorn water sampling bottle. Pre-sterilized, disposable sample bottles were used this year. The samples were immediately packed on ice. Water temperature, time of collection, and turbidity of the water was recorded, as well as numbers of boats and people.

After the morning (06:00 and 10:00) samples were collected, they were transported to the Glen Canyon National Recreation Area laboratory at Wahweap to be filtered and incubated before noon using the membrane filtration technique (9222 D.) described in Standard Methods for the Examination of Water and Wastewater (18th edition, 1992, pp. 9-60-61). The two separate 100 ml samples taken in the field at each site were processed individually, one filtered in 100 ml, and one as a 50 ml aliquot. This allowed for duplication as a means of verification as well as providing for a smaller volume sample

should counts become elevated. The morning samples were processed and in the incubator by noon, therefore meeting recommended six hour holding time. The third set of samples was then collected at around 1400 and processed and incubated in the afternoon. The samples were handled in this manner to reduce holding time and to insure that the samples were filtered within the six hour time limit recommended by Standard Methods (18th edition, 1992).

After a twenty-four hour incubation period in a water bath at 44.5° C, fecal coliform colonies were counted and recorded. The mFC media used for the fecal coliform test contains aniline blue dye and lactose. Fecal coliform bacteria ferment lactose as they grow, producing an acid. The acid reacts with the aniline blue dye, staining the fecal coliform colonies blue. Only those colonies exhibiting the blue color were counted. Those having a cream, grey or green color are non-fecal thermophiles and were not considered.

IV. Results and Discussion

The perennially cold water temperature range (8-11°C), and strong current, result in few visitors actually swimming in the Colorado River below Glen Canyon Dam to Lees Ferry. However, some enthusiasts wade in the shallow near shore waters off popular day use beaches, overnight campsites, and at the Lees Ferry launch ramp. River trips through the Grand Canyon depart from Lees Ferry. This summer concerns were raised due to several cases of illness reported by people who had taken river trips through the Grand Canyon. Most river groups obtain drinking water directly from the river which is purified through filters, by boiling, purification tablets, bleach, or a combination of methods. Coconino County Health Department conducted an investigation downstream through the canyon to determine health risks. To our knowledge, there were no reported cases of the illness from campers on the reach from the dam to Lees Ferry.

Due to the importance of Lees Ferry as the sole access point to both upstream and downstream reaches, we recommend extending our water quality monitoring to include a seventh site, sampling at the Lees' Ferry launch ramp, next year.

The highest fecal coliform level determined on the river this year was an event that averaged 44 cfu/100 ml from duplicate counts on 100ml and 50 ml replicates (counts of 61 and 28 cfu/100 ml, respectively) at site 3, Ferry Swale Camp, at 14:30 on July 11, 1994 (Table III). Ferry Swale campsite has a self-contained toilet on site, and a heavily used overnight campsite on this stretch of the river. Although counts never exceeded regulatory standards for full body immersion, the adequacy and integrity of the toilet at this site should be examined, because this site was identified as having the second highest counts along the river corridor in the 1992 report. Ferry Swale camp, site 3, had the most counts overall throughout the season, all totaled there were only 130 fecal coliform colonies detected at this site all year.

Petroglyph panel, site 4, had the next highest single coliform event this year, an average count 19 cfu/100 ml (replicates 16 and 22 cfu/100ml) again occurring on July 11, 1994 at 14:00 (Table IV). This site also had the second

highest coliform count overall, however, a total of only 100 fecal coliform colonies were detected from all samples combined at this site during the entire sampling period. Site 4 was identified as having the highest average counts on the river corridor in the 1992 report. Toilet paper and feces were noted at more than one location under the tamarisk around this site, despite there being two vault toilets available for use. The schedule of cleaning vault toilets, the adequacy of two units based upon volume capacity and use, and the integrity of the units, should be examined to determine if more frequent maintenance, or additional facilities would alleviate the problem. This site experiences heavy day use from Wilderness River Adventure tours, and private boaters.

The number of passengers aboard Wilderness River Adventures (WRA) day trips down this stretch of the river were obtained. These figures can be used as a rough indicator of how many people were on the river the days water samples were collected (Table I). Total number of WRA passengers in 1994 was 37,114, down about 8% from 1993. Monthly visitation totals are shown on Table II.

TABLE I: PASSENGERS ON WRA RIVER FLOAT TRIPS ON SAMPLE DAYS, 1994

June 24	July 11	August 8	September 12
162	295	94	156

TABLE II: MONTHLY PASSENGERS ON WRA RIVER FLOAT TRIPS, 1994

MAY	JUNE	JULY	AUGUST	SEPTEMBER
3,720	7,301	6,688	6,882	5,455

Generally, bacterial counts were lowest in the early morning samples. Counts were slightly higher in the samples collected later in the day, and also were slightly higher in July and August than in June or September. Reasons for this phenomena could be due to increased use through the day, and thermal warming of water producing slightly higher temperature in the shallows later in the day. Other possible causes could related to increased water volume, flow, beach inundation or erosion caused by daily flow variations of the interim flow regime.

This season completes the third year for seasonal monitoring of fecal coliform bacteria on the Colorado River from the Dam to Lees Ferry. Results were significantly lower this year than coliform levels reported in 1992 (coliform counts on Lake Powell were also higher in 1992 than in the recent two years). Ferry Swale camp (site 3), and Petroglyph Panel (site 4) had the highest single event and combined total of coliforms detected. This corresponds with the findings of the locations with highest bacterial counts in 1992, although counts were much lower this year. These two sites are the most heavily used, and both have self contained toilets on site.

River water quality results in 1994 and 1993 were comparable, both years indicated very low fecal coliform levels overall throughout this reach of the river. Although slight increases in coliform are noticed later in the day, the relationship between interim flows and coliform level remains inconclusive at this time. Continued monitoring for fecal coliform bacteria between the dam and Lees Ferry is recommended. Future issues potentially affecting water quality include increased recreational use, effects of planned flood releases, and discharging warmer water through selective withdrawal from multi-level intake structures.

TABLE III: RIVER WATER QUALITY AT SITE 1

DATE	TIME	WATER TEMP (°C)	TURBIDITY (NTU)	COLIFORM COUNT/ 100ML
6/24/94	6:05	8	1.0	0
	6:05	8	1.0	0
	11:00	9	1.2	0
	11:00	9	1.2	1
	14:36	11	1.2	3
	14:36	11	1.2	2
7/11/94	6:10	8	0.8	0
	6:10	8	0.8	0
	10:25	9	1.5	0
	10:25	9	1.5	0
	14:28	9	1.2	3
	14:28	9	1.2	2
8/8/94	6:14	9	6.4	0
	6:14	9	6.4	0
	11:08	9	6.5	6
	11:08	9	6.5	12
	14:54	9	-	1
	14:54	9	-	4
9/12/94	7:25	9	0.65	0
	7:25	9	0.65	0
	10:35	10	0.69	12
	10:35	10	0.69	12

TABLE IV: RIVER WATER QUALITY AT SITE 2

DATE	TIME	WATER TEMP (°C)	TURBIDITY (NTU)	COLIFORM COUNT/100 ML
6/24/94	6:17	8	0.8	0
	6:17	8	0.8	2
	10:50	9	1.3	0
	10:50	9	1.3	0
	14:45	9	1.6	6
	14:45	9	1.6	4
7/11/94	6:16	8	1.0	0
	6:16	8	1.0	2
	10:19	9	1.5	0
	10:19	9	1.5	0
	14:34	9	0.9	7
	14:34	9	0.9	8
8/8/94	6:21	9	6.4	0
	6:21	9	6.4	0
	11:01	10	6.3	2
	11:01	10	6.3	2
	15:00	9		3
	15:00	9		2
9/12/94	07:25	9	1.0	0
	07:25	9	1.0	0
	10:25	10	0.5	0
	10:25	10	0.5	0

TABLE V: RIVER WATER QUALITY AT SITE 3 (FERRY SWALE)

DATE	TIME	WATER TEMP (C)	TURBIDITY	COUNT
6/24/94	6:31	8	1.2	1
	6:31	8	1.2	0
	10:26	9	0.7	0
	10:26	9	0.7	4
	14:58	9	0.9	11
	14:58	9	0.9	6
7/11/94	6:26	8	1.5	0
	6:26	8	1.5	0
	9:59	9	1.3	0
	9:59	9	1.3	2
	14:28	9	1.2	61
	14:28	9	1.2	28
8/8/94	6:35	8	6.8	0
	6:35	8	6.8	0
	10:47	9	6.6	3
	10:47	9	6.6	4
	15:11	9		3
	15:11	9		4
9/12/94	7:50	10	0.9	1
	7:50	10	0.9	0
	10:15	10	0.4	0
	10:15	10	0.4	2

TABLE VI: RIVER WATER QUALITY AT SITE 4 (PETROGLYPH PANEL)

DATE	TIME	WATER TEMP (°C)	TURBIDITY (NTU)	COLIFORM COUNT/100 ML
6/24/94	6:39	8	0.9	0
	6:39	8	0.9	0
	10:17	9	1.0	1
	10:17	9	1.0	0
	15:09	10	1.0	15
	15:09	10	1.0	0
7/11/94	6:32	8	1.0	0
	6:32	8	1.0	0
	9:51	9	0.9	4
	9:51	9	0.9	0
	14:48	9	1.2	16
	14:48	9	1.2	22
8/8/94	6:36	8	6.3	0
	6:36	8	6.3	0
	10:39	9	6.7	8
	10:39	9	6.7	22
	15:18	9		4
	15:18	9		4
9/12/94	8:00	10	0.65	0
	8:00	10	0.65	2
	10:10	10	0.21	2
	10:10	10	0.21	0

TABLE VII: RIVER WATER QUALITY AT SITE 5 (FINGER ROCK LUNCH BEACH)

DATE	TIME	WATER TEMP (°C)	TURBIDITY (NTU)	COLIFORM COUNT/100 ML
6/24/94	6:52	8	1.1	0
	6:52	8	1.1	0
	10:00	9	1.2	0
	10:00	9	1.2	0
	14:24	10	1.3	3
	14:24	10	1.3	2
7/11/94	6:42	8	1.1	1
	6:42	8	1.1	0
	9:37	9	1.8	0
	9:37	9	1.8	0
	15:00	9	6.9	12
	15:00	9	6.9	4
8/8/94	6:46	9	6.5	3
	6:46	9	6.5	4
	10:02	9	6.5	0
	10:02	9	6.5	0
	15:28	9		9
	15:28	9		18
9/12/94	8:15	10	0.8	2
	8:15	10	0.8	0
	9:50	10	0.4	2
	9:50	10	0.4	0

TABLE VIII: RIVER WATER QUALITY AT SITE 6

DATE	TIME	WATER TEMP (°C)	TURBIDITY (NTU)	COLIFORM COUNT/100ML
6/24/94	7:13	8	0.9	3
	7:13	8	0.9	0
	9:30	9	1.2	0
	9:30	9	1.2	2
	15:34	10	1.2	0
	15:34	10	1.2	0
7/11/94	6:58	9	1.5	0
	6:58	9	1.5	2
	9:18	9	1.2	2
	9:18	9	1.2	2
	15:18	9	1.0	4
	15:18	9	1.0	2
8/8/94	7:07	9	6.5	2
	7:07	9	6.5	0
	9:36	9	6.6	5
	9:36	9	6.6	0
	15:45	9		11
	15:45	9		24
9/12/94	8:35	10	0.8	0
	8:35	10	0.8	2
	9:25	10	0.2	0
	9:25	10	0.2	6



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Memorandum

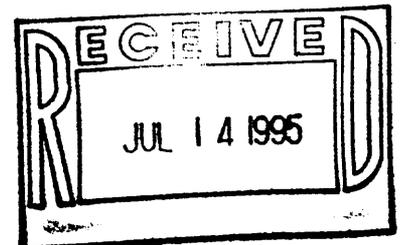
To: Interested Parties, Water Quality Monitoring on the Colorado River
From: Superintendent, Glen Canyon National Recreation Area (NRA)
Subject: 1994 Report of Fecal Coliform Monitoring on the Colorado River from Glen Canyon Dam to Lees Ferry

Enclosed for your information and use is the 1994 report (revised May 1995) of fecal coliform monitoring on the Colorado River from Glen Canyon Dam to Lees Ferry.

If you have any questions, please contact Aquatic Ecologist Susan B. Dodson at 520-608-6266.

Joseph F. Alston

Enclosure



MAILING LIST
FOR
1994 REPORT OF FECAL COLIFORM MONITORING
ON
COLORADO RIVER FROM GLEN CANYON DAM TO LEES FERRY

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