INFLUENCE OF GEOCHEMICAL PROCESSES ON NUTRIENT SPIRALING WITHIN THE RECIRCULATION ZONES OF THE COLORADO RIVER IN THE GRAND CANYON

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Project Name: Influence of Geochemical Processes on Nutrient Spiraling Within the Recirculation Zones of the Colorado River in the Grand Canyon

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Government Technical representative: Dr. Larry Stevens

Short Title of Work: BEACH GEOCHEMISTRY AND NUTRIENT SPIRALING: Annual report

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BEACH GEOCHEMISTRY AND NUTRIENT SPIRALING ANNUAL REPORT: 1993

A. MAJOR ACCOMPLISHMENTS

1. Overview of Project

The Bureau of Reclamation is the lead agency charged with preparing an Environmental Impact Statement on the impacts of Glen Canyon Dam operations on resources downstream in Glen and Grand Canyons. Implementation of Interim Flow criteria for Glen Canyon Dam during the EIS preparation period requires that sand bar conditions be monitored to assess whether conditions of those sediment resources has been stabilized by this action. The present research is a monitoring study designed to determine the influence of fluctuating flows on biogeochemical reactions occurring within the recirculation deposits, specifically the reattachment bar. This project is being conducted through the National Park Service Cooperative Parks Studies Unit at Northern Arizona University in Flagstaff

2. Objectives

A. Describe and interpret the redox chemistry, especially with respect to nitrogen species, within the alluvial deposits of the recirculation zones.

B. Document the changes in water chemistry as waters flow through the alluvium.

C. Construct a geochemical model providing insight into the relationship between geochemical processes within the alluvial deposits and the biogeochemistry of the main stem.

3. Accomplishments

We completed our first trip in April of this year, installed 49 wells on three reattachment bars; 43.1L, 71.1L and 194L. Wells were clustered in pairs with a shallow well at approximately three meters and a deeper well at approximately six meters. Wells were located in coarse sand units to avoid well screen clogging problems associated with fine-grained units. Samples were collected and field measurements were made at least 24 hours after installation. These sites were visited and sampled again in July and October. When available, return channel samples and at least two eddy samples were taken when wells were sampled. Our second trip was completed this past July. On this trip we added two field measurements; dissolved oxygen and ammonium concentrations. During reduction of the field measurements for nitrate and nitrite, we observed that regression curves were not satisfactory. In our subsequent discussion with Hach, our supplier, we were informed that the lot of reagents used for nitrate and nitrite analysis were bad, forcing us to question all our field nitrate and nitrite numbers from the July trip. We did collect samples for laboratory analysis of nitrate and nitrite. We will compare lab and field measurements of N-species for the April trip to determine if we can use lab values for N-species for our July trip. In June we went to -6 mile and installed 12 wells. This site was sampled in November. On the October trip, we had the opportunity to sample several wells at different river stage levels. Due to budget revisions, laboratory analysis of the all the samples had to be put off until fiscal year 1994. Field data collected on all the trips appears in Appendix 1.

We have also undertaken physical and chemical analysis of soil samples from all four beaches. These studies include grain size analysis and fractionated extractable phosphate. Studies are ongoing and results will be avaiable next summer.

4. Initial Conclusions

In focussing on N-species, Ph, and dissolved oxygen, we observe two important relationships;

A. The ground waters in the half of the beach closest to the river closely reflect river chemistry.

B. Ground waters near and under return channels are very strongly influenced by interaction with buried, overbank, flood flow deposits.

B. PROBLEMS ENCOUNTERED

Our nitrate and nitrite numbers from the July trip are suspect due to degradation problem with the reagents received from Hach Company. We discovered large amounts of drift in our Eh measurements which we believe are due to poorly poised waters. Therefore, we added Winkler titrations to our field measurements in order to gain accurate knowledge of the oxidation states within the reattachment bars.

C. FISCAL STATUS

Due to the budget shortfall for FY93, this project has been reduced in scope. All biological objectives have been suspended. In addition, the number of sampling trips has been reduced to five. In order to offset the reduction in sampling trips, we have submitted a pre-proposal to Dr. Patten, Department of Environmental Sciences, Arizona State University to sample extensively 194L before and during the experimental flood flow during the spring of 1995. Lastly, much of the laboratory analysis of samples collected this year will be put off until FY94.

1. Cooperative Agreement Amount:$108,566.23
2. Expenditures and Commitments to Date: $56,134.64
3. Estimated Funds Required to Complete Work: $52,431.59
4. Estimated Date of Completion of Work: 4-1-95

Final report, final management report,final oral report.....1 June, 1995

D. ACTION REQUESTED OF NPS

1.Continued support of this project during the analysis and report preparation phases is requested of the NPS.

E. FUTURE PLANS

1. The schedule has been modified as follows.

Table 1: Schedule for activities and deliverables.

Initiation	March 1, 1992 or on notification of funding
Quarterly report	April 1, 1993
Initial oral report to NPS	April 15, 1993
First sampling trip	April 17, 1993
Quarterly report	July 1, 1993
Second sampling trip	July 9, 1993
Quarterly report	October 1, 1993
Third sampling trip	October 10, 1993
Draft 1993 annual technical and administrative reports	December 1, 1993
Final 1993 annual and oral reports	January 15, 1994
Fourth sampling trip	January 5, 1994
Quarterly report	April 1, 1994
Quarterly report	July 1, 1994
Fifth sampling trip	October 10,1994
Quarterly report	October 1, 1994
Draft annual technical and administrative reports	December 1, 1994
Final 1994 annual and oral reports	January 15, 1995
Final technical and annual report	June 1, 1995

Appendix 1: Field measurements

Beach: 43.2L

Date: April 20,1993

Notes: EVH = eddy sample taken in return current
EM = eddy sample taken at reattachment point
RC = return current sample taken from beach backwater

Sample	T(C)	Sp. cond.	pH	[H+]	Eh	Alkalinity (meq/l)	[NO2]	[NO3]
1AS	17.2	1100	7.73	1.86E-08	131.5	3.28	0.000	0.00
1AD	15.0	1080	7.39	4.07E-08	120.5	4.26	0.000	0.00
1BS	14.3	990	7.73	1.86E-08	335.0	2.50	0.009	0.00
1BD	17.0	1020	7.75	1.78E-08	379.5	3.39	0.015	0.11
1CS	17.5	990	7.89	1.29E-08	380.5	3.77	0.009	0.10
1CD	18.0	940	7.89	1.29E-08	369.0	4.92	0.019	0.08
2AS	16.7	1300	7.15	7.08E-08	203.9	8.41	0.000	0.00
2AD	17.0	1210	7.29	5.13E-08	145.5	5.87	0.000	0.01
2BS	18.0	1160	7.35	4.47E-08	376.8	4.25	0.009	0.17
2BD	18.0	1120	7.67	2.14E-08	320.5	2.75	0.005	0.08
2CS	14.6	1280	7.55	2.82E-08	373.7	4.61	0.019	0.12
2CD	15.5	945	8.13	7.41E-09	409.8	6.30	0.013	0.07
3AS	16.5	1040	7.44	3.63E-08	154.5	3.92	0.000	0.07
3AD	17.0	1110	7.39	4.07E-08	177.5	4.66	0.016	0.11
3BS	16.5	990	7.54	2.88E-08	444.5	3.30	0.000	0.08
3BSS	Dry well, no sample							
3BD	16.5	1050	7.65	2.24E-08	409.5	3.23	0.016	0.20
3CS	17.0	980	7.55	2.82E-08	406.8	3.40	0.011	0.15
3CD	17.0	1110	7.63	2.34E-08	384.8	3.10	0.024	0.14
RC	24.5	1385	8.28	5.25E-09	411.2	2.97	0.008	0.08
EVH	17.0	980	7.99	1.02E-08	443.5	2.99	0.006	0.37
EM	17.4	960	8.12	7.59E-09	397.5	3.60	0.007	0.37

WK43B

Beach: 43.2L

Date: July 11 and 12,1993

Notes:

EVH = eddy sample taken in return current
EM = eddy sample taken at reattachment point
RC = return current sample taken from beach backwater
Nitrate and Nitrite numbers produced with bad reagents

Begin sampling in AM at peak water level. All A and C wells are under water. BEACH IS DRAINING.
Elevation is 3200 ft.

Sample	T(C)	Sp cond.	pH	[H+]	DO	Eh	NH4mv	NH4+	[NO2]	[NO3]
1AS	18.1	1645	6.98	1.05E-07	0.00	59	35.0	2.73	0.00	0.00
1AD	16.9	950	7.59	2.57E-08	0.00	255	202.0	0.04	2.09	0.10
1BS	22.8	1061	7.5	3.16E-08	0.71	83	129.0	0.39	0.00	0.03
1BD	20.6	866	7.7	2.00E-08	1.10	119	122.0	0.56	0.02	0.03
1CS	22.2	870	7.76	1.74E-08	0.00	230	130.0	0.37	0.03	0.07
1CD	20	810	7.73	1.86E-08	0.00	155	145.0	0.17	0.02	0.02
2AS	18.1	973	7.54	2.88E-08	3.26	134	124.0	0.51	0.01	0.07
2AD	17.1	954	7.62	2.40E-08	1.31	206	153.0	0.11	0.01	0.10
2BS	18.2	1252	7.24	5.75E-08	0.00	150	138.0	0.19	0.00	0.13
2BD	17.1	1346	7.48	3.31E-08	0.00	152	90.0	0.66	0.00	0.00
2CS	23	1010	7.21	6.17E-08	0.00	287	234.0	0.02	0.05	0.25
2CD	22.7	972	7.5	3.16E-08	0.00	358	227.0	0.02	0.04	0.12
3AS	19	959	7.62	2.40E-08	1.20	189	187.0	0.05	1.48	0.27
3AD	18.8	938	7.81	1.55E-08	1.41	182	175.0	0.07	0.60	0.09
3BS	19.4	992	7.6	2.51E-08	0.40	150	90.0	0.66	0.00	0.00
3BD	19.6	1129	7.51	3.09E-08	0.00	157	136.0	0.27	0.01	0.00
3CS	23	1016	7.63	2.34E-08	0.00	196	198.7	0.01	0.04	0.02
3CD	21.1	993	7.42	3.80E-08	0.00	168	157.4	0.09	0.00	0.00
RC	28.2	943	8.14	7.24E-09	6.48	162	177.0	0.03	0.00	0.10
EVH	14	916	7.95	1.12E-08	8.32	217	167.0	0.09	5.33	0.36
EM	14.6	915	7.9	1.26E-08	5.39	218	71.0	1.08	2.70	0.50
1AD			7.63	2.34E-08	0.75	5	178.0	0.07	0.34	0.03

Appendix 1: Field measurements

Beach: 43.2L

Date: October 8,1993

Notes: Begin sampling in AM at below peak water level. All wells are exposed. Beach is draining. Wells at 1B and 1C were sampled again at low water.

Sample	T(C)	Sp cond.	pH	[H+]	DO	NH4+	[NO2]	[NO3]
1AS	18.2	1684	7.01	9.77E-08	0.0	25.63	0.00	0.00
1AD	16.8	1182	7.29	5.13E-08	0.5	1.09	0.01	0.00
1BS	19.2	1043	7.45	3.55E-08	1.6	0.59	0.02	0.02
1BD	18.5	1081	7.67	2.14E-08	1.8	1.51	0.02	0.02
1CS	19.2	1227	7.57	2.69E-08	0.9	1.94	0.01	0.03
1CD	18.7	890	7.82	1.51E-08	1.5	1.33	0.02	0.04
2AS	16.6	1420	7.22	6.03E-08	0.9	2.30	0.00	0.00
2AD	16.6	1368	7.23	5.89E-08	0.6	2.03	0.00	0.00
2BS	19.2	1994	7.02	9.55E-08	1.8	0.31	0.01	0.04
2BD	18.7	1566	7.36	4.37E-08	0.4	2.10	0.00	0.00
2CS	19.5	1120	7.42	3.80E-08	2.6	0.17	0.00	0.04
2CD	18.5	1082	7.87	1.35E-08	1.4	0.80	0.00	0.02
3AS	18.1	1338	7.18	6.61E-08	1.3	0.45	0.01	0.03
3AD	17.0	1209	7.31	4.90E-08	1.3	0.31	0.01	0.06
3BS	20.0	1332	7.42	3.80E-08	6.4	0.88	0.00	0.00
3BD	19.1	1093	7.48	3.31E-08	1.0	0.73	0.00	0.02
3CS	20.2	1299	7.26	5.50E-08	1.8	0.12	0.01	0.06
3CD	18.3	1056	7.57	2.69E-08	1.4	0.43	0.00	0.03
RC	11.4	976	8.17	6.76E-09	8.4	0.12	0.02	0.31
EVH	11.2	924	8.04	9.12E-09	8.7	0.07	0.00	0.33
EM	12.3	923	8.01	9.77E-09	9.7	0.07	0.01	0.53
1BS-2	18.5	1033	7.53	2.95E-08	1.2	0.78	0.00	0.04
1BD-2	17.7	1201	7.68	2.09E-08	1.3	1.36	0.00	0.04
1CS-2	18.3	1260	7.65	2.24E-08	0.7	1.73	0.00	0.03
1CD-2	17.6	989	7.83	1.48E-08	1.2	1.11	0.01	0.05

Beach: 71.2L
Date: April 23,1993
Notes: Flow is approximately 9000 cfs

Sample	T(C)	Sp cond.	pH	[H+]	Eh	Alk. (meq/l)	NO2	NO3
IAS	14.5	1200	7.68	2E-08	317.0	5.45	0.007	0.04
IAD	19.0	1215	7.55	3E-08	318.0	7.45	0.013	0.14
IBS	13.5	1015	7.84	1E-08	398.0	7.90	0.008	0.11
IBS dup	13.1	1005	7.76	2E-08	358.0		0.010	0.14
IBD	13.5	890	7.63	2E-08	154.0	12.02	0.000	0.00
IIAS	20.0	1475	7.38	4E-08	172.5	7.74	0.000	0.01
IIAD	17.0	1105	7.53	3E-08	197.0	4.21	0.000	0.08
IIBS	18.5	1645	7.50	3E-08	322.0	13.04	0.000	0.06
IIBD	11.5	985	7.92	1E-08	203.0	4.09	0.014	0.13
IIIAS	17.5	1390	6.98	1E-07	113.0	8.91	0.000	0.00
IIIAD	15.5	1105	7.65	2E-08	200.0	3.41	0.021	0.16
IIIBS	17.0	1210	7.60	3E-08	140.0	8.46	0.000	0.07
IIIBD	18.0	1060	7.83	1E-08	308.0	3.29	0.012	0.19
RIVER	3.5	940	8.08	8E-09	334.0		0.018	0.35

Beach: 71.2L
Date: July 15 and 16,1993
Notes: IAS, IAD, IIAD, IIAS, IIBS, and IIBD are filled with sediment and have to be redeveloped. IAD, after redeveloping still has 13" of sediment and recharg slowly. Elevation is 2700 ft.
Nitrite and Nitrate numbers are suspect due to bad reagents!
* indicates disolved oxygen measured with Winkler titration

Sample	Temp.	Sp cond.	pH	[H+]	DO	Eh	NH4+
IAS	16.5	1333	7.4	4E-08	*1.1	168.7	0.2
IAD	21.8	1686	7.16	7E-08	*0.6	90.7	0.6
IBS	20.9	1187	7.5	3E-08	2.13	222.0	0.3
IBD	14.9	1525	7.05	9E-08	1.06	60.5	4.1
IIAS	17.3	1175	7.41	4E-08	*0.5	119.4	0.2
IIAD	16.7	1266	7.26	5E-08	*0.2	123.5	0.6
IIBS	18.8	2037	7.03	9E-08	*.1	63.2	0.6
IIBD	16.3	1015	7.61	2E-08	*0.7	166.7	0.2
IIIAS	16.4	2145	6.94	1E-07	3.23	75.5	4.7
IIIAD	14.9	1158	7.36	4E-08	4.23	85.3	1.4
IIIBS	16.7	1005	7.57	3E-08	4.69	84.1	0.5
IIIBD	15.6	1008	7.58	3E-08	3.76	89.6	0.6
RIVER	16.6	964	7.87	1E-08	9.49	177.5	0.1
RC	21.4	1211	8.38	4E-09	*2.6	232.7	0.0

Beach: 71.2L

Date: October 11,1993

Notes: IB wells have been washed away. Probably due to a flash flood in Cardenas Creek. No return channel sample this time.

Sample	T(C)	Sp cond.	pH	[H+]	DO	[NH4]	[NO2]	[NO3]
IAS	17.8	1305	7.4	4.47E-08	4.2	0.63	0.00	0.00
IAi	18.8	1475	7.5	3.31E-08	0.4	1.43	0.00	0.00
IAD	16.9	1822	7.1	7.76E-08	2.0	8.03	0.00	0.00
IIAS	15.8	1207	7.5	3.39E-08	0.5	1.50	0.00	0.00
IIAD	15.3	1211	7.3	5.62E-08	0.4	5.22	0.00	0.00
IIBS	16.0	2090	7.0	1.00E-07	0.0	5.47	0.00	0.18
IIBD	15.3	1169	7.7	2.19E-08	4.1	1.24	0.00	0.02
IIIAS	16.4	1620	6.8	1.45E-07	0.0	2.80	0.00	0.00
IIIAD	14.8	1160	7.3	5.37E-08	0.3	1.50	0.00	0.00
IIIBS	15.3	1212	7.6	2.63E-08	1.6	0.43	0.00	0.02
IIIBD	14.4	1030	7.6	2.40E-08	1.4	1.02	0.00	0.02
RIVER	12.6	989	8.2	6.92E-09	9.4	0.11	0.01	0.40

Beach: 194L
Date: April 27,1993
Notes: River is rising.
EM= eddy sample taken in return current
HM= river sample taken at reattachment point

Sample	T(C)	Sp cond.	pH	[H+]	Eh	NO2	NO3
50AD	20.8	1015	7.39	4.07E-08	137.50	0.00	0.00
100AS	23.0	1185	7.65	2.24E-08	222.50	0.00	0.00
100AD	20.5	985	7.89	1.29E-08	245.50	0.00	0.06
100BS	22.0	1340	7.60	2.51E-08	385.10	0.00	0.04
100BD	21.5	1190	7.66	2.19E-08	287.10	NA	0.29
100CS	27.5	1230	7.87	1.35E-08	372.10	NA	0.67
100CD	25.3	1100	8.02	9.55E-09	390.10	NA	0.47
200AS*	21.0	1550	7.28	5.25E-08	111.00	0.00	0.22
200AD	21.3	1220	7.76	1.74E-08	368.50	0.00	0.26
200BS	21.5	1395	7.70	2.00E-08	369.50	0.00	0.20
200BD	20.5	1140	8.00	1.00E-08	339.20	0.01	0.18
200CS	20.0	1145	7.68	2.09E-08	372.80	0.00	0.22
200CD	20.0	905	8.05	8.91E-09	346.80	0.01	0.08
300AS1*	18.0	960	7.52	3.02E-08	131.41	0.00	0.00
300AS2*	17.5	1090	7.42	3.80E-08	116.41	NA	NA
300BS	19.0	650	7.99	1.02E-08	401.50	0.02	0.06
300BD	22.7	655	8.28	5.25E-09	373.50	0.00	0.00
300CS	20.0	975	7.93	1.17E-08	367.50	0.01	0.01
300CD	23.5	660	8.19	6.46E-09	395.50	0.00	0.04
EM	20.5	1070	8.29	5.13E-09	399.40	NA	0.76
HM	19.0	1040	8.30	5.01E-09	282.40	NA	0.83

Appendix 1: Field measurements

Beach: 194L

Date: July 20 and 21,1993

Notes: River is rising.
Concentrations in ppm.

Sample	T(C)	Sp cond.	pH	[H+]	DO	Eh	[NH4+]	[NO2]	[NO3]
50AD	18.4	1657	7.2	5.9E-08	0.4	77.9	3.62E+09	0.00	0.00
100AS	18.9	1716	7.4	3.6E-08	1.9	254.2	4.50E+08	0.00	0.00
100AD	17.2	919	7.3	4.8E-08	1.0	267.4	6.98E+06	0.00	0.00
100BS	18.2	1403	7.4	3.8E-08	0.7	144.9	2.02E-05	0.00	0.00
100BD	18	1423	7.5	3.2E-08	0.4	131.9	1.82E+05	0.00	0.00
100CS	21.7	1427	7.6	2.8E-08	1.6	178.2	6.56E-08	0.04	0.03
100CD	19.9	1313	7.7	2.1E-08	0.9	142.9	7.75E-04	0.03	0.03
200AS*	21.6	1677	7.1	7.2E-08	0.6	113.9	1.15E+09	0.00	0.00
200AD	19.4	2003	7.4	4.5E-08	0.9	82.9	3.70E-03	0.00	0.00
200BS	21.7	1278	7.6	2.3E-08	0.7	156.6	1.80E-09	0.02	0.03
200BD	19.6	974	7.8	1.6E-08	1.0	143.4	1.59E+03	0.00	0.02
200CS	20.3	1162	7.6	2.4E-08	0.9	175.9	2.88E-09	0.02	0.02
200CD	18.9	1232	7.8	1.5E-08	0.8	147.9	2.39E-01	0.00	0.00
300AS1*	18.5	809	7.5	3.5E-08	0.8	111.9	2.49E+00	0.00	0.03
300AS2*	18.4	1353	7.3	5.1E-08	0.8	101.9	8.77E+04	0.00	0.00
300BS	24.2	515	8.0	1.1E-08	1.3	237.9	2.52E-06	0.00	0.08
300BD	22.4	503	8.2	6.5E-09	0.9	389.9	1.98E-08	0.00	0.11
300CS	23.5	529	7.8	1.7E-08	1.0	424.9	3.78E-10	0.00	0.06
300CD	22.4	500	8.1	8.9E-09	1.0	236.2	2.88E-09	0.00	0.07
EM	18.2	943	8.3	5E-09	2.7	172.9	5.27E-07	0.04	0.06
HM	18.8	944	8.3	4.9E-09	2.6	171.9	9.36E-12	0.02	0.11

Beach: 194L

Date: October 21,1993

Notes: 100CS is dry at beginning of sampling .

Sample	T(C)	Sp cond.	pH	[H+]	DO(ml)	[NH4+]	[NO2]	[NO3]
50AD	17.8	1773	6.76	1.74E-07	0.3	0.12	0.00	0.00
100AS	18.6	1476	7.22	6.03E-08	1.3	0.03	0.01	0.00
100AD	18.2	917	7.29	5.13E-08	1.1	0.02	0.01	0.16
100BS	21.6	1201	6.94	1.15E-07	0.7	0.00	0.10	0.15
100BD	20.2	1201	7.34	4.57E-08	1.1	0.01	0.00	0.02
100CS	19.7	1287	7.12	7.59E-08	2.0	0.00	0.09	0.18
100CD	20.7	1055	7.52	3.02E-08	1.8	0.00	0.06	0.21
200AS*	20.1	na	6.6	2.51E-07	0.4	0.05	0.00	0.01
200AD	20.6	1070	6.74	1.82E-07	0.9	0.01	0.00	0.08
200BS	20.8	1023	7.04	9.12E-08	1.6	0.00	0.03	0.20
200BD	20.9	931	7.07	8.51E-08	1.7	0.01	0.03	0.12
200CS	20.6	1488	7.1	7.94E-08	1.8	0.00	0.04	0.21
200CD	20.1	1402	7.26	5.50E-08	1.8	0.00	0.01	0.15
300AS1*	18.7	992	6.75	1.78E-07	1.2	0.01	0.09	0.16
300AS2*	18.5	1032	6.8	1.58E-07	1.9	0.03	0.05	0.11
300BS	24	775	6.89	1.29E-07	1.9	0.00	0.09	0.11
300BD	22.3	544	7.27	5.37E-08	1.7	0.00	0.11	0.14
300CS	24	756	6.9	1.26E-07	2.1	0.00	0.10	0.19
300CD	23.2	499	7.09	8.13E-08	1.7	0.00	0.10	0.21
EM	16.2	964	8.06	8.71E-09	9.5	0.00	0.13	0.63
HM	15.5	969	8.24	5.75E-09	9.7	0.00	0.07	0.37
100CD dup	21.5	1289	7.41	3.89E-08	1.6	0.00	0.13	0.20
Blank	20.4	0.002	na			0.00		

INFLUENCE OF GEOCHEMICAL PROCESSES ON NUTRIENT SPIRALING WITHIN THE RECIRCULATION ZONES OF THE COLORADO RIVER IN THE GRAND CANYON

QUARTERLY REPORT: 1 April, 1993

Roderic A. Parnell, Jeffery B. Bennett,
Geology Department
Northern Arizona University, Campus Box 4099
Flagstaff, AZ 86011

Cooperative Agreement: CA8000-8-0002

Project Name: Influence of Geochemical Processes on Nutrient Spiraling Within the Recirculation Zones of the Colorado River in the Grand Canyon

Principal Investigator: Dr. Roderic A. Parnell

Government Technical representative: Dr. Lawrence E. Stevens

Short Title of Work: BEACH GEOCHEMISTRY AND NUTRIENT SPIRALING: Quarterly Report

Effective Date of Cooperative Agreement: 2-15-93

Cooperative Agreement Expiration Date: 5-1-95

Funded by: The U.S. Department of Interior
Bureau of Reclamation
Glen Canyon Environmental Studies

Sponsored by: The U.S. Department of Interior
National Park Service
Cooperative Parks Studies Unit
Northern Arizona University, Campus Box 5614
Flagstaff, AZ 86011

National Park Service Cooperative Agreement: CA8000-8-0002

BEACH GEOCHEMISTRY AND NUTRIENT SPIRALING QUARTERLY REPORT: 1 APRIL, 1993

A. MAJOR ACCOMPLISHMENTS

1. Overview of Project

The Bureau of Reclamation is the lead agency charged with preparing an Environmental Impact Statement on the impacts of Glen Canyon Dam operations on resources downstream in Glen and Grand canyons. Implementation of Interim Flow criteria for Glen Canyon Dam during the EIS preparation period requires that sand bar conditions be monitored to assess whether degradation of those sediment resources has been stabilized by this action. The present research is a monitoring study designed to determine the influence of fluctuating flows on nutrient spiraling through the recirculation deposits. This project is being conducted through the National Park Service Cooperative Parks Studies Unit at Northern Arizona University in Flagstaff, Arizona, with Dr. Roderic A. Parnell as principal investigator, Mr. Jeffery B. Bennett as research assistant, and Dr. Lawrence E. Stevens as government contracting officer.

2. Objectives

A. Describe and interpret the redox chemistry within the alluvial deposits of the recirculation zones.

B. Document the changes in water chemistry as waters flow through the alluvium.

C. Description of the biota associated with nutrient transformation.

D. Construction of a geochemical model providing insight int the relationship between geochemical processes within the alluvial deposits and the nutrient biogeochemistry of the main stem.

3. Accomplishments

During the few weeks since initiation of the agreement, we have completed several tasks. These tasks include, completion of a preliminary well design, procurement of equipment and selection of personnel. Data collection will begin in April. We have scheduled a preliminary trip to -6 mile beach in early April to verify well installation protocol and to define sampling protocol. Our first sampling trip is scheduled for April 17-May 1.

B. PROBLEMS ENCOUNTERED

No problems have been encountered to date.

C. FISCAL STATUS

Because of the short time since initiation of this project, no expenditures have been verified by NAU, nor have encumbrances been identified.

D. ACTION REQUESTED OF NPS

1. Continued support of this project during the analysis and report preparation phases is requested of the NPS.

2. Recognition of budget problems associated with much higher than anticipated costs for well materials, and the impacts of the likely rejection of the requested budget modification of the project.

E. FUTURE PLANS

1. We are presently following the schedule submitted with the budget modification presented in February 1993, however our initial oral report to the NPS has been moved to May/June as discussed with our GTR.

Table 1: Schedule for activities and deliverables.

Initiation	March 1, 1992 or on notification of funding
Quarterly report	April 1, 1993
Initial oral report to NPS	April 15, 1993
First sampling trip	May 30, 1993
Quarterly report	July 1, 1993
Second sampling trip	August 1, 1993
Quarterly report	October 1, 1993
Third sampling trip	October 10, 1993
Draft 1993 annual technical and administrative reports	December 1, 1993
Final 1993 annual and oral reports	January 15, 1994
Fourth sampling trip	January 20, 1993
Quarterly report	April 1, 1994
Fifth sampling trip	April 15, 1994
Quarterly report	July 1, 1994
Sixth sampling trip	June 15, 1994
Quarterly report	October 1, 1994
Seventh sampling trip	October 10,1994
Draft annual technical and administrative reports	December 1, 1994
Final 1994 annual and oral reports	January 15, 1995
Final technical and annual report	April 1, 1995

INFLUENCE OF GEOCHEMICAL PROCESSES ON NUTRIENT SPIRALING WITHIN THE RECIRCULATION ZONES OF THE COLORADO RIVER IN THE GRAND CANYON

QUARTERLY REPORT: 1 APRIL, 1993

Roderic A. Parnell, Jeffery B. Bennett,
Geology Department
Northern Arizona University, Campus Box 4099
Flagstaff, AZ 86011

Cooperative Agreement: CA8000-8-0002

Project Name: Influence of Geochemical Processes on Nutrient Spiraling Within the Recirculation Zones of the Colorado River in the Grand Canyon

Principal Investigator: Dr. Roderic A. Parnell

Government Technical representative: Dr. Larry Stevens

Short Title of Work: BEACH GEOCHEMISTRY AND NUTRIENT SPIRALING: Annual report

Effective Date of Cooperative Agreement: 2-15-93

Cooperative Agreement Expiration Date: 5-1-95

Funded by: The U.S. Department of Interior
Bureau of Reclamation
Glen Canyon Environmental Studies

Sponsored by: The U.S. Department of Interior
National Park Service
Cooperative Parks Studies Unit
Northern Arizona University, Campus Box 5614
Flagstaff, AZ 86011

National Park Service Cooperative Agreement: CA8000-8-0002

BEACH GEOCHEMISTRY AND NUTRIENT SPIRALING ANNUAL REPORT: 1993

A. MAJOR ACCOMPLISHMENTS

1. Overview of Project

The Bureau of Reclamation is the lead agency charged with preparing an Environmental Impact Statement on the impacts of Glen Canyon Dam operations on resources downstream in Glen and Grand Canyons. Implementation of Interim Flow criteria for Glen Canyon Dam during the EIS preparation period requires that sand bar conditions be monitored to assess whether conditions of those sediment resources has been stabilized by this action. The present research is a monitoring study designed to determine the influence of fluctuating flows on biogeochemical reactions occurring within the recirculation deposits, specifically the reattachment bar. This project is being conducted through the National Park Service Cooperative Parks Studies Unit at Northern Arizona University in Flagstaff

2. Objectives

A. Describe and interpret the redox chemistry, especially with respect to nitrogen species, within the alluvial deposits of the recirculation zones.

B. Document the changes in water chemistry as waters flow through the alluvium.

C. Construct a geochemical model providing insight into the relationship between geochemical processes within the alluvial deposits and the biogeochemistry of the main stem.

3. Accomplishments

We have completed four trips to three of our sites. On our first trip, 49 wells were installed and sampled on three reattachment bars; 43.1L, 71.1L and 194L. Wells were clustered in pairs with a shallow well at approximately three meters and a deeper well at approximately six meters. Wells were located in coarse sand units to avoid well screen clogging problems associated with fine-grained units. Samples were collected and field measurements were made at least 24 hours after installation. These sites were visited and sampled again in July, October, and January. When available, return channel samples and at least two eddy samples were taken when wells were sampled. Our second trip was completed this past July. On this trip we added two field measurements; dissolved oxygen and ammonium concentrations. During reduction of the field measurements for nitrate and nitrite, we observed that regression curves were not satisfactory. In our subsequent discussion with Hach, our supplier, we were informed that the lot of reagents used for nitrate and nitrite analysis were bad, forcing us to question all our field nitrate and nitrite numbers from the July trip. We did collect samples for laboratory analysis of nitrate and nitrite. We will compare lab and field measurements of N-species for the April trip to determine if we can use lab values for N-species for our July trip. In June we went to -6 mile and installed 12 wells. This site was sampled in November and will be sampled again on this month. On the October trip, we had the opportunity to sample several wells at different river stage levels. Due to budget revisions, laboratory analysis of the all the samples had to be put off until this fiscal year, 1994. This analysis is ongoing and will be completed this summer. Field data collected on all the trips appears in Appendix 1.

We have also undertaken physical and chemical analysis of soil samples from all four beaches. These studies include grain size analysis and fractionated extractable phosphate. Studies are ongoing and results will be avaiable next summer.

4. Initial Conclusions

In focussing on N-species, Ph, and dissolved oxygen, we observe two important relationships;

A. The ground waters in the half of the beach closest to the river closely reflect river chemistry.

B. Ground waters near and under return channels are very strongly influenced by interaction with buried, overbank, flood flow deposits.

B. PROBLEMS ENCOUNTERED

Our nitrate and nitrite numbers from the July trip are suspect due to degradation problem with the reagents received from Hach Company. We discovered large amounts of drift in our Eh measurements which we believe are due to poorly poised waters. Therefore, we added Winkler titrations to our field measurements in order to gain accurate knowledge of the oxidation states within the reattachment bars.

C. FISCAL STATUS

Due to the budget shortfall for FY93, this project has been reduced in scope. All biological objectives have been suspended. In addition, the number of sampling trips has been reduced to five. In order to offset the reduction in sampling trips, we have submitted a pre-proposal to Dr. Patten, Department of Environmental Sciences, Arizona State University to sample extensively 194L before and during the experimental flood flow during the spring of 1995. Lastly, much of the laboratory analysis of samples collected this year will be put off until FY94.

1. Cooperative Agreement Amount:$133,849

2. Expenditures and Commitments to Date: $50,055.68

3. Estimated Funds Required to Complete Work: $83,794

4. Estimated Date of Completion of Work: 4-1-95

Final report, final management report,final oral report.....1 June, 1995

D. ACTION REQUESTED OF NPS

1.Continued support of this project during the analysis and report preparation phases is requested of the NPS.

E. FUTURE PLANS

1. The schedule has been modified as follows.

Table 1: Schedule for activities and deliverables.

Initiation	March 1, 1992 or on notification of funding
Quarterly report	April 1, 1993
Initial oral report to NPS	April 15, 1993
First sampling trip	April 17, 1993
Quarterly report	July 1, 1993
Second sampling trip	July 9, 1993
Quarterly report	October 1, 1993
Third sampling trip	October 10, 1993
Draft 1993 annual technical and administrative reports	December 1, 1993
Final 1993 annual and oral reports	January 15, 1994
Fourth sampling trip	January 5, 1994
Quarterly report	April 1, 1994
Quarterly report	July 1, 1994
Fifth sampling trip	October 10,1994
Quarterly report	October 1, 1994
Draft annual technical and administrative reports	December 1, 1994
Final 1994 annual and oral reports	January 15, 1995
Final technical and annual report	June 1, 1995

Appendix 1: Field measurements

Beach: 43.2L

Date: April 20,1993

Notes:
EVH = eddy sample taken in return current
EM = eddy sample taken at reattachment point
RC = return current sample taken from beach backwater

Sample	T(C)	Sp. cond.	pH	[H+]	Eh	Alkalinity (meq/l)	[NO2]	[NO3]
1AS	17.2	1100	7.73	1.86E-08	131.5	3.28	0.000	0.00
1AD	15.0	1080	7.39	4.07E-08	120.5	4.26	0.000	0.00
1BS	14.3	990	7.73	1.86E-08	335.0	2.50	0.009	0.00
1BD	17.0	1020	7.75	1.78E-08	379.5	3.39	0.015	0.11
1CS	17.5	990	7.89	1.29E-08	380.5	3.77	0.009	0.10
1CD	18.0	940	7.89	1.29E-08	369.0	4.92	0.019	0.08
2AS	16.7	1300	7.15	7.08E-08	203.9	8.41	0.000	0.00
2AD	17.0	1210	7.29	5.13E-08	145.5	5.87	0.000	0.01
2BS	18.0	1160	7.35	4.47E-08	376.8	4.25	0.009	0.17
2BD	18.0	1120	7.67	2.14E-08	320.5	2.75	0.005	0.08
2CS	14.6	1280	7.55	2.82E-08	373.7	4.61	0.019	0.12
2CD	15.5	945	8.13	7.41E-09	409.8	6.30	0.013	0.07
3AS	16.5	1040	7.44	3.63E-08	154.5	3.92	0.000	0.07
3AD	17.0	1110	7.39	4.07E-08	177.5	4.66	0.016	0.11
3BS	16.5	990	7.54	2.88E-08	444.5	3.30	0.000	0.08
3BSS	Dry well, no sample							
3BD	16.5	1050	7.65	2.24E-08	409.5	3.23	0.016	0.20
3CS	17.0	980	7.55	2.82E-08	406.8	3.40	0.011	0.15
3CD	17.0	1110	7.63	2.34E-08	384.8	3.10	0.024	0.14
RC	24.5	1385	8.28	5.25E-09	411.2	2.97	0.008	0.08
EVH	17.0	980	7.99	1.02E-08	443.5	2.99	0.006	0.37
EM	17.4	960	8.12	7.59E-09	397.5	3.60	0.007	0.37

WK43B

Beach: 43.2L

Date: July 11 and 12,1993

Notes:

EVH = eddy sample taken in return current
EM = eddy sample taken at reattachment point
RC = return current sample taken from beach backwater
Nitrate and Nitrite numbers produced with bad reagents

Begin sampling in AM at peak water level. All A and C wells are under water. BEACH IS DRAINING.
Elevation is 3200 ft.

Sample	T(C)	Sp cond.	pH	[H+]	DO	Eh	NH4mv	NH4+	[NO2]	[NO3]
1AS	18.1	1645	6.98	1.05E-07	0.00	59	35.0	2.73	0.00	0.00
1AD	16.9	950	7.59	2.57E-08	0.00	255	202.0	0.04	2.09	0.10
1BS	22.8	1061	7.5	3.16E-08	0.71	83	129.0	0.39	0.00	0.03
1BD	20.6	866	7.7	2.00E-08	1.10	119	122.0	0.56	0.02	0.03
1CS	22.2	870	7.76	1.74E-08	0.00	230	130.0	0.37	0.03	0.07
1CD	20	810	7.73	1.86E-08	0.00	155	145.0	0.17	0.02	0.02
2AS	18.1	973	7.54	2.88E-08	3.26	134	124.0	0.51	0.01	0.07
2AD	17.1	954	7.62	2.40E-08	1.31	206	153.0	0.11	0.01	0.10
2BS	18.2	1252	7.24	5.75E-08	0.00	150	138.0	0.19	0.00	0.13
2BD	17.1	1346	7.48	3.31E-08	0.00	152	90.0	0.66	0.00	0.00
2CS	23	1010	7.21	6.17E-08	0.00	287	234.0	0.02	0.05	0.25
2CD	22.7	972	7.5	3.16E-08	0.00	358	227.0	0.02	0.04	0.12
3AS	19	959	7.62	2.40E-08	1.20	189	187.0	0.05	1.48	0.27
3AD	18.8	938	7.81	1.55E-08	1.41	182	175.0	0.07	0.60	0.09
3BS	19.4	992	7.6	2.51E-08	0.40	150	90.0	0.66	0.00	0.00
3BD	19.6	1129	7.51	3.09E-08	0.00	157	136.0	0.27	0.01	0.00
3CS	23	1016	7.63	2.34E-08	0.00	196	198.7	0.01	0.04	0.02
3CD	21.1	993	7.42	3.80E-08	0.00	168	157.4	0.09	0.00	0.00
RC	28.2	943	8.14	7.24E-09	6.48	162	177.0	0.03	0.00	0.10
EVH	14	916	7.95	1.12E-08	8.32	217	167.0	0.09	5.33	0.36
EM	14.6	915	7.9	1.26E-08	5.39	218	71.0	1.08	2.70	0.50
1AD			7.63	2.34E-08	0.75	5	178.0	0.07	0.34	0.03

Beach: 43.2L

Appendix 1: Field measurements

Date: October 8,1993

Notes: Begin sampling in AM at below peak water level. All wells are exposed. Beach is draining. Wells at 1B and 1C were sampled again at low water.

Sample	T(C)	Sp cond.	pH	[H+]	DO	NH4+	[NO2]	[NO3]
1AS	18.2	1684	7.01	9.77E-08	0.0	25.63	0.00	0.00
1AD	16.8	1182	7.29	5.13E-08	0.5	1.09	0.01	0.00
1BS	19.2	1043	7.45	3.55E-08	1.6	0.59	0.02	0.02
1BD	18.5	1081	7.67	2.14E-08	1.8	1.51	0.02	0.02
1CS	19.2	1227	7.57	2.69E-08	0.9	1.94	0.01	0.03
1CD	18.7	890	7.82	1.51E-08	1.5	1.33	0.02	0.04
2AS	16.6	1420	7.22	6.03E-08	0.9	2.30	0.00	0.00
2AD	16.6	1368	7.23	5.89E-08	0.6	2.03	0.00	0.00
2BS	19.2	1994	7.02	9.55E-08	1.8	0.31	0.01	0.04
2BD	18.7	1566	7.36	4.37E-08	0.4	2.10	0.00	0.00
2CS	19.5	1120	7.42	3.80E-08	2.6	0.17	0.00	0.04
2CD	18.5	1082	7.87	1.35E-08	1.4	0.80	0.00	0.02
3AS	18.1	1338	7.18	6.61E-08	1.3	0.45	0.01	0.03
3AD	17.0	1209	7.31	4.90E-08	1.3	0.31	0.01	0.06
3BS	20.0	1332	7.42	3.80E-08	6.4	0.88	0.00	0.00
3BD	19.1	1093	7.48	3.31E-08	1.0	0.73	0.00	0.02
3CS	20.2	1299	7.26	5.50E-08	1.8	0.12	0.01	0.06
3CD	18.3	1056	7.57	2.69E-08	1.4	0.43	0.00	0.03
RC	11.4	976	8.17	6.76E-09	8.4	0.12	0.02	0.31
EVH	11.2	924	8.04	9.12E-09	8.7	0.07	0.00	0.33
EM	12.3	923	8.01	9.77E-09	9.7	0.07	0.01	0.53
1BS-2	18.5	1033	7.53	2.95E-08	1.2	0.78	0.00	0.04
1BD-2	17.7	1201	7.68	2.09E-08	1.3	1.36	0.00	0.04
1CS-2	18.3	1260	7.65	2.24E-08	0.7	1.73	0.00	0.03
1CD-2	17.6	989	7.83	1.48E-08	1.2	1.11	0.01	0.05

WK43D

Beach: 43.2L

Date: January 4 and 5, 1994

Notes: Begin sampling in AM at below peak water level. All wells are exposed. Beach is draining. Wells at 1B and 1C were sampled again at low water.
2BS regeitered in mili-siemens, not micro

Sample	Temp.	Sp cond.	pH	[H+]	DO
1AS	11.2	1743	6.62	2.4E-07	0
1AD	12.3	1424	6.94	1.1E-07	0.7
1BS	10	1025	6.73	1.9E-07	2.3
1BD	11.4	1203	7.48	3.3E-08	2.4
1CS	10.6	1180	7.85	1.4E-08	2.1
1CD	11.8	794	7.88	1.3E-08	1.9
2AS	10.7	1617	7.13	7.4E-08	2.6
2AD	10.4	930	7.26	5.5E-08	2.7
2BS	13.3	2.22	6.95	1.1E-07	1
2BD	14.2	1627	7.28	5.2E-08	0.7
2CS	10.6	1067	7.16	6.9E-08	2.6
2CD	12.2	1012	7.35	4.5E-08	2.2
3AS	11.8	1231	7.08	8.3E-08	0.9
3AD	13.1	1318	7.30	5E-08	1.8
3BS	13.9	1288	7.32	4.8E-08	1.3
3BD	15.4	1152	7.34	4.6E-08	1.4
3CS	11.6	1138	7.09	8.1E-08	2.2
3CD	13.7	1064	7.20	6.3E-08	1.6
RC	10.4	795	7.15	7.1E-08	8.1
EVH	9.7	801	7.42	3.8E-08	9.8
EM	10.1	792	7.35	4.5E-08	9.7

Beach: 71.2L
Date: April 23,1993
Notes: Flow is approximately 9000 cfs

Sample	T(C)	Sp cond.	pH	[H+]	Eh	Alk. (meq/l)	NO2	NO3
IAS	14.5	1200	7.68	2E-08	317.0	5.45	0.007	0.04
IAD	19.0	1215	7.55	3E-08	318.0	7.45	0.013	0.14
IBS	13.5	1015	7.84	1E-08	398.0	7.90	0.008	0.11
IBS dup	13.1	1005	7.76	2E-08	358.0		0.010	0.14
IBD	13.5	890	7.63	2E-08	154.0	12.02	0.000	0.00
IIAS	20.0	1475	7.38	4E-08	172.5	7.74	0.000	0.01
IIAD	17.0	1105	7.53	3E-08	197.0	4.21	0.000	0.08
IIBS	18.5	1645	7.50	3E-08	322.0	13.04	0.000	0.06
IIBD	11.5	985	7.92	1E-08	203.0	4.09	0.014	0.13
IIIAS	17.5	1390	6.98	1E-07	113.0	8.91	0.000	0.00
IIIAD	15.5	1105	7.65	2E-08	200.0	3.41	0.021	0.16
IIIBS	17.0	1210	7.60	3E-08	140.0	8.46	0.000	0.07
IIIBD	18.0	1060	7.83	1E-08	308.0	3.29	0.012	0.19
RIVER	3.5	940	8.08	8E-09	334.0		0.018	0.35

Beach: 71.2L
Date: July 15 and 16,1993
Notes: IAS, IAD, IIAD, IIAS, IIBS, and IIBD are filled with sediment and have to be redeveloped. IAD, after redeveloping still has 13" of sediment and recharg slowly. Elevation is 2700 ft.
Nitrite and Nitrate numbers are suspect due to bad reagents!
* indicates disolved oxygen measured with Winkler titration

Sample	Temp.	Sp cond.	pH	[H+]	DO	Eh	NH4+
IAS	16.5	1333	7.4	4E-08	*1.1	168.7	0.2
IAD	21.8	1686	7.16	7E-08	*0.6	90.7	0.6
IBS	20.9	1187	7.5	3E-08	2.13	222.0	0.3
IBD	14.9	1525	7.05	9E-08	1.06	60.5	4.1
IIAS	17.3	1175	7.41	4E-08	*0.5	119.4	0.2
IIAD	16.7	1266	7.26	5E-08	*0.2	123.5	0.6
IIBS	18.8	2037	7.03	9E-08	*.1	63.2	0.6
IIBD	16.3	1015	7.61	2E-08	*0.7	166.7	0.2
IIIAS	16.4	2145	6.94	1E-07	3.23	75.5	4.7
IIIAD	14.9	1158	7.36	4E-08	4.23	85.3	1.4
IIIBS	16.7	1005	7.57	3E-08	4.69	84.1	0.5
IIIBD	15.6	1008	7.58	3E-08	3.76	89.6	0.6
RIVER	16.6	964	7.87	1E-08	9.49	177.5	0.1
RC	21.4	1211	8.38	4E-09	*2.6	232.7	0.0

Beach: 71.2L

Date: October 11,1993

Notes: IB wells have been washed away. Probably due to a flash flood in Cardenas Creek. No return channel sample this time.

Sample	T(C)	Sp cond.	pH	[H+]	DO	[NH4]	[NO2]	[NO3]
IAS	17.8	1305	7.4	4.47E-08	4.2	0.63	0.00	0.00
IAi	18.8	1475	7.5	3.31E-08	0.4	1.43	0.00	0.00
IAD	16.9	1822	7.1	7.76E-08	2.0	8.03	0.00	0.00
IIAS	15.8	1207	7.5	3.39E-08	0.5	1.50	0.00	0.00
IIAD	15.3	1211	7.3	5.62E-08	0.4	5.22	0.00	0.00
IIBS	16.0	2090	7.0	1.00E-07	0.0	5.47	0.00	0.18
IIBD	15.3	1169	7.7	2.19E-08	4.1	1.24	0.00	0.02
IIIAS	16.4	1620	6.8	1.45E-07	0.0	2.80	0.00	0.00
IIIAD	14.8	1160	7.3	5.37E-08	0.3	1.50	0.00	0.00
IIIBS	15.3	1212	7.6	2.63E-08	1.6	0.43	0.00	0.02
IIIBD	14.4	1030	7.6	2.40E-08	1.4	1.02	0.00	0.02
RIVER	12.6	989	8.2	6.92E-09	9.4	0.11	0.01	0.40

Beach: 71.2L

Date: January 7,1994

Notes: IB wells have been washed away. Probably due to a flash flood in Cardenas Creek. No return channel sample this time.

Sample	Temp.	Sp cond.	pH	[H+]	DO
IAS	11.0	1404	7.39	4.07E-08	1.4
IAi	9.8	1504	7.49	3.24E-08	0.8
IAD	11.3	1810	7.33	4.68E-08	1.1
IIAS	11.6	1210	7.47	3.39E-08	1.2
IIAD	12.5	1264	7.27	5.37E-08	0.6
IIBS	11.6	1906	6.96	1.10E-07	0
IIBD	11.5	1152	7.61	2.45E-08	1.4
IIIAS	9.7	1442	6.96	1.10E-07	0
IIIAD	11.1	1103	7.39	4.07E-08	1.5
IIIBS	9.4	1148	7.68	2.09E-08	1.7
IIIBD	10.5	991	7.78	1.66E-08	1.5
RIVER	9.0	879	8.10	7.94E-09	9.6

Beach: 194L
Date: April 27,1993
Notes:

River is rising.
EM= eddy sample taken in return current
HM= river sample taken at reattachment point

Sample	T(C)	Sp cond.	pH	[H+]	Eh	NO2	NO3
50AD	20.8	1015	7.39	4.07E-08	137.50	0.00	0.00
100AS	23.0	1185	7.65	2.24E-08	222.50	0.00	0.00
100AD	20.5	985	7.89	1.29E-08	245.50	0.00	0.06
100BS	22.0	1340	7.60	2.51E-08	385.10	0.00	0.04
100BD	21.5	1190	7.66	2.19E-08	287.10	NA	0.29
100CS	27.5	1230	7.87	1.35E-08	372.10	NA	0.67
100CD	25.3	1100	8.02	9.55E-09	390.10	NA	0.47
200AS*	21.0	1550	7.28	5.25E-08	111.00	0.00	0.22
200AD	21.3	1220	7.76	1.74E-08	368.50	0.00	0.26
200BS	21.5	1395	7.70	2.00E-08	369.50	0.00	0.20
200BD	20.5	1140	8.00	1.00E-08	339.20	0.01	0.18
200CS	20.0	1145	7.68	2.09E-08	372.80	0.00	0.22
200CD	20.0	905	8.05	8.91E-09	346.80	0.01	0.08
300AS1*	18.0	960	7.52	3.02E-08	131.41	0.00	0.00
300AS2*	17.5	1090	7.42	3.80E-08	116.41	NA	NA
300BS	19.0	650	7.99	1.02E-08	401.50	0.02	0.06
300BD	22.7	655	8.28	5.25E-09	373.50	0.00	0.00
300CS	20.0	975	7.93	1.17E-08	367.50	0.01	0.01
300CD	23.5	660	8.19	6.46E-09	395.50	0.00	0.04
EM	20.5	1070	8.29	5.13E-09	399.40	NA	0.76
HM	19.0	1040	8.30	5.01E-09	282.40	NA	0.83

Beach: 194L

Date: July 20 and 21,1993

Notes: River is rising.
Concentrations in ppm.

Sample	T(C)	Sp cond.	pH	[H+]	DO	Eh	[NH4+]	[NO2]	[NO3]
50AD	18.4	1657	7.2	5.9E-08	0.4	77.9	3.62E+09	0.00	0.00
100AS	18.9	1716	7.4	3.6E-08	1.9	254.2	4.50E+08	0.00	0.00
100AD	17.2	919	7.3	4.8E-08	1.0	267.4	6.98E+06	0.00	0.00
100BS	18.2	1403	7.4	3.8E-08	0.7	144.9	2.02E-05	0.00	0.00
100BD	18	1423	7.5	3.2E-08	0.4	131.9	1.82E+05	0.00	0.00
100CS	21.7	1427	7.6	2.8E-08	1.6	178.2	6.56E-08	0.04	0.03
100CD	19.9	1313	7.7	2.1E-08	0.9	142.9	7.75E-04	0.03	0.03
200AS*	21.6	1677	7.1	7.2E-08	0.6	113.9	1.15E+09	0.00	0.00
200AD	19.4	2003	7.4	4.5E-08	0.9	82.9	3.70E-03	0.00	0.00
200BS	21.7	1278	7.6	2.3E-08	0.7	156.6	1.80E-09	0.02	0.03
200BD	19.6	974	7.8	1.6E-08	1.0	143.4	1.59E+03	0.00	0.02
200CS	20.3	1162	7.6	2.4E-08	0.9	175.9	2.88E-09	0.02	0.02
200CD	18.9	1232	7.8	1.5E-08	0.8	147.9	2.39E-01	0.00	0.00
300AS1*	18.5	809	7.5	3.5E-08	0.8	111.9	2.49E+00	0.00	0.03
300AS2*	18.4	1353	7.3	5.1E-08	0.8	101.9	8.77E+04	0.00	0.00
300BS	24.2	515	8.0	1.1E-08	1.3	237.9	2.52E-06	0.00	0.08
300BD	22.4	503	8.2	6.5E-09	0.9	389.9	1.98E-08	0.00	0.11
300CS	23.5	529	7.8	1.7E-08	1.0	424.9	3.78E-10	0.00	0.06
300CD	22.4	500	8.1	8.9E-09	1.0	236.2	2.88E-09	0.00	0.07
EM	18.2	943	8.3	5E-09	2.7	172.9	5.27E-07	0.04	0.06
HM	18.8	944	8.3	4.9E-09	2.6	171.9	9.36E-12	0.02	0.11

Beach: 194L

Date: October 21,1993

Notes: 100CS is dry at beginning of sampling .

Sample	T(C)	Sp cond.	pH	[H+]	DO(ml)	[NH4+]	[NO2]	[NO3]
50AD	17.8	1773	6.76	1.74E-07	0.3	0.12	0.00	0.00
100AS	18.6	1476	7.22	6.03E-08	1.3	0.03	0.01	0.00
100AD	18.2	917	7.29	5.13E-08	1.1	0.02	0.01	0.16
100BS	21.6	1201	6.94	1.15E-07	0.7	0.00	0.10	0.15
100BD	20.2	1201	7.34	4.57E-08	1.1	0.01	0.00	0.02
100CS	19.7	1287	7.12	7.59E-08	2.0	0.00	0.09	0.18
100CD	20.7	1055	7.52	3.02E-08	1.8	0.00	0.06	0.21
200AS*	20.1	na	6.6	2.51E-07	0.4	0.05	0.00	0.01
200AD	20.6	1070	6.74	1.82E-07	0.9	0.01	0.00	0.08
200BS	20.8	1023	7.04	9.12E-08	1.6	0.00	0.03	0.20
200BD	20.9	931	7.07	8.51E-08	1.7	0.01	0.03	0.12
200CS	20.6	1488	7.1	7.94E-08	1.8	0.00	0.04	0.21
200CD	20.1	1402	7.26	5.50E-08	1.8	0.00	0.01	0.15
300AS1*	18.7	992	6.75	1.78E-07	1.2	0.01	0.09	0.16
300AS2*	18.5	1032	6.8	1.58E-07	1.9	0.03	0.05	0.11
300BS	24	775	6.89	1.29E-07	1.9	0.00	0.09	0.11
300BD	22.3	544	7.27	5.37E-08	1.7	0.00	0.11	0.14
300CS	24	756	6.9	1.26E-07	2.1	0.00	0.10	0.19
300CD	23.2	499	7.09	8.13E-08	1.7	0.00	0.10	0.21
EM	16.2	964	8.06	8.71E-09	9.5	0.00	0.13	0.63
HM	15.5	969	8.24	5.75E-09	9.7	0.00	0.07	0.37
100CD dup	21.5	1289	7.41	3.89E-08	1.6	0.00	0.13	0.20
Blank	20.4	0.002	na			0.00		

Beach: 194L

Date: January 13,14, and 15, 1994

Notes: The C wells in each profile were sampled a second time at low water.

Sample	Temp.	Sp cond.	pH	[H+]	DO(ml)	NH4mv
50AD	14	1841	7.42	3.80E-08	0.6	77.7
100AS	12.4	1180	7.67	2.14E-08	1.9	96
100AD	13.1	841	7.78	1.66E-08	2.1	100.2
100BS	12.3	1946	7.46	3.47E-08	2.3	128
100BD	14.8	1333	7.7	2.00E-08	1.6	96
100CS	12.2	1284	7.74	1.82E-08	2.3	139
100CD	14.1	1400	7.82	1.51E-08	2.2	119
200AS*	10.4	1502	7.5	3.16E-08	1.3	93.9
200AD	13.9	1794	7.87	1.35E-08	1.1	97.7
200BS	13.3	1150	7.64	2.29E-08	2.7	131
200BD	13.8	943	7.86	1.38E-08	2	101
200CS	12.1	906	7.65	2.24E-08	2.3	142
200CD	13.9	1289	7.91	1.23E-08	1.7	121
300AS1*	14.4	1006	7.78	1.66E-08	0.4	114
300AS2*	13.2	943	7.78	1.66E-08	1.4	99
300BS	15.6	570	8.07	8.51E-09	1	125
300BD	17.4	524	8.42	3.80E-09	2	143
300CS	15	557	7.79	1.62E-08	2.6	137
300CD	19.5	504	8.1	7.94E-09	1.7	140
EM	9.3	867	8.45	3.55E-09	10.3	136
HM	9.5	866	8.45	3.55E-09	10.2	138
100CS	7.2	1281	7.65	2.24E-08	1.8	131
100CD	13.4	1408	7.82	1.51E-08	1	116.8
200CS	13.9	948	7.67	2.14E-08	2.2	135
200CD	11.7	1280	7.94	1.15E-08	1.8	123.4
300CS	11.1	572	7.79	1.62E-08	3.8	128
300CD	18.9	508	8.04	9.12E-09	2	130

A PROPOSAL TO DETERMINE THE INFLUENCE OF GEOCHEMICAL PROCESSES ON NUTRIENT SPIRALING WITHIN THE RECIRCULATION ZONES OF THE COLORADO RIVER IN THE GRAND CANYON

Adjustments in Scope of Work Caused by Budget Revisions of February 8, 1993
June 30, 1993

Roderic A. Parnell, Jr. and Jeffrey B. Bennett
Geology Department
Northern Arizona University, Campus Box 4099
Flagstaff, AZ 86011

Cooperative Agreement: CA8000-8-0002

Principal Investigator: Dr. Roderic A. Parnell, Jr.

Government Technical Representative: Dr. Larry Stevens

Short Title of Work: Geochemical Processes in Sand Bars

Effective Date of Cooperative Agreement: 2-15-93

Cooperative Agreement Expiration Date: 5-1-95

Funded by: The U.S. Department of the Interior
Bureau of Reclamation
Glen Canyon Environmental Studies

Sponsored by: The U. S. Department of the Interior
National Park Service
Cooperative Park Studies Unit
Northern Arizona University, Campus Box 5614
Flagstaff, AZ 86011

WAP 6/12b - adj prop

INTRODUCTION: Glen Canyon Environmental Studies has agreed to support our efforts to describe the geochemistry of waters percolating through beaches within the Grand Canyon. This study is necessary in order to evaluate the impact of beach geochemistry on nutrient spiraling along the river continuum. We have installed monitoring wells at four sites below GCD and are currently sampling from these wells for chemical analysis. While our sampling program will allow us to interpret spatial and temporal variability in pore water chemistry, it has not allowed us to determine hydrologic characteristics of the beaches, nor will we be able to establish kinetic controls on geochemical processes caused by rapidly fluctuating water levels.

In response to a request to adjust our budget in light of constraints during FY93, we have put together a package of budget cuts which achieved a FY93 budget reduction of $25,523. The following major reductions were necessary based upon the budget reduction: 1) cut two research trips, down from 7 to five, 2) cut the biological sampling and analysis of the hyporheic zone, and 3) move most analyses from the first two sampling trips into FY 94.

To avoid jeopardizing the comprehensive nature of the project, we retained sampling trips in every season of the year. We have cut the Spring, 1994 trip and the Summer, 1994 trip, leaving us with trips in Spring, 1993; Summer, 1993; Fall, 1993; Winter, 1994; and Fall, 1994. We have submitted a pre-proposal to Dr. Duncan Patton for another trip during the scheduled flood of Spring, 1994. If funded, that proposal would restore one of the cut trips. Although the cost of any sampling trip itself is not too expensive, the costs associated with analyzing collected samples and interpreting that data are. The major expenses associated with each trip are analytical time, expendable equipment and supplies, and instrument use charges.

We have also cut the biological analysis of hyporheic samples throughout the project. Our reasoning was that a minimum of five trips were necessary to begin to characterize beach geochemistry, and thus, no further geochemistry cuts could be made in order to preserve the biological analyses. Thus, the FY 93 annual report from this project will include data from only two trips and will include no hyporheic data.

Because we cut a significant amount of analytical expenses from the FY 93 budget, we are using the funds for the cancelled sixth and seventh trips in FY 94 and FY 95 to pay for the analytical costs incurred for FY 93 samples.

FUTURE PLANS

We are presently following the schedule submitted with the budget modification, as amended due to the February, 1993 budget adjustments. See table 1 for our current schedule.

Table 1. Schedule of activities and deliverables.

Initiation	Feb. 15, 1993
Quarterly Report	April 1, 1993
Initial Oral Report to NPS	April 15, 1993
First Sampling Trip	April, 1993
Quarterly Report	July 1, 1993
Second Sampling Trip	July, 1993
Quarterly Report	October 1, 1993
Third Sampling Trip	October, 1993
Draft 1993 annual technical and administrative reports	December 1, 1993
Fourth Sampling Trip	January 5, 1994
Final 1993 annual and oral reports	January 15, 1994
Quarterly Report	April 1, 1994
(Proposed flood flow sampling trip	March/April, 1994)
Quarterly Report	July 1, 1994
Fifth Sampling Trip	October, 1994
Quarterly Report	October 1, 1994
Draft annual technical and administrative reports	December 1, 1994
Final 1994 annual and oral reports	January 15, 1995
Final Technical and annual report	June 1, 1995

INFLUENCE OF GEOCHEMICAL PROCESSES ON NUTRIENT SPIRALING WITHIN THE RECIRCULATION ZONES OF THE COLORADO RIVER IN THE GRAND CANYON

QUARTERLY REPORT: 1 July, 1993

Roderic A. Parnell, Jeffery B. Bennett,
Geology Department
Northern Arizona University, Campus Box 4099
Flagstaff, AZ 86011

Cooperative Agreement: CA8000-8-0002

Project Name: Influence of Geochemical Processes on Nutrient Spiraling Within the Recirculation Zones of the Colorado River in the Grand Canyon

Principal Investigator: Dr. Roderic A. Parnell

Government Technical representative: Dr. Larry Stevens

Short Title of Work: BEACH GEOCHEMISTRY AND NUTRIENT SPIRALING: Quarterly Report

Effective Date of Cooperative Agreement: 2-15-93

Cooperative Agreement Expiration Date: 5-1-95

Funded by: The U.S. Department of Interior
Bureau of Reclamation
Glen Canyon Environmental Studies

Sponsored by: The U.S. Department of Interior
National Park Service
Cooperative Parks Studies Unit
Northern Arizona University, Campus Box 5614
Flagstaff, AZ 86011

National Park Service Cooperative Agreement: CA8000-8-0002

BEACH GEOCHEMISTRY AND NUTRIENT SPIRALING QUARTERLY REPORT: 1 APRIL, 1993

A. MAJOR ACCOMPLISHMENTS

1. Overview of Project

The Bureau of Reclamation is the lead agency charged with preparing an Environmental Impact Statement on the impacts of Glen Canyon Dam operations on resources downstream in Glen and Grand canyons. Implementation of Interim Flow criteria for Glen Canyon Dam during the EIS preparation period requires that sand bar conditions be monitored to assess whether degradation of those sediment resources has been stabilized by this action. The present research is a monitoring study designed to determine the influence of fluctuating flows on nutrient spiraling through the recirculation deposits. This project is being conducted through the National Park Service Cooperative Parks Studies Unit at Northern Arizona University in Flagstaff

2. Objectives

A. Describe and interpret the redox chemistry within the alluvial deposits of the recirculation zones.

B. Document the changes in water chemistry as waters flow through the alluvium.

C. Construction of a geochemical model providing insight int the relationship between geochemical processes within the alluvial deposits and the biogeochemistry of the main stem.

3. Accomplishments

Our first sampling trip began April 17, 1993. During our 14 days on the river we installed 49 wells on three beaches; 43.1L, 71.1L and 194L. Wells were clustered in pairs with a shallow well at three meters and a deeper well at six meters. Samples were collected and field measurements were made at least 24 hours after installation. In June we went to -6 mile and installed 12 wells. We have not sampled these wells yet. Laboratory analysis of the samples has been put off until fiscal year 1994. Field data colleted on the spring, 1993 sampling trip appears in appendix 1.

B. PROBLEMS ENCOUNTERED

No serious problems have been encountered yet.

C. FISCAL STATUS

Due to the budget shortfall for FY93, this project has been reduced in scope. All biological objectives have been suspended. In addition, the number of sampling trips has been reduced to five. In order to offset the reduction in sampling trips, we have submitted a pre-proposal to Dr. Patten, Department of Environmental Sciences, Arizona State University to sample extensively 194L during the experimental flood flow during the spring of 1994. Lastly, much of the analysis of samples collected this year will be put off until FY94.

1. Cooperative Agreement Amount:$108,566.23

2. Expenditures and Commitments to Date: $15,000.00

3. Estimated Funds Required to Complete Work: $93,566.23

4. Estimated Date of Completion of Work: 4-1-95

Final report, final management report,
final oral report.....1 June, 1995

D. ACTION REQUESTED OF NPS

1.Continued support of this project during the analysis and report preparation phases is requested of the NPS.

E. FUTURE PLANS

1. The schedule has been modified as follows.

Table 1: Schedule for activities and deliverables.

Initiation	March 1, 1992 or on notification of funding
Quarterly report	April 1, 1993
Initial oral report to NPS	April 15, 1993
First sampling trip	April 17, 1993
Quarterly report	July 1, 1993
Second sampling trip	July 9, 1993
Quarterly report	October 1, 1993
Third sampling trip	October 10, 1993
Draft 1993 annual technical and administrative reports	December 1, 1993
Final 1993 annual and oral reports	January 15, 1994
Fourth sampling trip	January 5, 1994
Quarterly report	April 1, 1994
Proposed flood flow trip	April, 1994
Quarterly report	July 1, 1994
Fifth sampling trip	October 10,1994
Quarterly report	October 1, 1994
Draft annual technical and administrative reports	December 1, 1994
Final 1994 annual and oral reports	January 15, 1995
Final technical and annual report	June 1, 1995

Appendix 1

43.2 4-20-93

Sample	Temp.	Specific cond	pH	Eh(mv)	zobells	alk.(meq/l)
1AS	17.2	1100	7.33	-143.0	192	3.28
1AD	15.0	1080	7.39	-154.0	192	4.26
1BS	14.3	990	7.73	70.5	202	2.50
1BD	17.0	1020	7.75	112.0	199	3.39
1CS	17.5	990	7.89	110.0	193	3.77
1CD	18.0	940	7.89	93.5	188	4.92
2AS	16.7	1300	7.15	-64.6	197	8.41
2AD	17.0	1210	7.29	-123.0	198	5.87
2BS	18.0	1160	7.35	110.0	196.7	4.25
2BD	18.0	1120	7.67	54.0	197	2.75
2CS	14.6	1280	7.55	103.7	196.5	4.61
2CD	15.5	945	8.13	140.0	196.7	6.30
3AS	16.5	1040	7.44	-114.0	198	3.92
3AD	17.0	1110	7.39	-91.0	198	4.66
3BS	16.5	990	7.54	170.0	192	3.30
3BD	16.5	1050	7.65	135.0	192	3.23
3CS	17.0	980	7.55	137.0	196.7	3.40
3CD	17.0	1110	7.63	115.0	196.7	3.10
RC	24.5	1385	8.28	149.7	198	2.97
EVH	17.0	980	7.99	174.0	197	2.99
EM	7.4	960	8.12	128.0	197	3.60

71L 4-23-93

Sample	Temp.	Specific cond	pH	Eh (mv)	zobells	alk.(meq/l)
IAS	14.5	1200	7.68	48.0	191	5.45
IAD	19.0	1215	7.55	52.0	191	7.45
IBS	13.5	1015	7.84	141.0	203	7.90
IBS dup	13.1	1005	7.76	101.0	203	
IBD	13.5	890	7.63	-103.0	203	12.02
IIAS	20.0	1475	7.38	-94.5	190	7.74
IIAD	17.0	1105	7.53	-73.0	190	4.21
IIBS	18.5	1645	7.50	56.0	191	13.04
IIBD	11.5	985	7.92	-56.0	190	4.09
IIIAS	17.5	1390	6.98	-154.0	190	8.91
IIIAD	15.5	1105	7.65	-70.0	190	3.41
IIIBS	17.0	1210	7.60	-130.0	190	8.46
IIIBD	18.0	1060	7.83	41.0	190	3.29
RIVER	3.5	940	8.08	62.0	190	

194L 4-27-93

Sample	Temp.	Specific cond	pH	Eh	zobells
50AD	20.8	1015	7.39	-136.0	190
100AS	23.0	1185	7.65	-47.0	190
100AD	20.5	985	7.89	-28.0	190
100BS	22.0	1340	7.60	118.0	185
100BD	21.5	1190	7.66	20.0	185
100CS	27.5	1230	7.87	112.0	186
100CD	25.3	1100	8.02	127.0	186
200AS*	21.0	1550	7.28	-162.5	190
200AD	21.3	1220	7.76	95.0	190
200BS	21.5	1395	7.70	96.0	190
200BD	20.5	1140	8.00	65.7	190
200CS	20.0	1145	7.68	99.3	190
200CD	20.0	905	8.05	73.3	190
300AS1*	18.0	960	7.52	-133.0	200
300AS2*	17.5	1090	7.42	-148.0	200
300BS	19.0	650	7.99	128.0	190
300BD	22.7	655	8.28	111.0	184
300CS	20.0	975	7.93	94.0	190
300CD	23.5	660	8.19	133.0	184
EM	20.5	1070	8.29	134.0	189
HM	19.0	1040	8.30	17.0	189

INFLUENCE OF GEOCHEMICAL PROCESSES ON NUTRIENT SPIRALING WITHIN THE RECIRCULATION ZONES OF THE COLORADO RIVER IN THE GRAND CANYON

QUARTERLY REPORT: 1 October, 1993

Roderic A. Parnell, Jeffery B. Bennett,
Geology Department
Northern Arizona University, Campus Box 4099
Flagstaff, AZ 86011

Cooperative Agreement: CA8000-8-0002

Project Name: Influence of Geochemical Processes on Nutrient Spiraling Within the Recirculation Zones of the Colorado River in the Grand Canyon

Principal Investigator: Dr. Roderic A. Parnell

Government Technical representative: Dr. Larry Stevens

Short Title of Work: BEACH GEOCHEMISTRY AND NUTRIENT SPIRALING: Quarterly Report

Effective Date of Cooperative Agreement: 2-15-93

Cooperative Agreement Expiration Date: 5-1-95

Funded by: The U.S. Department of Interior
Bureau of Reclamation
Glen Canyon Environmental Studies

Sponsored by: The U.S. Department of Interior
National Park Service
Cooperative Parks Studies Unit
Northern Arizona University, Campus Box 5614
Flagstaff, AZ 86011

National Park Service Cooperative Agreement: CA8000-8-0002

BEACH GEOCHEMISTRY AND NUTRIENT SPIRALING QUARTERLY REPORT: 1 APRIL, 1993

A. MAJOR ACCOMPLISHMENTS

1. Overview of Project

The Bureau of Reclamation is the lead agency charged with preparing an Environmental Impact Statement on the impacts of Glen Canyon Dam operations on resources downstream in Glen and Grand canyons. Implementation of Interim Flow criteria for Glen Canyon Dam during the EIS preparation period requires that sand bar conditions be monitored to assess whether degradation of those sediment resources has been stabilized by this action. The present research is a monitoring study designed to determine the influence of fluctuating flows on nutrient spiraling through the recirculation deposits. This project is being conducted through the National Park Service Cooperative Parks Studies Unit at Northern Arizona University in Flagstaff

2. Objectives

A. Describe and interpret the redox chemistry within the alluvial deposits of the recirculation zones.

B. Document the changes in water chemistry as waters flow through the alluvium.

C. Construction of a geochemical model providing insight int the relationship between geochemical processes within the alluvial deposits and the biogeochemistry of the main stem.

3. Accomplishments

We completed our first trip in April of this year, installed 49 wells on three beaches; 43.1L, 71.1L and 194L. Wells were clustered in pairs with a shallow well at three meters and a deeper well at six meters. Samples were collected and field measurements were made at least 24 hours after installation. In June we went to -6 mile and installed 12 wells. Due to budgetary shortfalls and lack of sample storage space we have not sampled these wells yet. Our second trip was completed this past July. On this trip we added two field measurements; dissolved oxygen and ammonium concentrations. During reduction of the field measurements for nitrate and nitrite, we observed that regression curves were not satisfactory. In our subsequent discussion with Hach, our supplier, we were informed that the lot of reagents used for nitrate and nitrite analysis were bad, forcing us to question all our nitrate and nitrite numbers from the July trip. We did collect samples for laboratory analysis of nitrate and nitrite. We will compare lab and field measurements of N-species for the April trip to determine if we can use lab values for N-species for our July trip. Laboratory analysis of the all the samples had to be put off until fiscal year 1994. Field data collected on both the trips appears in appendix 1.

B. PROBLEMS ENCOUNTERED

Our nitrate and nitrite numbers from the July trip are suspect due to degradation problem with the reagents received from Hach Company.

C. FISCAL STATUS

Due to the budget shortfall for FY93, this project has been reduced in scope. All biological objectives have been suspended. In addition, the number of sampling trips has been reduced to five. In order to offset the reduction in sampling trips, we have submitted a pre-proposal to Dr. Patten, Department of Environmental Sciences, Arizona State University to sample extensively 194L during the experimental flood flow during the spring of 1994. Lastly, much of the analysis of samples collected this year will be put off until FY94.

1. Cooperative Agreement Amount:$108,566.23

2. Expenditures and Commitments to Date: $15,000.00

3. Estimated Funds Required to Complete Work: $93,566.23

4. Estimated Date of Completion of Work: 4-1-95

Final report, final management report,
final oral report.....1 June, 1995

D. ACTION REQUESTED OF NPS

1.Continued support of this project during the analysis and report preparation phases is requested of the NPS.

E. FUTURE PLANS

1. The schedule has been modified as follows.

Table 1: Schedule for activities and deliverables.

Initiation	March 1, 1992 or on notification of funding
Quarterly report	April 1, 1993
Initial oral report to NPS	April 15, 1993
First sampling trip	April 17, 1993
Quarterly report	July 1, 1993
Second sampling trip	July 9, 1993
Quarterly report	October 1, 1993
Third sampling trip	October 10, 1993
Draft 1993 annual technical and administrative reports	December 1, 1993
Final 1993 annual and oral reports	January 15, 1994
Fourth sampling trip	January 5, 1994
Quarterly report	April 1, 1994
Proposed flood flow trip	April, 1994
Quarterly report	July 1, 1994
Fifth sampling trip	October 10,1994
Quarterly report	October 1, 1994
Draft annual technical and administrative reports	December 1, 1994
Final 1994 annual and oral reports	January 15, 1995
Final technical and annual report	June 1, 1995

Beach: 43.2L
Date: April 20,1993
Notes:

EVH= eddy sample taken in return current
EM= eddy sample taken at reattachment point
RC= return current sample taken from beach

Sample	T(C)	Sp. cond.	pH	[H+]	Eh	alk.(meq/l)	NO2	NO3
1AS	17.2	1100	7.73	1.86E-08	-143.0	3.28	0.000	0.00
1AD	15.0	1080	7.39	4.07E-08	-154.0	4.26	0.000	0.00
1BS	14.3	990	7.73	1.86E-08	70.5	2.50	0.009	0.00
1BD	17.0	1020	7.75	1.78E-08	112.0	3.39	0.015	0.11
1CS	17.5	990	7.89	1.29E-08	110.0	3.77	0.009	0.10
1CD	18.0	940	7.89	1.29E-08	93.5	4.92	0.019	0.08
2AS	16.7	1300	7.15	7.08E-08	-64.6	8.41	0.000	0.00
2AD	17.0	1210	7.29	5.13E-08	-123.0	5.87	0.000	0.01
2BS	18.0	1160	7.35	4.47E-08	110.0	4.25	0.009	0.17
2BD	18.0	1120	7.67	2.14E-08	54.0	2.75	0.005	0.08
2CS	14.6	1280	7.55	2.82E-08	103.7	4.61	0.019	0.12
2CD	15.5	945	8.13	7.41E-09	140.0	6.30	0.013	0.07
3AS	16.5	1040	7.44	3.63E-08	-114.0	3.92	0.000	0.07
3AD	17.0	1110	7.39	4.07E-08	-91.0	4.66	0.016	0.11
3BS	16.5	990	7.54	2.88E-08	170.0	3.30	0.000	0.08
3BSS	Dry well, no sample							
3BD	16.5	1050	7.65	2.24E-08	135.0	3.23	0.016	0.20
3CS	17.0	980	7.55	2.82E-08	137.0	3.40	0.011	0.15
3CD	17.0	1110	7.63	2.34E-08	115.0	3.10	0.024	0.14
RC	24.5	1385	8.28	5.25E-09	149.7	2.97	0.008	0.08
EVH	17.0	980	7.99	1.02E-08	174.0	2.99	0.006	0.37
EM	7.4	960	8.12	7.59E-09	128.0	3.60	0.007	0.37

Beach: 43.2L
Date: July 11,1993
Notes:

EVH= eddy sample taken in return current
EM= eddy sample taken at reattachment point
RC= return current sample taken from beach backwater.

Begin sampling in AM at peak water level. All A and C wells are under water.

* indicates raw data

Sample	T(C)	Sp cond.	pH1	[H+]	Eh*	DO*	NO2	NO3	NH4mv
1AS	18.1	1645	7	1.05E-07	-203.0	1.00	0.00	0.00	35
1AD	16.9	950	7.6	2.57E-08	-10.0	1.32	0.54	0.09	202
1BS	22.8	1061	7.5	3.16E-08	-160.0	2.02	0.00	0.02	129
1BD	20.6	866	7.7	2.00E-08	-128.0	2.41	0.00	0.02	122
1CS	22.2	870	7.8	1.74E-08	-17.0	1.90	0.11	0.07	130
1CD	20	810	7.7	1.86E-08	-92.0	1.38	0.00	0.01	145
2AS	18.1	973	7.5	2.88E-08	-117.0	5.29	0.00	0.06	124
2AD	17.1	954	7.6	2.40E-08	-48.0	3.34	0.00	0.10	153
2BS	18.2	1252	7.2	5.75E-08	-102.0	2.32	0.15	0.12	138
2BD	17.1	1346	7.5	3.31E-08	-103.0	1.40	0.00	0.00	90
2CS	23	1010	7.2	6.17E-08	35.0	2.20	0.71	0.27	234
2CD	22.7	972	7.5	3.16E-08	102.0	1.28	0.31	0.13	227
3AS	19	959	7.6	2.40E-08	-73.0	2.83	0.48	0.23	187
3AD	18.8	938	7.8	1.55E-08	-80.0	2.62	0.40	0.08	175
3BS	19.4	992	7.6	2.51E-08	-102.0	2.84	0.00	0.00	90
3BD	19.6	1129	7.5	3.09E-08	-99.0	2.30	0.00	0.00	136
3CS	23	1016	7.6	2.34E-08	-58.0	3.12	0.31	0.01	198.7
3CD	21.1	993	7.4	3.80E-08	-90.0	2.29	0.00	0.00	157.4
RC	28.2	943	8.1	7.24E-09	-93.0	8.20	0.46	0.09	177
EVH	14	916	8	1.12E-08	-48.0	9.53	0.83	0.31	167
EM	14.6	915	7.9	1.26E-08	-47.0	6.60	0.59	0.42	71

Beach: 71.2L
Date: April 23,1993
Notes: Flow is approximately 9000 cfs

* indicates raw data

Sample	T(C)	Sp cond.	pH	[H+]	Eh*	lk.(meq/	NO2	NO3
IAS	14.5	1200	7.68	2.09E-08	48.0	5.45	0.007	0.04
IAD	19.0	1215	7.55	2.82E-08	52.0	7.45	0.013	0.14
IBS	13.5	1015	7.84	1.45E-08	141.0	7.90	0.008	0.11
IBS dup	13.1	1005	7.76	1.74E-08	101.0		0.010	0.14
IBD	13.5	890	7.63	2.34E-08	-103.0	12.02	0.000	0.00
IIAS	20.0	1475	7.38	4.17E-08	-94.5	7.74	0.000	0.01
IIAD	17.0	1105	7.53	2.95E-08	-73.0	4.21	0.000	0.08
IIBS	18.5	1645	7.50	3.16E-08	56.0	13.04	0.000	0.06
IIBD	11.5	985	7.92	1.2E-08	-56.0	4.09	0.014	0.13
IIIAS	17.5	1390	6.98	1.05E-07	-154.0	8.91	0.000	0.00
IIIAD	15.5	1105	7.65	2.24E-08	-70.0	3.41	0.021	0.16
IIIBS	17.0	1210	7.60	2.51E-08	-130.0	8.46	0.000	0.07
IIIBD	18.0	1060	7.83	1.48E-08	41.0	3.29	0.012	0.19
RIVER	3.5	940	8.08	8.32E-09	62.0		0.018	0.35

Beach: 71.2L
Date: July 15,1993
Notes: IAS,IAD,IIAD,IIAS, IIBS and IIBD are filled with sediment and have to be redeveloped. After redeveloping, IAD still has 13" of sediment in the bottom and recharges slowly.

Sample	T(C)	Sp cond.	pH1	[H+]	DO*	Eh*	NH4m	NO2	NO3
IAS	16.5	1333	7.4	3.98E-08	1.1	-89	107	0.000	0.00
IAD	21.8	1686	7.2	6.92E-08	0.6	-164	61	0.000	0.00
IBS	20.9	1187	7.5	3.16E-08	2.77	-30	136	0.012	0.06
IBD	14.9	1525	7.1	8.91E-08	1.7	-194.5	82	0.000	0.00
IIAS	17.3	1175	7.4	3.89E-08	0.5	-138.3	94	0.000	0.00
IIAD	16.7	1266	7.3	5.5E-08	0.2	-135.7	62	0.000	0.00
IIBS	18.8	2037	7	9.33E-08	0.1	-191.5	62	0.000	0.00
IIBD	16.3	1015	7.6	2.45E-08	0.7	-91	98	0.022	0.03
IIIAS			6.9	1.15E-07	1.7	-179.5	79	0.000	0.00
IIIAD	14.9	1158	7.4	4.37E-08	1.9	-183.3	104	0.000	0.00
IIIBS	16.7	1005	7.6	2.69E-08	1.89	-184.5	127	0.000	0.02
IIIBD	15.6	1008	7.6	2.63E-08	1.77	-179	121	0.000	0.00
RIVER	16.6	964	7.9	1.35E-08	9.35	-77.5	153	0.018	0.44
RC	21.4	1211	8.4	4.17E-09	2.6	-22	160	0.020	0.24

Beach: 194L
Date: April 27,1993
Notes: River is rising

Sample	Temp.	Sp cond.	pH	[H+]	Eh*	NO2	NO3
50AD	20.8	1015	7.39	4.07E-08	-136.0	0.002	0.05
100AS	23.0	1185	7.65	2.24E-08	-47.0	0.007	0.07
100AD	20.5	985	7.89	1.29E-08	-28.0	0.011	0.15
100BS	22.0	1340	7.60	2.51E-08	118.0	0.013	0.13
100BD	21.5	1190	7.66	2.19E-08	20.0	0.000	0.38
100CS	27.5	1230	7.87	1.35E-08	112.0	0.000	0.76
100CD	25.3	1100	8.02	9.55E-09	127.0	0.000	0.57
200AS*	21.0	1550	7.28	5.25E-08	-162.5	0.031	0.31
200AD	21.3	1220	7.76	1.74E-08	95.0	0.016	0.35
200BS	21.5	1395	7.70	2.00E-08	96.0	0.015	0.29
200BD	20.5	1140	8.00	1.00E-08	65.7	0.019	0.28
200CS	20.0	1145	7.68	2.09E-08	99.3	0.015	0.32
200CD	20.0	905	8.05	8.91E-09	73.3	0.020	0.17
300AS1*	18.0	960	7.52	3.02E-08	-133.0	0.003	0.02
300AS2*	17.5	1090	7.42	3.80E-08	-148.0	0.000	0.00
300BS	19.0	650	7.99	1.02E-08	128.0	0.027	0.16
300BD	22.7	655	8.28	5.25E-09	111.0	0.004	0.02
300CS	20.0	975	7.93	1.17E-08	94.0	0.014	0.14
300CD	23.5	660	8.19	6.46E-09	133.0	0.008	0.14
EM	20.5	1070	8.29	5.13E-09	134.0	0.000	0.85
HM	19.0	1040	8.30	5.01E-09	17.0	0.000	0.92

Beach: 194L
Date: July 20,1993

Sample	Temp.	Sp cond.	pH1	[H+]	DO(ml)*	Eh*	NO2	NO3	NH4mv
50AD	18.4	1657	7.2	5.89E-08	0.4	-183	0.00	0.00	85.0
100AS	18.9	1716	7.4	3.63E-08	1.9	-6.7	0.00	0.00	89.0
100AD	17.2	919	7.3	4.79E-08	1	3.5	0.00	0.05	97.0
100BS	18.2	1403	7.4	3.8E-08	0.7	-116	0.00	0.04	148.0
100BD	17.95	1423	7.5	3.16E-08	0.4	-129	0.00	0.00	104.0
100CS	21.7	1427	7.6	2.75E-08	1.6	-82.7	0.04	0.07	159.0
100CD	19.9	1313	7.7	2.09E-08	0.9	-118	0.03	0.07	141.0
200AS*	21.6	1677	7.1	7.24E-08	0.6	-147	0.00	0.00	87.2
200AD	19.4	2003	7.4	4.47E-08	0.9	-178	0.00	0.00	138.0
200BS	21.7	1278	7.6	2.29E-08	0.7	-104.3	0.02	0.07	165.9
200BD	19.6	974	7.8	1.58E-08	1	-117.5	0.02	0.06	113.1
200CS	20.3	1162	7.6	2.4E-08	0.9	-85	0.02	0.06	165.0
200CD	18.9	1232	7.8	1.48E-08	0.8	-113	0.00	0.04	130.0
300AS1*	18.5	809	7.5	3.55E-08	0.8	-149	0.00	0.03	125.5
300AS2*	18.4	1353	7.3	5.13E-08	0.8	-159	0.00	0.00	105.4
300BS	24.2	515	8	1.12E-08	1.3	-19	0.00	0.08	152.0
300BD	22.4	503	8.2	6.46E-09	0.9	129	0.00	0.11	161.3
300CS	23.5	529	7.8	1.66E-08	1	168	0.00	0.06	168.9
300CD	22.4	500	8.1	8.91E-09	1	-24.7	0.00	0.07	165.0
EM	18.2	943	8.3	5.01E-09	2.7	-88	0.04	0.11	155.0
HM	18.8	944	8.3	4.9E-09	2.6	-89	0.02	0.16	176.0
RC	20.6	967	8.1	8.91E-09	2.9	146	0.04	0.16	150.0

INFLUENCE OF GEOCHEMICAL PROCESSES ON NUTRIENT SPIRALING WITHIN THE RECIRCULATION ZONES OF THE COLORADO RIVER IN THE GRAND CANYON

QUARTERLY REPORT: 1 July, 1994

Roderic A. Parnell, Jeffery B. Bennett,
Geology Department
Northern Arizona University, Campus Box 4099
Flagstaff, AZ 86011

Cooperative Agreement: CA8000-8-0002

Project Name: Influence of Geochemical Processes on Nutrient Spiraling Within the Recirculation Zones of the Colorado River in the Grand Canyon

Principal Investigator: Dr. Roderic A. Parnell

Government Technical representative: Dr. Larry Stevens

Short Title of Work: BEACH GEOCHEMISTRY AND NUTRIENT SPIRALING: Quarterly report

Effective Date of Cooperative Agreement: 2-15-93

Cooperative Agreement Expiration Date: 5-1-95

Funded by: **The U.S. Department of Interior**
Bureau of Reclamation
Glen Canyon Environmental Studies

Sponsored by: **The U.S. Department of Interior**
National Park Service
Cooperative Parks Studies Unit
Northern Arizona University, Campus Box 5614
Flagstaff, AZ 86011

National Park Service Cooperative Agreement: CA8000-8-0002

BEACH GEOCHEMISTRY AND NUTRIENT SPIRALING ANNUAL REPORT: 1993

A. MAJOR ACCOMPLISHMENTS

1. Overview of Project

The Bureau of Reclamation is the lead agency charged with preparing an Environmental Impact Statement on the impacts of Glen Canyon Dam operations on resources downstream in Glen and Grand Canyons. Implementation of Interim Flow criteria for Glen Canyon Dam during the EIS preparation period requires that sand bar conditions be monitored to assess whether conditions of those sediment resources has been stabilized by this action. The present research is a monitoring study designed to determine the influence of fluctuating flows on biogeochemical reactions occurring within the recirculation deposits, specifically the reattachment bar. This project is being conducted through the National Park Service Cooperative Parks Studies Unit at Northern Arizona University in Flagstaff

2. Objectives

A. Describe and interpret the redox chemistry, especially with respect to nitrogen species, within the alluvial deposits of the recirculation zones.

B. Document the changes in water chemistry as waters flow through the alluvium.

C. Construct a geochemical model providing insight into the relationship between geochemical processes within the alluvial deposits and the biogeochemistry of the main stem.

3. Accomplishments

We have completed four trips to three of our sites. On our first trip, 49 wells were installed and sampled on three reattachment bars; 43.1L, 71.1L and 194L. Wells were clustered in pairs with a shallow well at approximately three meters and a deeper well at approximately six meters. Wells were located in coarse sand units to avoid well screen clogging problems associated with fine-grained units. Samples were collected and field measurements were made at least 24 hours after installation. These sites were visited and sampled again in July, October, and January. When available, return channel samples and at least two eddy samples were taken when wells were sampled. Our second trip was completed this past July. On this trip we added two field measurements; dissolved oxygen and ammonium concentrations. During reduction of the field measurements for nitrate and nitrite, we observed that regression curves were not satisfactory. In our subsequent discussion with Hach, our supplier, we were informed that the lot of reagents used for nitrate and nitrite analysis were bad, forcing us to question all our field nitrate and nitrite numbers from the July trip. We did collect samples for laboratory analysis of nitrate and nitrite. We will compare lab and field measurements of N-species for the April trip to determine if we can use lab values for N-species for our July trip. In June we went to -6 mile and installed 12 wells. This site was sampled in November and in April of this year. On the October trip, we had the opportunity to sample several wells at different river stage levels. Laboratory analysis of the all the samples is currently ongoing and the data will be available for the next report. Field data collected on all the trips appears in Appendix 1. Data is presented in parts per million unless otherwise noted.

We have also undertaken physical and chemical analysis of soil samples from all four beaches. These studies include grain size analysis and fractionated extractable phosphate. Studies are ongoing and results will be avaiable October 1, 1994.

4. Initial Conclusions

In focussing on N-species, Ph, and dissolved oxygen, we observe two important relationships;

A. The ground waters in the half of the beach closest to the river closely reflect river chemistry.

B. Ground waters near and under return channels are very strongly influenced by interaction with buried, overbank, flood flow deposits.

B. PROBLEMS ENCOUNTERED

Our nitrate and nitrite numbers from the July trip are suspect due to degradation problem with the reagents received from Hach Company. We discovered large amounts of drift in our Eh measurements which we believe are due to poorly poised waters. Therefore, we added Winkler titrations to our field measurements in order to gain accurate knowledge of the oxidation states within the reattachment bars.

C. FISCAL STATUS

Due to the budget shortfall for FY93, this project has been reduced in scope. All biological objectives have been suspended. In addition, the number of sampling trips has been reduced to five. In order to offset the reduction in sampling trips, we have submitted a pre-proposal to Dr. Patten, Department of Environmental Sciences, Arizona State University to sample extensively 194L before and during the experimental flood flow during the spring of 1995. Lastly, much of the laboratory analysis of samples collected this year will be put off until FY94.

1. Cooperative Agreement Amount:$133,849
2. Expenditures and Commitments to Date: $90,0740
3. Estimated Funds Required to Complete Work: $43,109
4. Estimated Date of Completion of Work: 4-1-95

Final report, final management report,final oral report.....1 June, 1995

D. ACTION REQUESTED OF NPS

1.Continued support of this project during the analysis and report preparation phases is requested of the NPS.

E. FUTURE PLANS

1. The schedule has been modified as follows.

Table 1: Schedule for activities and deliverables.

Initiation	March 1, 1992 or on notification of funding
Quarterly report	April 1, 1993
Initial oral report to NPS	April 15, 1993
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Quarterly report	October 1, 1993
Third sampling trip	October 10, 1993
Draft 1993 annual technical and administrative reports	December 1, 1993
Final 1993 annual and oral reports	January 15, 1994
Fourth sampling trip	January 5, 1994
Quarterly report	April 1, 1994
Quarterly report	July 1, 1994
Sampling trip to -6 mile	July 26, 1994
Quarterly report	October 1, 1994
Sampling trip to -6 mile	November,1994
Draft annual technical and administrative reports	December 1, 1994
Fifth sampling trip	January ,1994
Final 1994 annual and oral reports	January 30, 1995
Final technical and annual report	June 1, 1995

Appendix 1: Field measurements

Beach: Hidden Slough (-6 mile)

Date: October 21,1993

Notes: Nitrate and Nitrite numbers will be reinterpreted at a future date

Sample	T(C)	Sp cond.	pH	[H+]	DO(ml)	NH4+	[NO2]	[NO3]	IC
Aways averag	12.35	1148	7.5	4E-08	1.20	1.88	0.00	0.027	74.5
Aways std. de	1.28	96	0.2	1E-08	0.51	1.21	0.00	0.028	15.9
Mid average	12.20	1056	7.5	3E-08	1.75	0.63	0.00	0.028	56
Mid std. dev.	1.02	108	0.2	1E-08	0.52	1.22	0.00	0.029	16.2
Close average	9.95	908	7.9	1E-08	2.23	1.09	0.01	0.268	43.4
Close std. dev	1.20	139	0.2	2E-08	0.99	1.30	0.01	0.292	20.5
Avg. surface	7.55	869	8.2	7E-09	7.78	0.41	0.01	0.495	31.9
Std.dev.	3.32	1	0.1	9E-10	0.67	0.07	NA	NA	0.47
10AS	13.1	1188	7.5	3.1E-08	1.60	0.73	0.00	0.06	58.2
10AD	13.4	1169	7.5	2.9E-08	1.01	0.41	0.00	0.02	73.4
10BS	12.4	1060	7.5	3.5E-08	2.05	0.66	0.01	0.01	57
10BD	12	1058	7.6	2.3E-08	2.38	0.84	0.01	0.08	48.9
10CS	9.5	915	7.8	1.4E-08	1.97	2.24	0.01	0.06	40.1
10CD	10.7	1008	7.8	1.4E-08	1.58	1.34	0.00	0.03	63.4
30AS	11.7	1183	7.3	5.2E-08	0.99	2.46	0.00	0.01	88.2
30AD	11.2	1052	7.5	3.0E-08	1.19	3.93	0.00	0.02	78.4
30BS	12.7	1201	7.4	4.2E-08	0.97	0.38	0.01	0.01	69
30BD	11.7	906	7.6	2.4E-08	1.60	0.66	0.00	0.00	49.2
30CS	9.1	858	8	1.1E-08	4.00	0.36	0.01	0.85	32
30CD	10.5	850	7.9	1.3E-08	1.35	0.43	0.01	0.13	38.1
RC	5.2	868	8.1	7.6E-09	8.25	0.36	0.01	0.50	32.2
RIVER	9.9	869	8.2	6.3E-09	7.3	0.45			31.5

Appendix 1: Field measurements

Beach: Hidden Slough

Date: April 23,1994

Notes: RIVER IS RISING. Nitrate and Nitrite numbers will be reinterpreted at a future d

Sample	T(C)	Sp cond.	pH	[H+]	DO	NH4mv	NH4+	[NO2]	[NO3]	IC	DOC
Aways averag	15.3	1091	7.5	3.47E-08	1.1	108.8	1.7	0.00	0.0	77.3	80.0
Aways std. de	2.15	107	0.2	9.69E-09	0.52	32.2	0.69	0.00	0.05	17	19.1
Mid average	16.1	950	7.5	3.61E-08	1.3	134.8	1.1	0.01	0.07	52.9	54.4
Mid std. dev.	2.23	83	0.2	1.35E-08	0.58	30.2	0.66	0.01	0.04	17	19
Close average	16.1	876	7.9	1.43E-08	0.9	128.8	1.3	0.01	0.19	46.2	43.9
Close std. dev	1.98	92	0.3	1.64E-08	0.28	35.0	0.71	0.01	0.13	21	22.5
Avg. surface	15.6	850	8.7	2.85E-09	14.1	157.0	0.8	0.02	0.14	32.4	30.7
Std.dev.	6.58	17	0.5	2.58E-09	NA	4.2	0.05	0.00	0.06	NA	3.73
10AS	15.6	1135	7.53	2.95E-08	1.30	153	0.83	0.00	0.13	72	70.9
10AD	17.5	1086	7.50	3.16E-08	1.1	133	1.09	0.00	0.00	70	71.5
10BS	19.4	908	7.56	2.75E-08	2.2	138	1.02	0.01	0.08	56	56.5
10BD	17.2	941	7.63	2.34E-08	1.6	148	0.89	0.01	0.07	44	42.7
10CS	16.9	860	7.78	1.66E-08	1.2	105	1.62	0.01	0.07	39	37.8
10CD	13.2	889	7.78	1.66E-08	0.5	94	1.89	0.00	0.05	76	68.4
30AS	13.6	1082	7.33	4.68E-08	1	79	2.33	0.00	0.00	87	92.6
30AD	14.4	1060	7.51	3.09E-08	0.8	70	2.64	0.00	0.00	80	84.9
30BS	14.2	923	7.28	5.25E-08	0.5	146	0.91	0.00	0.02	54	54.9
30BD	13.7	1026	7.39	4.07E-08	0.8	107	1.57	0.02	0.11	58	63.5
30CS	15.3	900	7.94	1.15E-08	NA	156	0.79	0.00	0.31	36	35.3
30CD	19.0	856	7.90	1.26E-08	NA	160	0.75	0.01	0.33	34	34.1
RC	20.2	838	8.99	1.02E-09	14	154	0.81	0.01	0.09		28
RIVER	10.9	862	8.33	4.68E-09	NA	160	0.75	0.02	0.18	32	33.3
30CD dup	13.0	858	7.90	1.26E-08	NA	162	0.73	0.01	0.11	35	35.2

Beach: 43.2L WK43A

Date: April 20,1993

Notes:

Sample	T(C)	Sp. cond.	pH	[H+]	Eh	Alkalinity (meq/l)	NO2	NO3
aways average	16.6	1140	7.40	4.31E-08	155.6	5.07	0.00	0.0
awas std. dev.	1.26	115	0.28	1.79E-08	112.69	1.55	0.01	0.1
middles average	16.7	1055	7.62	2.56E-08	377.6	3.24	0.01	0.1
middles std. dev.	1.17	118	0.27	1.75E-08	103.45	1.59	0.01	0.1
close average	16.6	1041	7.77	1.88E-08	387.4	4.35	0.02	0.1
close td. dev.	0.95	118	0.26	1.70E-08	106.22	1.54	0.01	0.1
Avg. surface wate	19.6	1108	8.13	7.69E-09	417.4	3.19	0.01	0.3
Std.dev.	4.22	240	0.15	2.49E-09	23.62	0.36	0.00	0.2
1AS	17.2	1100	7.73	1.86E-08	131.5	3.28	0.000	0.00
1AD	15.0	1080	7.39	4.07E-08	120.5	4.26	0.000	0.00
1BS	14.3	990	7.73	1.86E-08	335.0	2.50	0.009	0.00
1BD	17.0	1020	7.75	1.78E-08	379.5	3.39	0.015	0.11
1CS	17.5	990	7.89	1.29E-08	380.5	3.77	0.009	0.10
1CD	18.0	940	7.89	1.29E-08	369.0	4.92	0.019	0.08
2AS	16.7	1300	7.15	7.08E-08	203.9	8.41	0.000	0.00
2AD	17.0	1210	7.29	5.13E-08	145.5	5.87	0.000	0.01
2BS	18.0	1160	7.35	4.47E-08	376.8	4.25	0.009	0.17
2BD	18.0	1120	7.67	2.14E-08	320.5	2.75	0.005	0.08
2CS	14.6	1280	7.55	2.82E-08	373.7	4.61	0.019	0.12
2CD	15.5	945	8.13	7.41E-09	409.8	6.30	0.013	0.07
3AS	16.5	1040	7.44	3.63E-08	154.5	3.92	0.000	0.07
3AD	17.0	1110	7.39	4.07E-08	177.5	4.66	0.016	0.11
3BS	16.5	990	7.54	2.88E-08	444.5	3.30	0.000	0.08
3BSS	Dry well, no sample							
3BD	16.5	1050	7.65	2.24E-08	409.5	3.23	0.016	0.20
3CS	17.0	980	7.55	2.82E-08	406.8	3.40	0.011	0.15
3CD	17.0	1110	7.63	2.34E-08	384.8	3.10	0.024	0.14
RC	24.5	1385	8.28	5.25E-09	411.2	2.97	0.008	0.08
EVH	17.0	980	7.99	1.02E-08	443.5	2.99	0.006	0.37
EM	17.4	960	8.12	7.59E-09	397.5	3.60	0.007	0.37

Beach: 43.2L WK43B

Date: July 11 and 12,1993

Notes:

Sample	T(C)	Sp cnd.	pH	[H+]	DO	Eh	NH4mv	NH4+	[NO2]	[NO3]	IC ppm
aways averag	18.0	1070	7.5	3.71E-08	1.20	171	146.0	0.6	0.70	0.1	56.4
aways std. de	2.26	225	0.2	2.43E-08	0.95	80	53.3	0.7	0.65	0.082	43.2
mid average	20.2	1089	7.5	3.18E-08	0.37	142	128.0	0.4	0.01	0.0	73.9
mid std. dev.	2.15	142	0.2	1.34E-08	0.92	68	44.1	0.24	0.40	0.084	30.4
close average	21.8	931	7.5	3.18E-08	0.13	201	178.6	0.1	0.08	0.1	54.9
close std. dev	2.11	141	0.2	1.34E-08	0.92	77	43.1	0.23	0.40	0.086	31.5
Avg. surface	18.9	925	8.0	1.04E-08	6.73	199	138.3	0.4	2.68	0.3	125.4
Std.dev.	8.03	16	0.1	2.78E-09	1.48	32	58.5	0.59	2.66	0.203	160.7
1AS	18.1	1645	7	1.05E-07	0.00	59	35.0	2.73	0.00	0.00	170.6
1AD	16.9	950	7.6	2.57E-08	0.00	255	202.0	0.04	2.09	0.10	33.08
1BS	22.8	1061	7.5	3.16E-08	0.71	83	129.0	0.39	0.00	0.03	46.45
1BD	20.6	866	7.7	2.00E-08	1.10	119	122.0	0.56	0.02	0.03	43.95
1CS	22.2	870	7.8	1.74E-08	0.00	230	130.0	0.37	0.03	0.07	57.385
1CD	20	810	7.7	1.86E-08	0.00	155	145.0	0.17	0.02	0.02	66
2AS	18.1	973	7.5	2.88E-08	3.26	134	124.0	0.51	0.01	0.07	38.85
2AD	17.1	954	7.6	2.40E-08	1.31	206	153.0	0.11	0.01	0.10	31.84
2BS	18.2	1252	7.2	5.75E-08	0.00	150	138.0	0.19	0.00	0.13	98.83
2BD	17.1	1346	7.5	3.31E-08	0.00	152	90.0	0.66	0.00	0.00	128
2CS	23	1010	7.2	6.17E-08	0.00	287	234.0	0.02	0.05	0.25	37.59
2CD	22.7	972	7.5	3.16E-08	0.00	358	227.0	0.02	0.04	0.12	103.1
3AS	19	959	7.6	2.40E-08	1.20	189	187.0	0.05	1.48	0.27	31.7
3AD	18.8	938	7.8	1.55E-08	1.41	182	175.0	0.07	0.60	0.09	32.06
3BS	19.4	992	7.6	2.51E-08	0.40	150	90.0	0.66	0.00	0.00	86.18
3BD	19.6	1129	7.5	3.09E-08	0.00	157	136.0	0.27	0.01	0.00	53.538
3CS	23	1016	7.6	2.34E-08	0.00	196	198.7	0.01	0.04	0.02	39.87
3CD	21.1	993	7.4	3.80E-08	0.00	168	157.4	0.09	0.00	0.00	32.92
1AD dup			7.6	2.34E-08	0.75	5	178.0	0.07	0.34	0.03	32.321
RC	28.2	943	8.1	7.24E-09	6.48	162	177.0	0.03	0.00	0.10	34.19
EVH	14	916	8	1.12E-08	8.32	217	167.0	0.09	5.33	0.36	31.09
EM	14.6	915	7.9	1.26E-08	5.39	218	71.0	1.08	2.70	0.50	311.03

Beach: 43.2L WK43C

Date: October 8,1993

Notes:

Sample	Temp.	Sp cond.	pH	[H+]	DO	NH4mv	NH4+	[NO2]	[NO3]
aways average	17.2	1367	7.2	6.39E-08	0.8	84.4	5.3	0.0	0.0
awas std. dev.	1.03	292	0.27	2.6E-08	0.68	25.628	6.59	0.0379	0.038
middles average	19.1	1352	7.4	4.45E-08	2.2	97.9	1.0	0.0	0.0
middles std. dev.	1.12	265	0.24	2.17E-08	1.42	19.575	0.76	0.03	0.04
close average	18.8	1115	7.6	2.66E-08	1.4	103.0	1.0	0.0	0.0
close td. dev.	1.05	251	0.24	2.2E-08	1.31	18.442	0.719	0.0292	0.039
Avg. surface wate	11.6	941.0	8.1	8.55E-09	8.9	145.5	0.1	0.0	0.4
Std.dev.	0.59	30	0.09	1.6E-09	0.68	6.5	0.03	0.0216	0.124
1AS	18.2	1684	7.01	9.77E-08	0	26.8	25.63	-0.06	-0.05
1AD	16.8	1182	7.29	5.13E-08	0.5	92.7	1.09	0.01	-0.02
1BS	19.2	1043	7.45	3.55E-08	1.6	105.4	0.59	0.02	0.02
1BD	18.5	1081	7.67	2.14E-08	1.8	85.9	1.51	0.02	0.02
1CS	19.2	1227	7.57	2.69E-08	0.9	80.6	1.94	0.01	0.03
1CD	18.7	890	7.82	1.51E-08	1.5	88.5	1.33	0.02	0.04
2AS	16.6	1420	7.22	6.03E-08	0.9	77.1	2.30	0.00	-0.06
2AD	16.6	1368	7.23	5.89E-08	0.6	79.7	2.03	-0.01	-0.04
2BS	19.2	1994	7.02	9.55E-08	1.8	119	0.31	0.01	0.04
2BD	18.7	1566	7.36	4.37E-08	0.4	79	2.10	0.00	-0.02
2CS	19.5	1120	7.42	3.80E-08	2.6	131	0.17	-0.01	0.04
2CD	18.5	1082	7.87	1.35E-08	1.4	99	0.80	-0.11	0.02
3AS	18.1	1338	7.18	6.61E-08	1.3	111	0.45	0.01	0.03
3AD	17.0	1209	7.31	4.90E-08	1.3	119	0.31	0.01	0.06
3BS	20.0	1332	7.42	3.80E-08	6.4	97	0.88	-0.02	-0.07
3BD	19.1	1093	7.48	3.31E-08	1	101	0.73	0.00	0.02
3CS	20.2	1299	7.26	5.50E-08	1.8	138	0.12	0.01	0.06
3CD	18.3	1056	7.57	2.69E-08	1.4	112	0.43	-0.01	0.03
1BS-2	18.5	1033	7.53	2.95E-08	1.2	99.5	0.78	0.00	0.04
1BD-2	17.7	1201	7.68	2.09E-08	1.3	88	1.36	0.00	0.04
1CS-2	18.3	1260	7.65	2.24E-08	0.7	83	1.73	0.00	0.03
1CD-2	17.6	989	7.83	1.48E-08	1.2	92.2	1.11	0.01	0.05
RC	11.4	976	8.17	6.76E-09	8.4	138	0.12	0.02	0.31
EVH	11.2	924	8.04	9.12E-09	8.7	149.5	0.07	-0.02	0.33
EM	12.3	923	8.01	9.77E-09	9.7	149	0.07	0.01	0.53

Beach: 43.2L WK43D

Date: January 4 and 5, 1994

Notes: Ammonia probe failure

Sample	T(C)	Sp cond.	pH	[H+]	DO	IC ppm
aways averag	11.6	1377	7.1	1.03E-07	1.5	94.9
awas std. dev	1.23	434	0.36	6.43E-08	0.87	42.352
middles aver	13.0	1050	7.2	7.96E-08	1.5	86.1
middles std.	1.65	393	0.31	4.40E-08	0.68	34.822
close averag	11.8	1043	7.4	4.76E-08	2.1	57.6
close td. dev.	1.57	392	0.27	2.63E-08	0.66	34.77
Avg. surface	10.1	796	7.3	5.12E-08	9.2	22.2
Std.dev.	0.35	5	0.14	1.73E-08	0.95	0.8985
1AS	11.2	1743	6.62	2.4E-07	0	170.7
1AD	12.3	1424	6.94	1.1E-07	0.7	115
1BS	10	1025	6.73	1.9E-07	2.3	37.14
1BD	11.4	1203	7.48	3.3E-08	2.4	55.4
1CS	10.6	1180	7.85	1.4E-08	2.1	74.055
1CD	11.8	794	7.88	1.3E-08	1.9	53.358
2AS	10.7	1617	7.13	7.4E-08	2.6	104
2AD	10.4	930	7.26	5.5E-08	2.7	36.53
2BS	13.3	2.22	6.95	1.1E-07	1	134.8
2BD	14.2	1627	7.28	5.2E-08	0.7	139.6
2CS	10.6	1067	7.16	6.9E-08	2.6	45.319
2CD	12.2	1012	7.35	4.5E-08	2.2	82.33
3AS	11.8	1231	7.08	8.3E-08	0.9	53.26
3AD	13.1	1318	7.30	5E-08	1.8	90.01
3BS	13.9	1288	7.32	4.8E-08	1.3	104.7
3BD	15.4	1152	7.34	4.6E-08	1.4	45.1
3CS	11.6	1138	7.09	8.1E-08	2.2	44.24
3CD	13.7	1064	7.20	6.3E-08	1.6	46.31
RC	10.4	795	7.15	7.1E-08	8.1	22.87
EVH	9.7	801	7.42	3.8E-08	9.8	21.181
EM	10.1	792	7.35	4.5E-08	9.7	22.557

Beach: 71.2L
Date: April 23,1993
Notes:

Sample	T(C)	Sp cond.	pH	[H+]	Eh	Alk. (meq/l)	NO2	NO3
aways average	17.3	1248.3	7.5	0.0	219.6	6.2	0.0	0.1
awas std. dev.	2.79	232.3731	0.25	3E-08	94.54	3.277061	0.007	0.061
middles average	15.0	1115.7	7.7	0.0	269.0	8.1	0.0	0.1
middles std. dev.	2.68	235.1711	0.26	3E-08	96.24	3.5084218	0.007	0.066
IAS	14.5	1200	7.68	2E-08	317.0	5.45	0.007	0.04
IAD	19.0	1215	7.55	3E-08	318.0	7.45	0.013	0.14
IBS	13.5	1015	7.84	1E-08	398.0	7.90	0.008	0.11
IBS dup	13.1	1005	7.76	2E-08	358.0		0.010	0.14
IBD	13.5	890	7.63	2E-08	154.0	12.02	0.000	0.00
IIAS	20.0	1475	7.38	4E-08	172.5	7.74	0.000	0.01
IIAD	17.0	1105	7.53	3E-08	197.0	4.21	0.000	0.08
IIBS	18.5	1645	7.50	3E-08	322.0	13.04	0.000	0.06
IIBD	11.5	985	7.92	1E-08	203.0	4.09	0.014	0.13
IIIAS	17.5	1390	6.98	1E-07	113.0	8.91	0.000	0.00
IIIAD	15.5	1105	7.65	2E-08	200.0	3.41	0.021	0.16
IIIBS	17.0	1210	7.60	3E-08	140.0	8.46	0.000	0.07
IIIBD	18.0	1060	7.83	1E-08	308.0	3.29	0.012	0.19
RIVER	3.5	940	8.08	8E-09	334.0		0.018	0.35

Beach: 71.2L

Date: July 15 and 16,1993

Notes: IAS, IAD, IIAD, IIAS, IIBS, and IIBD are filled with sediment and have to b
IAD, after redeveloping still has 13" of sediment and recharges slowly.
Elevation is 2700 ft.
Nitrite and Nitrate numbers are suspect due to bad reagents!
* indicates disolved oxygen measured with Winkler titration

Sample	Temp.	Sp cond.	pH	[H+]	DO	Eh	NH4mv	NH4+	IC ppm
aways average	17.3	1461	7.3	0.0	3.7	110.5	84.5	1.3	115.37
awas std. dev.	2.35	388	0.22	3E-08	1.37	53.46	24.158	1.7	37.47
middles average	17.2	1296	7.4	0.0	2.9	114.4	104.3	1.1	89.93
middles std. dev	1.83	420	0.25	3E-08	1.37	51.15	25.933	1.7	45.87
IAS	16.5	1333	7.4	4E-08	*1.1	168.7	107	0.2	130.90
IAD	21.8	1686	7.16	7E-08	*0.6	90.7	61	0.6	150.10
IBS	20.9	1187	7.5	3E-08	2.13	222.0	136	0.3	78.21
IBD	14.9	1525	7.05	9E-08	1.06	60.5	82	4.1	134.40
IIAS	17.3	1175	7.41	4E-08	*0.5	119.4	94	0.2	98.73
IIAD	16.7	1266	7.26	5E-08	*0.2	123.5	62	0.6	124.70
IIBS	18.8	2037	7.03	9E-08	*.1	63.2	62	0.6	179.57
IIBD	16.3	1015	7.61	2E-08	*0.7	166.7	98	0.2	70.68
IIIAS	16.4	2145	6.94	1E-07	3.23	75.5	79	4.7	125.80
IIIAD	14.9	1158	7.36	4E-08	4.23	85.3	104	1.4	61.97
IIIBS	16.7	1005	7.57	3E-08	4.69	84.1	127	0.5	36.68
IIIBD	15.6	1008	7.58	3E-08	3.76	89.6	121	0.6	40.06
RIVER	16.6	964	7.87	1E-08	9.49	177.5	153	0.1	32.16
RC	21.4	1211	8.38	4E-09	*2.6	232.7	160	0.0	32.08

Beach: 71.2L

Date: October 11,1993

Notes: IB wells have been washed away. Probably due to a flash flood in Cardenas Creek. No return channel sample this time.

Sample	Temp.	Sp cond.	pH	[H+]	DO	NH4mv	[NH4]	[NO2]	[NO3]
aways average	16.5	1486	7.2	6.80E-08	1.0	75.8	3.3	0.0	0.0
awas std. dev.	1.24	334	0.27	4.15E-08	1.78	18.437	2.65	0.00	0.06
middles averag	15.3	1375	7.5	4.30E-08	1.8	88.8	2.0	0.0	0.1
middles std. de	0.74	401	0.35	5.03E-08	1.57	18.184	1.84	0.00	0.07
IAS	17.8	1305	7.4	4.47E-08	4.2	104	0.63	0.00	0.00
IAi	18.8	1475	7.5	3.31E-08	0.4	87	1.43	0.00	0.00
IAD	16.9	1822	7.1	7.76E-08	2.0	51	8.03	0.00	0.00
IIAS	15.8	1207	7.5	3.39E-08	0.5	86	1.50	0.00	0.00
IIAD	15.3	1211	7.3	5.62E-08	0.4	60	5.22	0.00	0.00
IIBS	16.0	2090	7.0	1.00E-07	0.0	59	5.47	0.00	0.18
IIBD	15.3	1169	7.7	2.19E-08	4.1	90	1.24	0.00	0.02
IIIAS	16.4	1620	6.8	1.45E-07	0.0	73	2.80	0.00	0.00
IIIAD	14.8	1160	7.3	5.37E-08	0.3	86	1.50	0.00	0.00
IIIBS	15.3	1212	7.6	2.63E-08	1.6	112	0.43	0.00	0.02
IIIBD	14.4	1030	7.6	2.40E-08	1.4	94	1.02	0.00	0.02
RIVER	12.6	989	8.2	6.92E-09	9.4	141	0.11	0.01	0.40

Beach: 71.2L
Date: January 7,1994
Notes:

Sample	T(C)	Sp cond.	pH	[H+]	DO	IC ppm
aways average	11.0	1391	7.3	5.11E-08	0.9	108.2
awas std. dev.	0.89	282	0.23	3.23E-08	0.58	41.789
middles average	10.8	1299	7.5	4.29E-08	1.2	93.2
middles std. dev.	0.93	336	0.36	4.41E-08	0.79	47.323
IAS	11.0	1404	7.39	4.07E-08	1.4	124.9
IAi	9.8	1504	7.49	3.24E-08	0.8	133.2
IAD	11.3	1810	7.33	4.68E-08	1.1	151.1
IIAS	11.6	1210	7.47	3.39E-08	1.2	70.909
IIAD	12.5	1264	7.27	5.37E-08	0.6	115.76
IIBS	11.6	1906	6.96	1.10E-07	0	170.05
IIBD	11.5	1152	7.61	2.45E-08	1.4	68.4
IIIAS	9.7	1442	6.96	1.10E-07	0	119.12
IIIAD	11.1	1103	7.39	4.07E-08	1.5	42.59
IIIBS	9.4	1148	7.68	2.09E-08	1.7	76.99
IIIBD	10.5	991	7.78	1.66E-08	1.5	57.4
RIVER	9.0	879	8.10	7.94E-09	9.6	25.83

Beach: 194L
Date: April 27,1993
Notes:

Sample	Temp.	Sp cond.	pH	[H+]	Eh	NO2	NO3
aways average	20.3	1143.6	7.6	3.06E-08	190.4	0.0	0.1
awas std. dev.	2.442847	233.973	0.27	1.3E-08	108.173	0.0051	0.1884
middles average	21.2	1061.7	7.9	1.54E-08	359.3	0.0	0.1
middles std. dev.	2.655742	255.152	0.28	1.30E-08	107.733	0.0049	0.1926
close average	22.7	1002.5	8.0	1.18E-08	374.1	0.0	0.2
close td. dev.	2.74126	270.95	0.29	1.35E-08	108.989	0.0054	0.1978
Avg. surface wat	19.8	1055.0	8.3	5.07E-09	340.9	0.0	0.8
Std.dev.	1.06066	21.2132	0.01	8.25E-11	82.7315	0	0.0484
50AD	20.8	1015	7.39	4.07E-08	137.50	0.00	0.00
100AS	23.0	1185	7.65	2.24E-08	222.50	0.00	0.00
100AD	20.5	985	7.89	1.29E-08	245.50	0.00	0.06
100BS	22.0	1340	7.60	2.51E-08	385.10	0.00	0.04
100BD	21.5	1190	7.66	2.19E-08	287.10	BDL	0.29
100CS	27.5	1230	7.87	1.35E-08	372.10	BDL	0.67
100CD	25.3	1100	8.02	9.55E-09	390.10	BDL	0.47
200AS*	21.0	1550	7.28	5.25E-08	111.00	0.00	0.22
200AD	21.3	1220	7.76	1.74E-08	368.50	0.00	0.26
200BS	21.5	1395	7.70	2.00E-08	369.50	0.00	0.20
200BD	20.5	1140	8.00	1.00E-08	339.20	0.01	0.18
200CS	20.0	1145	7.68	2.09E-08	372.80	0.00	0.22
200CD	20.0	905	8.05	8.91E-09	346.80	0.01	0.08
300AS1*	18.0	960	7.52	3.02E-08	131.41	0.00	0.00
300AS2*	17.5	1090	7.42	3.80E-08	116.41	BDL	BDL
300BS	19.0	650	7.99	1.02E-08	401.50	0.02	0.06
300BD	22.7	655	8.28	5.25E-09	373.50	0.00	0.00
300CS	20.0	975	7.93	1.17E-08	367.50	0.01	0.01
300CD	23.5	660	8.19	6.46E-09	395.50	0.00	0.04
EM	20.5	1070	8.29	5.13E-09	399.40	0.00	0.76
HM	19.0	1040	8.30	5.01E-09	282.40	0.00	0.83

Beach: 194L
Date: July 20 and 21,1993
Notes:

Sample	T(C)	Sp cond.	pH	[H+]	DO	NH4mv	[NH4+]	[NO2]	[NO3]	IC ppm
Aways averag	18.9	1447.7	7.3	4.96E-08	2.7	103.9	1.3	0.0	0.0	81.3
Aways std. de	1.9	412.2	0.3	1.79E-08	1.2	29.0	0.8	0.0	0.0	28.0
Mid average	20.7	1016.0	7.8	2.10E-08	2.5	140.7	0.4	0.0	0.0	59.6
Mid std. dev.	1.9	412.6	0.3	1.77E-08	0.9	25.3	0.6	0.0	0.0	18.8
Close average	21.1	1027.2	7.8	1.88E-08	3.1	154.8	0.1	0.0	0.0	51.9
Close std. dev	1.9	472.4	0.3	1.86E-08	0.8	25.9	0.6	0.0	0.0	16.2
Avg. surface	18.5	943.5	8.3	4.95E-09	8.0	165.5	0.1	0.0	0.1	30.5
Std.dev.	0.4	0.7	0.0	8.07E-11	0.2	14.8	0.1	0.0	0.0	1.9
50AD	18.4	1657	7.2	5.9E-08	1.2	85.00	2.42	0.00	0.00	138.2
100AS	18.9	1716	7.4	3.6E-08	5.7	89.00	2.05	0.00	0.00	113.8
100AD	17.2	919	7.3	4.8E-08	3.0	97.00	1.47	0.00	0.00	49.96
100BS	18.2	1403	7.4	3.8E-08	2.1	148.00	0.18	0.00	0.00	74.05
100BD	18	1423	7.5	3.2E-08	1.2	104.00	1.10	0.00	0.00	99.25
100CS	21.7	1427	7.6	2.8E-08	4.8	159.00	0.11	0.04	0.03	50.98
100CD	19.9	1313	7.7	2.1E-08	2.7	141.00	0.23	0.03	0.03	78.23
200AS*	21.6	1677	7.1	7.2E-08	1.8	87.20	2.21	0.00	0.00	93.3
200AD	19.4	2003	7.4	4.5E-08	2.7	138.00	0.27	0.00	0.00	56.42
200BS	21.7	1278	7.6	2.3E-08	2.1	165.90	0.08	0.02	0.03	51.86
200BD	19.6	974	7.8	1.6E-08	3.0	113.10	0.75	0.00	0.02	55.87
200CS	20.3	1162	7.6	2.4E-08	2.7	165.00	0.09	0.02	0.02	52.28
200CD	18.9	1232	7.8	1.5E-08	2.4	130.00	0.37	0.00	0.00	53.46
300AS1*	18.5	809	7.5	3.5E-08	2.4	125.50	0.26	0.00	0.03	48.57
300AS2*	18.4	1353	7.3	5.1E-08	2.4	105.40	0.67	0.00	0.00	69.05
300BS	24.2	515	8.0	1.1E-08	3.9	152.00	0.08	0.00	0.08	37.78
300BD	22.4	503	8.2	6.5E-09	2.7	161.30	0.05	0.00	0.11	38.93
300CS	23.5	529	7.8	1.7E-08	3.0	168.90	0.03	0.00	0.06	40.75
300CD	22.4	500	8.1	8.9E-09	3.0	165.00	0.04	0.00	0.07	35.77
BM	18.2	943	8.3	5E-09	8.1	155.00	0.13	0.04	0.06	29.19
HM	18.8	944	8.3	4.9E-09	7.8	176.00	0.05	0.02	0.11	31.81

Beach: 194L
Date: October 21,1993
Notes: 100CS is dry at beginning of sampling

Sample	Temp.	Sp cond.	pH	[H+]	DO(ml)	NH4+	[NO2]	[NO3]
aways average	18.9	1210.0	6.9	1.51E-07	1.0	0.0	0.0	0.1
awas std. dev.	1.58	302.576	0.26	6.23E-08	0.5431	0.0302	0.0401	0.0726
middles average	21.6	945.8	7.1	8.66E-08	1.5	0.0	0.1	0.1
middles std. dev.	1.39	251.447	0.26	6.34E-08	0.5093	0.0146	0.0402	0.0631
close average	21.4	1081.2	7.2	7.46E-08	1.9	0.0	0.1	0.2
close td. dev.	1.75	297.752	0.25	6.14E-08	0.4665	0.0148	0.0395	0.0586
Avg. surface wate	15.9	966.5	8.2	7.23E-09	9.6	0.0	0.1	0.5
Std.dev.	0.49	3.53553	0.13	2.09E-09	0.1414	0	0.0424	0.1838
50AD	17.8	1773	6.76	1.74E-07	0.3	0.12	0	0
100AS	18.6	1476	7.22	6.03E-08	1.3	0.03	0.01	0
100AD	18.2	917	7.29	5.13E-08	1.1	0.02	0.01	0.16
100BS	21.6	1201	6.94	1.15E-07	0.7	0	0.1	0.15
100BD	20.2	1201	7.34	4.57E-08	1.1	0.01	0	0.02
100CS	19.7	1287	7.12	7.59E-08	2	0	0.09	0.18
100CD	20.7	1055	7.52	3.02E-08	1.8	0	0.06	0.21
200AS*	20.1	NA	6.6	2.51E-07	0.4	0.05	0	0.01
200AD	20.6	1070	6.74	1.82E-07	0.9	0.01	0	0.08
200BS	20.8	1023	7.04	9.12E-08	1.6	0	0.03	0.2
200BD	20.9	931	7.07	8.51E-08	1.7	0.01	0.03	0.12
200CS	20.6	1488	7.1	7.94E-08	1.8	0	0.04	0.21
200CD	20.1	1402	7.26	5.50E-08	1.8	0	0.01	0.15
300AS1*	18.7	992	6.75	1.78E-07	1.2	0.01	0.09	0.16
300AS2*	18.5	1032	6.8	1.58E-07	1.9	0.03	0.05	0.11
300BS	24	775	6.89	1.29E-07	1.9	0	0.09	0.11
300BD	22.3	544	7.27	5.37E-08	1.7	0	0.11	0.14
300CS	24	756	6.9	1.26E-07	2.1	0	0.1	0.19
300CD	23.2	499	7.09	8.13E-08	1.7	0	0.1	0.21
BM	16.2	964	8.06	8.71E-09	9.5	0	0.13	0.63
HM	15.5	969	8.24	5.75E-09	9.7	0	0.07	0.37
100 CD dup	21.5	1289	7.41		1.6	0	0.13	0.2
Blank	20.4	0.002	na			0		

Beach: 194L

Date: January 13,14, and 15, 1994

Notes:

Sample	Temp.	Sp cond.	pH	[H+]	DO(ml)	NH4mv
aways average	13.1	1301	7.7	2.20E-08	1.3	96.9
awas std. dev.	1.57	413	0.24	8.93E-09	0.6	19.6
middles average	14.5	1078	7.9	1.73E-08	1.9	120.7
middles std. dev.	1.69	410	0.24	8.25E-09	0.6	17.8
close average	14.5	990	7.8	1.54E-08	2.1	133.0
close td. dev.	2.25	401	0.23	6.97E-09	0.7	18.0
Avg. surface wat	10.3	1345	7.7	1.88E-08	1.4	123.9
Std.dev.	4.38	90	0.12	5.13E-09	0.6	10.0
50AD	14	1841	7.42	3.80E-08	0.6	77.7
100AS	12.4	1180	7.67	2.14E-08	1.9	96
100AD	13.1	841	7.78	1.66E-08	2.1	100.2
100BS	12.3	1946	7.46	3.47E-08	2.3	128
100BD	14.8	1333	7.7	2.00E-08	1.6	96
100CS	12.2	1284	7.74	1.82E-08	2.3	139
100CD	14.1	1400	7.82	1.51E-08	2.2	119
200AS*	10.4	1502	7.5	3.16E-08	1.3	93.9
200AD	13.9	1794	7.87	1.35E-08	1.1	97.7
200BS	13.3	1150	7.64	2.29E-08	2.7	131
200BD	13.8	943	7.86	1.38E-08	2	101
200CS	12.1	906	7.65	2.24E-08	2.3	142
200CD	13.9	1289	7.91	1.23E-08	1.7	121
300AS1*	14.4	1006	7.78	1.66E-08	0.4	114
300AS2*	13.2	943	7.78	1.66E-08	1.4	99
300BS	15.6	570	8.07	8.51E-09	1	125
300BD	17.4	524	8.42	3.80E-09	2	143
300CS	15	557	7.79	1.62E-08	2.6	137
300CD	19.5	504	8.1	7.94E-09	1.7	140
100CS	7.2	1281	7.65	2.24E-08	1.8	131
100CD	13.4	1408	7.82	1.51E-08	1	116.8
200CS	13.9	948	7.67	2.14E-08	2.2	135
200CD	11.7	1280	7.94	1.15E-08	1.8	123.4
300CS	11.1	572	7.79	1.62E-08	3.8	128
300CD	18.9	508	8.04	9.12E-09	2	130
EM	9.3	867	8.45	3.55E-09	10.3	136
HM	9.5	866	8.45	3.55E-09	10.2	138