SPECIAL STUDIES

THE EFFECT OF INFLOW LOCATION ON BEAR LAKE MARSH MASS BALANCES

Prepared for:

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1.0 INTRODUCTION

As a result of several investigations on the nutrient budgets of the large marsh complex at the north end of Bear Lake (ERI 1982; USF&WS 1985), the potential of utilizing its ability to remove nitrogen and phosphorus has been suggested. During the spring when Bear River water is passing through the marsh and into Bear Lake, nitrogen and phosphorus have been reduced significantly within the marsh complex. In addition, these studies noted that water passing through the causeway had less nutrients than water passing through Lifton station.

In order to confirm these results and to develop possible low cost management options, a special study was undertaken to quantitatively determine the effect of water entrance point on nutrient removal. The objectives of this special study were:

(1) Design and implement a sampling program which will allow a direct comparison between Lifton station and the causeway on nutrient mass loading to Bear Lake and

(2) Develop low cost management options which may reduce these nutrient loadings.

This study was undertaken on May 14, 1991. PacifiCorp Electric Operations helped in the design and implementation of the study. Their cooperation and participation was critical in the successful conclusion of the special studies monitoring program.

2.0 METHODS

The experimental design for monitoring water quality of the Bear River before and after it flowed through the Bear Lake Marsh can be seen in Table 2-1. The experiment called for grab samples to be collected twice daily (800 and 1600 hrs) over a three day period at one of two outflowing locations. In addition at 10:00, Bear River water flowing into the marsh was sampled. The first set of samples attempted to document the effect of water flowing through Lifton station and were collected from May 14-16, 1991. The second set of samples were collected at the causeway from May 20-22, 1991.

Samples were preserved and placed on ice for transport to the laboratory. Parameters included nitrate, nitrite, ammonia, total nitrogen, total phosphorus, and ortho phosphate.

TABLE 2-1. The experimental design for the Bear Lake marsh special studies.

DATE	TIME	LIFTON TAILRACE	GAUGE 12	CAUSEWAY	SPECIAL INSTRUCTIONS
5/14 Tuesday	8:30 a.m.	*	275 cfs		
	10:00 a.m.				
	4:00 p.m.	*			
5/15 Wednesday	8:30 a.m.	*	277 cfs		
	10:00 a.m.				
	4:00 p.m.	*			
5/16 Thursday	8:30 a.m.	*	257 cfs		
	10:00 a.m.				
	4:00 p.m.	*			
5/17 Friday	9:00 a.m.				Close sluice open causeway
5/20 Monday	8:30 a.m.		293 cfs	*	
	10:00 a.m.				
	4:00 p.m.			*	
5/21 Tuesday	8:30 a.m.		260 cfs	*	
	10:00 a.m.				
	4:00 p.m.			*	
5/22 Wednesday	8:30 a.m.		255 cfs	*	
	10:00 a.m.				
	4:00 p.m.			*	

3.0 RESULTS

The results of the mass balance experiment can be seen in figures 3-1, 3-2, and 3-3. Instantaneous mass balances for nitrite (mg/sec) ranged from 0 (in balance) to -7.27 mg/sec when water was flowing through Lifton station. Negative values indicate that the marsh is removing nutrients while positive values indicate that the marsh is a source. While flowing through the causeway, nitrate loadings ranged from +8.29 to -14.72 mg/sec. No temporal pattern was evident for nitrite.

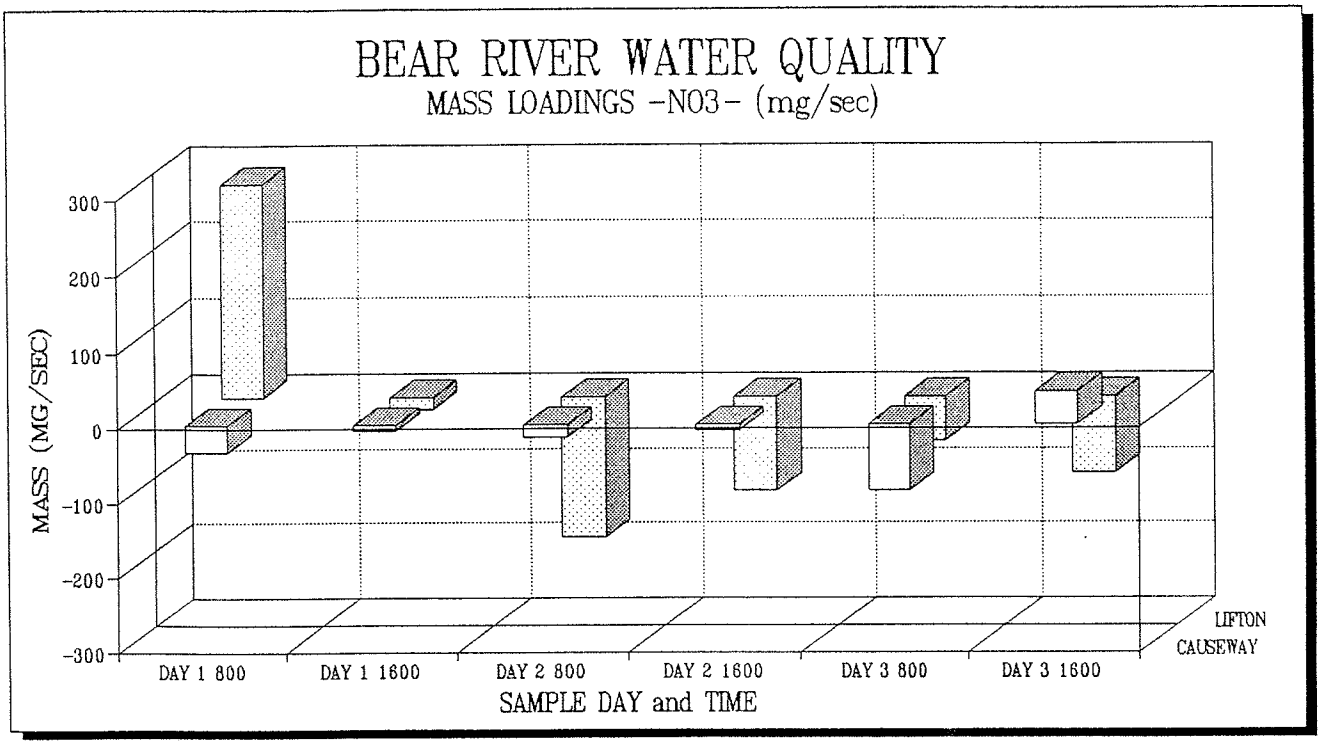
Nitrate had a significantly higher magnitude of mass gains and losses. The Lifton station treatment had a range of +280.17 to -188.14 mg/sec with most sample times showing a mass loss in the marsh. Although differing in magnitude, (+43.30 to -88.30), the causeway treatment had a similar temporal pattern for the three day experiment.

The sum of all the dissolved inorganic fractions (NO_2 + NO_3 + NH_3) is represented by total inorganic nitrogen (TIN). Because, inorganic nitrogen can change forms rapidly, this value represents the total available nitrogen to the plants in the aquatic system. The ranges and temporal patterns between the two treatments were very similar with the causeway having a slightly higher removal rate. The range for Lifton station was +280.17 to -1403.7 mg/sec while the causeway range was +527.77 to -701.70 mg/sec.

Total nitrogen (the sum of all nitrogen components in the system) represented the greatest difference between treatments. The data indicates that during the time when water was passing through the causeway, the marsh was consistently a source for nitrogen (over the six sample times). Only during one period was the marsh a sink (-2302 mg/kg) while the remaining five periods had +4875 to +6482 mg/sec (sources) of nitrogen. During the Lifton treatment the range was +1081 to -690 mg/sec, significantly different than the causeway treatment.

The phosphorus fractions (ortho phosphate and total phosphorus) displayed different temporal patterns. The ortho phosphate mass balances for the two treatments tended to be near balance with a range at Lifton of --15.6 to 21.8 mg/sec and a range at the causeway of 0 to 29.4. However, most values were near 0 (no net changes).

Total phosphorus mass balances for both treatments represented the most consistent pattern of all the water quality parameters measured. The mass balances for all sample dates were always less than or equal to



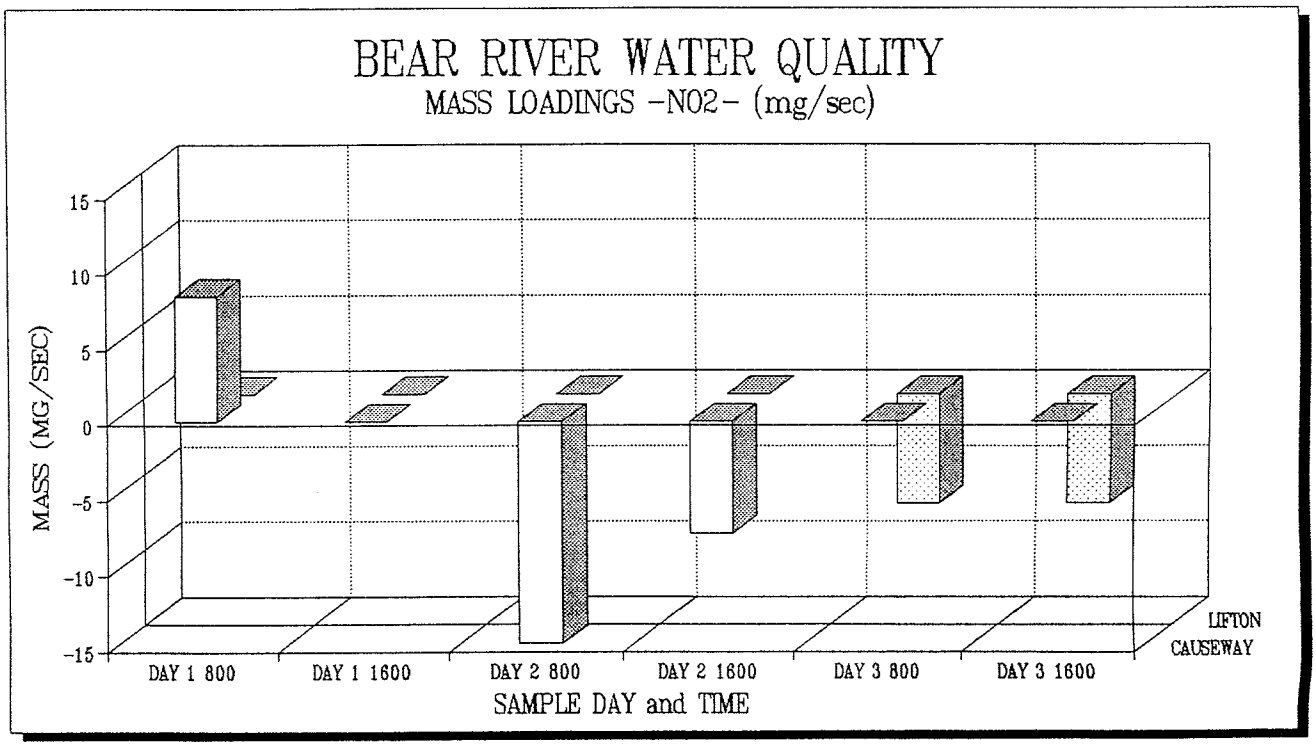
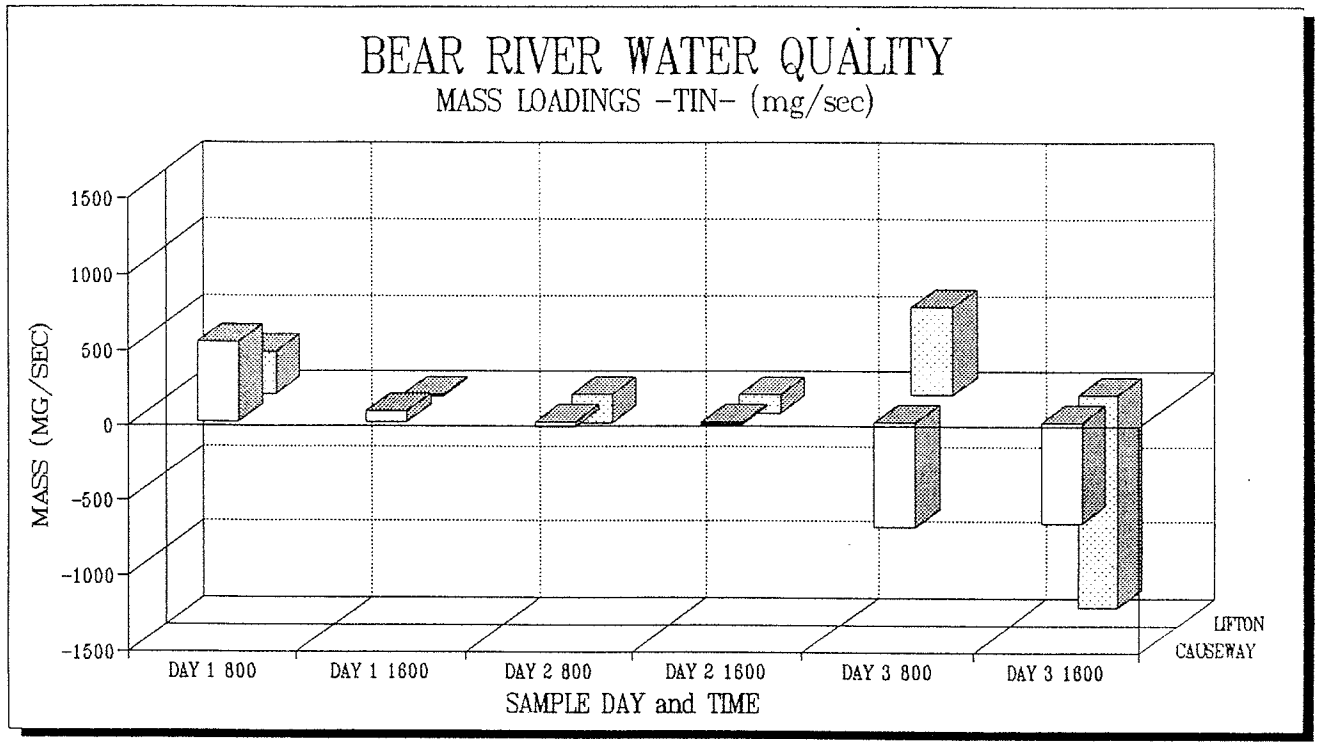


FIGURE 3-1. The Bear Lake marsh mass balances for nitrate (above) and nitrite (below) for outflows at Lifton station or the causeway during the two sets of three day experiments.



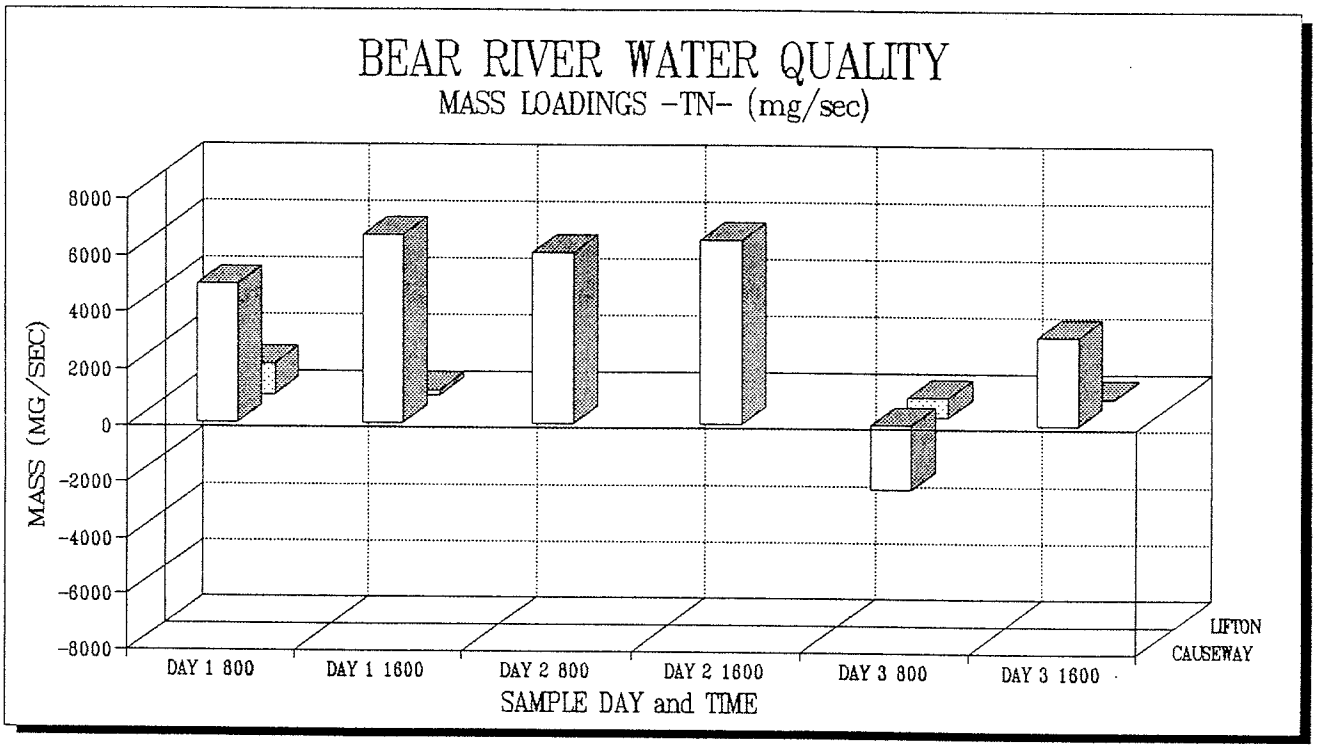
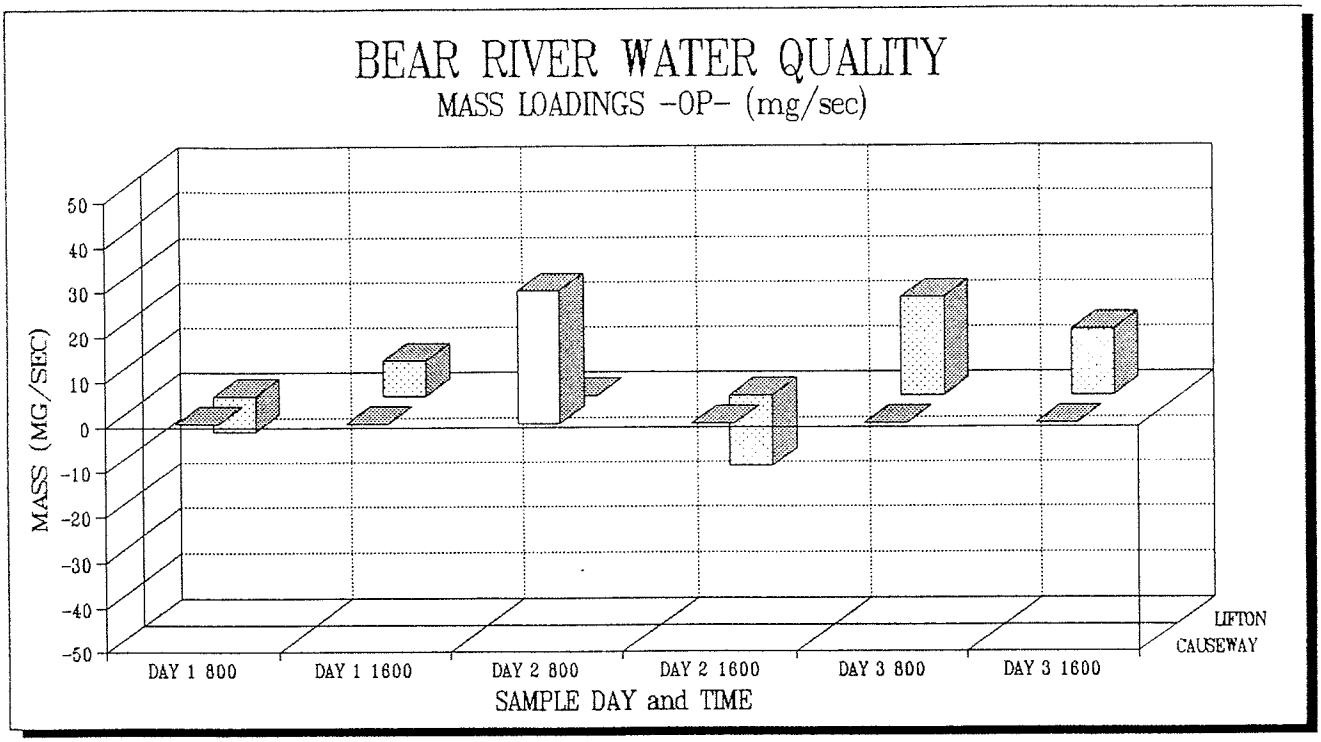


FIGURE 3-2. The Bear Lake marsh mass balances for total inorganic nitrogen (above) and total nitrogen (below) for outflows at Lifton station or the causeway during the two sets of three day experiments.



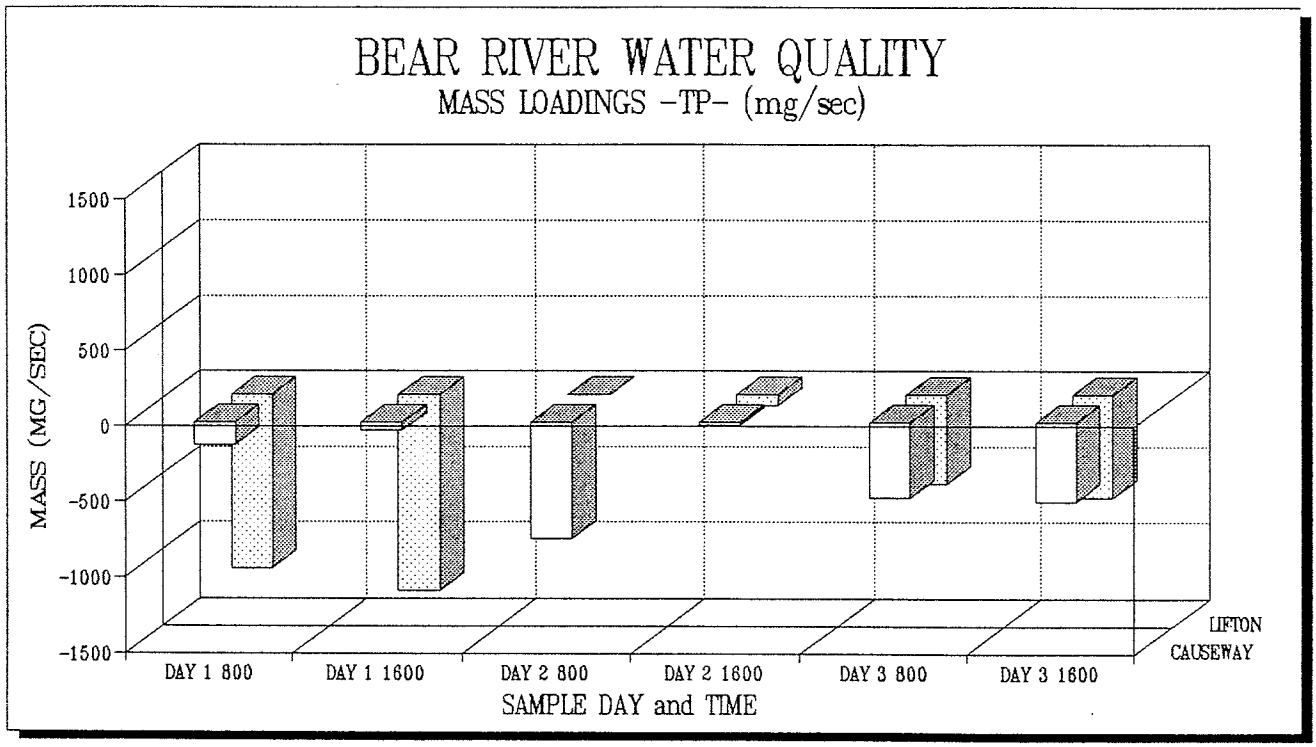


FIGURE 3-3. The Bear Lake marsh mass balances for ortho phosphate (above) and total phosphorus (below) for outflows at Lifton station or the causeway during the two sets of three day experiment.

zero, indicating the marsh was a sink for phosphorus. The range at Lifton was 0 to -1291 mg/sec and at the causeway -49 to -526 mg/sec.

4.0 DISCUSSION AND CONCLUSION

As noted in the introduction of this report, one objective of this investigation was to quantitatively document the effect of different discharge locations on the mass balances of the Bear Lake marsh. A summary of this objective can be seen in Table 4-1. The data indicates that the causeway treatment removed more nitrite, ammonia, and total inorganic nitrogen, while the Lifton treatment removed more nitrate, total nitrogen, total phosphorus and orthophosphate.

Upon inspection of the flow data, the results of this investigation are explainable. During the experiment the flows ranged between 255 cfs and 293 cfs (Table 2-1). At these flow ranges, the turnover time in the inflow canal at Lifton would be less than one week while the turnover time at the causeway would be greater than 30 days. The result of these flows on the experiment would be to underestimate the effect of the causeway treatment. In hindsight, two precautions would have improved the experiment. (1) run the experiment at flows grater than 1000 cfs or (2) wait 2-3 weeks between treatments to allow the Mud Lake waters to flush from the system. It was the resident Mud Lake water that was sampled during the causeway treatment (see the total nitrogen data) and not passed through Bear River water. After 1-2 weeks of causeway flows, visual inspection of the water at the causeway indicated significantly better water quality when compared to water flowing through Lifton Station at the same time.

In conclusion, it is recommended that the experiment be conducted in 1992 with the sample design changed to include either higher flows, longer sample periods, or simultaneous inflows at Lifton and the causeway.

TABLE 4-1. The total net mass loadings (kg/day) entering Bear Lake through Lifton station or the causeway during the special study.

	Parameter (kg/day)						
LOCATION	NO_2	NO_3	NH_3	TIN	TN	TP	OP
Lifton	-0.0093	-0.283	+0.281	-0.012	0.731	-3.163	+0.013
Causeway	-0.0193	-0.138	-0.426	-0.583	23.360	-1.689	+0.031